RESEARCH ARTICLE

Evaluation of the quality characteristics of fermented sausages and sausage-like products sold in Kars

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Received: 03.03.2013, Accepted: 24.04.2013
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Özet

Sezer Ç, Aksoy A, Çelebi Ö, Deprem T, Öğün M, Bilge Oral N, Vatansever L, Güven A. Kars'ta satışa sunulan fermente sucuk ve sucuk benzeri ürünlerin kalite kriterlerinin belirlenmesi. **Eurasian J Vet Sci, 2013, 29, 3, 143-149**

Amaç: Bu çalışmada Kars ilinde yerel kasapların geleneksel yöntemle ürettikleri fermente sucuklar ile marketlerden temin edilen sucuk ve sucuk benzeri ürünlerin mikrobiyolojik, fizikokimyasal ve histolojik kalitelerinin belirlemesi amaçlandı.

Gereç ve Yöntem: Fermente sucuk (n: 30) ve ısıl işlem görmüş sucuk benzeri ürün (n: 10) olmak üzere farklı firmalara ait tüm örnekler, şehir merkezindeki kasap ve marketlerden aynı gün içerisinde temin edildi. Mikrobiyolojik kriterler petri plak yöntemi ile histolojik kalite Crossman triple boya ve hematoxylin-eosin boya yöntemi ile fizikokimyasal kriterler ise gravimetrik ve spektrofotometrik yöntemler ile analiz edildi.

Bulgular: Biri ısıl işlem görmüş sucuk diğeri fermente sucuk olmak üzere 2 örnekte *Escherichia coli* belirlendi. Örneklerde *Clostridium perfringens* ve *E. coli* O157:H7 identifiye edilmedi. Fermente sucukların 4 tanesinde (%10) *Listeria monocytogenes*, 2 tanesinde ise (%5) *Salmonella* spp identifiye edildi. Örneklerin nitrat ve nitrit seviyeleri sırasıyla 14.88-943.71 mg/kg ve 0.46-378.16 mg/kg olarak belirlendi. Örneklerin 13 tanesinde (%32.5) epitel doku, 11 örnekte (%27.5) çoğunluğu serö-muköz karakterde bez epiteline rastlandı. Örneklerin 5 adedinde (%12.5) düz kas dokusu ile kıkırdak ve kemik dokusu belirlendi.

Öneri: Analiz edilen örneklerin tamamının standartların belirttiği özellikleri taşımadığı tespit edilmiştir. Bu sonuç üretimin ve üretim sonrası denetimlerin çok önemli olduğunu göstermektedir.

Anahtar kelimeler: Fermente sucuk, sucuk benzeri ürün, histolojik kalite, fizikokimyasal kalite, mikrobiyolojik kalite

Abstract

Sezer C, Aksoy A, Celebi O, Deprem T, Ogun M, Bilge Oral N, Vatansever L, Guven A. Evaluation of the quality characteristics of fermented sausages and sausage-like products sold in Kars. **Eurasian J Vet Sci, 2013, 29, 3, 143-149**

Aim: This study was conducted for the purpose of identifying the microbiological, physico-chemical and histological aspects of quality criteria in sausage-like products obtained from local markets and different samples of fermented sausages produced using traditional methods by local butcher shops in the province of Kars.

Materials and Methods: Sampling was made during just one day and all the fermented sausages (n:30) and cooked sausage-like products (n:10) were purchased from all butchers and market points in Kars city centre. Microbiological analysis was performed by spread and/or pour plate techniques. Histological analysis was performed by Crossman triple stain and hematoxylin-eosin stains. Physico-chemical analysis was performed by gravimetric and spectrophotometric methods.

Results: *Escherichia coli* was identified in one of the cooked sausage-like products and in one sample of fermented sausage. Neither *Clostridium perfringens* nor *E. coli* O157:H7 were identified in any of the samples. *Listeria monocytogenes* was isolated in four (10%) of the fermented sausage samples and *Salmonella* spp in two fermented sausage samples (5%). Nitrate and nitrite levels in the sausage were found to be 14.88–943.71 mg/kg and 0.46-378.16 mg/kg, respectively. Thirteen (32.5%) of the sausage samples that were examined contained epithelial tissue, 27.5% (11 samples) contained glandular epithelial tissue, which was mostly seromucous in nature, and five (12.5%) contained cartilage and bone tissue with smooth muscle tissue.

Conclusion: None of the sausage samples met the requirements of the standards. This shows that controlled production and post-production inspection are very important.

Keywords: Fermented sausage, sausage-like product, histological quality, physico-chemical quality, microbiological quality.

Introduction

Sausage is a meat product obtained by filling either natural or artificial casings with a sausage mixture prepared from the carcasses of healthy feedstock animals and/or buffalo slaughtered in government or private slaughterhouses, after which it is cured for a specified period of time (Anonymous 2002).

In general, two kinds of sausages are produced in Turkey; heat treated sausage-like product and traditional fermented sausage. Fermented sausage is a meat product that is ripened at industrial or spontaneous conditions. The sausage-like product is described as a meat product that is heat treated after casing and being partially ripened as a mixture of meat, spices and additives (Anonymous 2002, Anonymous 2007).

These types of sausages have different chemical, microbiological and sensorial features specifically taste, flavour and texture. Even though this meat product, which is extremely popular in Turkey, is produced in modern facilities as a safe, high-quality product, it can also be produced in small businesses or illegal facilities with non-standard methods that do not utilise the required technology and hygiene standards. A number of factors affect the quality of the sausage including the use of low-quality meat as a raw ingredient, high levels of fat, meat from different animals, internal organs, the use of poor quality spices and the improper or excessive use of additives, which in turn poses a risk to human health (Sancak et al 1996, Atasever et al 1999, Erdoğrul 2002, Sancak et al 2008). A number of studies have been conducted on fermented sausage in our country. The results of these studies show that pathogens have been isolated in ready-to-eat sausage samples, which fell far short of standards and which demonstrated poor microbiological and organoleptic quality (Güven and Patır 1998, Çon et al 2002, Doğu et al 2002).

This study was conducted for the purpose of determining the microbiological, physico-chemical and histological quality of ready-to-eat sausages made using traditional methods by local butcher shops in the province of Kars.

Materials and Methods

Sampling was made during just one day and all the fermented sausages (n: 30) and cooked sausage-like products (n: 10) were purchased from all butchers and market points in Kars city centre. Each sample was different, representing just one butcher or company. Sample products were transported to the laboratory while kept in the cold chain then stored at 4°C for the duration of the study.

Microbiological analyses

Twenty-five grams were weighed from the samples and homogenised with 225 mL of sterile saline solution. After homogenisation was complete, decimal solutions of the samples were prepared and inoculated using spread and/or pour plate techniques under the following incubation conditions: Plate Count Agar (Oxoid CM 325) 30°C/48 hours for Total Mesophilic Aerobic Colony count; Violet Red Bile Lactose Agar (Oxoid CM 107) 37°C/24 hours for Coliform Group Bacteria; Violet Red Bile Lactose Agar (Oxoid CM 107) 44.5°C/24-48 hours for *E. coli*; Potato Dextrose Agar (Difco B 13) 22°C/5-10 days for Yeast-Mold; Perfringens Agar (Oxoid, CM 0543) with selective supplement A and B (Oxoid, SR0076 and SR0077) 35°C/18-24 hours (Anaerobic) for *C. perfringens*; and Baird Parker Agar (Oxoid, CM 275) 37°C/24-48 hours for *Staphylococcus aureus* (Harrigan 1998, Halkman 2005). The colonies growing on VRBA after being incubated at 44.5°C and having the same qualifications as coliforms were identified as *E. coli* after applying Gram staining, Indole, Methyl Red, Voges-Proskauer, citrate, gas production from glucose and lactose, motility and lysine decarboxylase tests (Harrigan 1998, Halkman 2005). Gram staining, catalase, motility, nitrate reduction, Reverse CAMP, gelatine hydrolysis, lactose fermentation, acid phosphatase identification tests were applied to the typical black colonies with 2-4 mm diameter grown on Perfringens Agar (Harrigan 1998, Rhodehamel and Harmon 2001, Halkman 2005). The black colonies with 1-1.5 mm diameter and surrounded by a zone indicating lecithinase activity were identified as *S. aureus* after applying Gram staining, catalase, coagulase, glucose and mannitol fermentation and termonuclease tests (Harrigan 1998, Bennett and Lancette 2001, Halkman 2005).

Isolation of Salmonella spp.

Twenty-five grams were weighed from the sausage sample, homogenised with 225 mL of Buffered Peptone Water (Oxoid, CM0509) and incubated for 24 hours at 37°C. At the end of the incubation period, while 0.1 mL of enriched culture was inoculated in 10ml of Rappaport Vassiliadis Broth (Oxoid, CM 669) and incubated for 18-24 hours at 42°C, 1 mL of the same culture was inoculated in 10ml of Muller- Kauffman tetrathionate / novobiocin broth (Oxoid CM 1048) and incubated for 24 hours at 37°C. This step was followed by inoculation of selective agars, Brilliant Green Agar (Oxoid, CM 263), Hektoen Enteric Agar (Oxoid, CM 419), Xylose Lysine Deoxycholate Agar (Oxoid, CM 469) using the spread technique and incubation of them for 18-24 hours at 37°C. Ten colonies were removed from each typical colony that reproduced in the Xylose Lysine Deoxycholate Agar and stocked in Nutrient slant agar (Fluka, 70148). Then, biochemical tests were performed for identification. The following tests were conducted and the results evaluated: urea test, formation of acid and gas from glucose, the use of lactose and sucrose and the formation of H2S in Triple Sugar Iron Agar, lysine decarboxylase test, Voges-Proskauer, and Indole. The *Salmonella* latex test (Oxoid FT 203) was applied to the isolates for serological analysis (Andrews and Hammack 1995, ISO 2002).

Isolation of L. monocytogenes

Twenty-five grams were weighed from the sample, homogenized with 225 mL of Listeria Enrichment Broth (Oxoid, CM 862) and incubated for 4 hours at 30°C. The incubation was continued at the same temperature for 24 hours after adding selective supplement (Oxoid, SR 0141). At the end of the incubation period, the enriched culture was inoculated on Listeria Selective Agar (Oxoid, CM 856) using the spread technique and incubated for 72 hours at 37°C. Ten colonies were removed from each typical colony that reproduced in the Listeria selective agar and stocked in Nutrient slant agar. Then, for identification the following biochemical tests were conducted. The following tests were conducted: Gram staining, catalase, oxidase, Indole, Methyl Red, Voges-Proskauer, nitrate reduction, motility, CAMP and carbohydrate fermentation test (Seliger and Jones 1986, Hitchins and Jinneman 2011).

Isolation of E. coli O157:H7

Twenty-five grams were weighed from the sample, homogenized with 225 mL of modified EC broth (mEC+novobiocin/14582, Merck) and then incubated for 18 hours at 37°C. After the enrichment stage, it was spread on Sorbitol Mac Conkey agar (SMAC) with added cefixime and tellurite (CT-SMAC Agar/109207, Merck) and incubated for 18-24 hours at 41-42°C. Sorbitol negative colourless colonies that reproduced in the medium were removed and inoculated into MacConkey Agar (Oxoid, CM007) containing 4-methylumbelliferyl-D-glucuronide (Oxoid, BR0071). After incubation for 18 hours at 41-42°C, MUG negative colonies were selected and stocked in slant agar. The following biochemical tests were conducted on the isolates: Gram reaction, Indole, Methyl Red, Voges-Proskauer, citrate, hydrogen sulphide production, gas production from glucose, lactose, motility and lysine decarboxylase (Harrigan 1998, Halkman 2005, Feng and Weagant 2011).

Physico-chemical Analyses

The salt content in the samples was determined using the modified Mohr technique, while the modified Babcock technique was used for fat content and the gravimetric technique for ash and dry matter. The pH of the samples was measure using a pH meter (Thermo Scientific, Ayer Rajah, Singapore) (AOAC 1990, Gökalp et al 2001). The nitrite and nitrate content of the samples was determined with the spectrophotometric technique reported by Miranda et al (2001).

Histological Analyses

6-8 µm thick slices of the sausage samples were obtained with a freezing microtime (Leica Biosystems, Nussloch, Germany) and placed on slides coated in chrome alum gelatine for the histological analysis. Crossman triple stain and hematoxylin-eosin stains were applied to the slices to examine the histological composition of the sausage. The resulting preparations were examined and photographed in a BX-051 Olympus (Japan) brand research microscope (Luna 1968, Culling et al 1985).

Results

Microbiological Analysis

Sausage-like meat products

E. coli was identified in one of the sausage-like samples. *C. perfringens*, *L. monocytogenes*, *Salmonella* spp, E. coli O157:H7 were not identified in the samples (Table 1).

Fermented sausage

E. coli was identified in one sample of fermented sausage. *C. perfringens* and *E. coli* O157:H7 were not identified in the samples. *L. monocytogenes* was isolated in four of the sausage samples and *Salmonella* spp. in two samples (Table 1).

Table 1. Results of microbiological analysis of 30 fermented and 10 sausage-like products sold in Kars (cfu/g).

Fermented sausage (n:30)				
Microorganism	Min	Max	X	SX
Total mesophilic aerobic colony count	$2.0x10^2$	$8.0x10^7$	$1.7x10^7$	$2.3x10^7$
S. aureus	$4.0x10^1$	$1.3x10^5$	$1.4x10^4$	$3.1x10^4$
Yeast-mold	$1.6x10^3$	$1.2x10^6$	$1.5x10^5$	$3.9x10^5$
Coliform	$4.0x10^1$	$4.9x10^3$	$1.6x10^3$	$1.9x10^3$
E. coli	0	$6.0x10^2$	$2.0x10^1$	$1.1x10^2$
Sausage-like meat products (n:10)				
Total mesophilic aerobic colony count	$4.4x10^2$	$1.2x10^7$	$1.9x10^6$	$4.1x10^6$
S. aureus	0	$1.2x10^4$	$3.2x10^3$	$4.4x10^3$
Yeast-mould	0	0	0	0
Coliform	0	$2.7x10^3$	$2.7x10^2$	$8.5x10^2$
E. coli	0	$4.0x10^2$	$4.0x10^1$	$1.2x10^2$

* Iranian National Standards

Table 2. Results of physico-chemical analysis of 30 fermented and 10 sausage-like products sold in Kars.

Fermented sausage (n:30)				
Criteria	Min	Max	X	SX
Fat (%)	20	58	35.66	9.73
Dry Matter (%)	39.4	52.1	43.69	3.76
Ash (%)	2.77	5.42	3.88	0.57
pH	4.94	6.97	6.18	0.69
Salt (%)	1.4	3.15	2.36	0.46
Nitrate (mg/kg)	14.88	943.71	358.07	245.01
Nitrite (mg/kg)	0.46	196.90	67.25	50.34
Sausage-like meat products (n:10)				
Fat (%)	23	37	30.2	4.79
Dry Matter (%)	31.3	38.9	35.12	2.96
Ash (%)	2.81	6.03	4.02	1.01
pH	6.4	6.92	6.74	0.14
Salt (%)	1.64	3.51	2.77	0.51
Nitrate (mg/kg)	96.72	794.90	502.23	186.64
Nitrite (mg/kg)	25.76	378.16	155.54	115.48

* Iranian National Standards

Physico-chemical Analysis

The results of physic-chemical analysis of fermented sausage and sausage-like samples are presented in Table 2.

Histological Analysis

Sausage-like meat product

As a result of the microscopic examination conducted in the histological examination of the sausage samples, the following tissues types were identified in all samples: collagen fibre, connective tissue, nerve tissue, adipose tissue and skeletal muscle tissue (Table 3).

Fermented sausage

As a result of the microscopic examination conducted in the histological examination of the sausage samples, the following tissues types were identified in all samples: collagen fibre, connective tissue, nerve tissue, adipose tissue and skeletal muscle tissue. In addition, the following were each identified in one different sample: animal hair and hair root, spleen, oesophagus and epithelium from sensory organs. In addition to these tissues, there were lymph nodes and structures that included elastic membranes which should not normally be found in sausage (Table 3).

Table 3. Results of histological analysis of 30 fermented and 10 sausage-like products sold in Kars.

	Fermented Sausage (n:30)	Sausage-like meat products (n:10)
Tissues	Number of Samples in which the Tissue was Found -(Percentage)	
Collagen Fibres	30 (100%)	10 (100%)
Connective Tissue	30 (100%)	10 (100%)
Nerve Tissue	30 (100%)	10 (100%)
Adipose Tissue	30 (100%)	10 (100%)
Epithelial Tissue	8 (26.6%)	5 (50%)
Hair and Hair Root	1 (3.33%)	-
Glandular Epithelium	8 (26.6%)	3 (30%)
Skeletal Muscle	30 (100%)	10 (100%)
Smooth Muscle	4 (13.3%)	1 (10%)
Heart Tissue	-	-
Liver Tissue	-	-
Spleen Tissue	1 (3.33%)	-
Mammary Tissue	-	-
Cartilage and Bone Tissue	2 (6.66%)	3 (30%)

Discussion

Fermented sausage, which is a traditional meat product, is very popular with the public at large. Products packaged and sold on the market as cooked sausage-like products are unfortunately viewed as fermented sausage because the public is not well-informed regarding the matter. There is a huge difference in taste between the two products. Because the local public does not find the taste they expect in these cooked sausages that they view as ready-to-eat sausage, they have trended towards sausages from butcher shops. Local butcher shops offer fermented sausage at affordable prices. However, the pricing does not reflect the quality of the sausage.

The conditions of manufacturing facilities and the production methods seem to be the main reason for the poor quality of the products. In fact, sausage samples obtained from production performed without the use of starter culture with improper technology and poor hygiene relying completely upon an uncontrolled, natural environment are also sold in conditions that fail to meet the required standards. The chemical, physical, organoleptic and microbiological characteristics of these products are extremely diverse.

The total number of mesophilic aerobic colony is not very significant in the evaluation of the microbial quality of fermented products like sausage, even though using this with other criteria provides information about the degree of ripening of sausages. Examination of the total mesophilic aerobic colony numbers in the samples determined that these values varied between 10^2-10^7 cfu/g. In this study, none of the heat treated products had yeasts or moulds meeting the requirements of Turkish standards. However, the fermented sausages had these organisms at 10^6 cfu/g level indicating the negative effect of the lack of heat treatment on product safety. The Yeast¬-Mould count varied between 10^3-10^6 cfu/g, and in 9 samples of fermented sausage (30%) it was determined to have exceeded the limit permitted by the TS 1070 (Anonymous 2005). Atasever et al (1999) found that the total bacteria count of fermented sausages those they examined was 10^6 cfu/g. Çon et al (2002) found that the average total mesophilic aerobic colony count was 10^7 cfu/g while the yeast-mold count was 10^4 cfu/g and *S. aureus* count was 10^4 cfu/g. The results of this study were similar to those we detected in our investigation. *S. aureus* count varied between 10^1-10^4 cfu/g, and in 2 sausage-like samples (20%) it was determined to have exceeded the limit permitted by the TS 13297 (Anonymous 2007). *S. aureus* count varied between 10^1-10^5 cfu/g, and in 5 fermented sausage samples (16.6%) it was determined to have exceeded the limit permitted by the TS 1070 (Anonymous 2002). The total bacteria count of sausages could change depending on the use of starter culture, the ripening method and hygienic conditions at any stage from production to consumption.

In this study, it was found that 4 fermented sausage samples were contaminated with *L. monocytogenes* and 2 samples were carrying *Salmonella* spp. while none of the heat treated sausage-like products had any pathogens. Güven and Patır (1998) isolated *L. monocytogenes* in 7.5% of their sausage samples. Çolak et al (2007) reported isolating *L. monocytogenes* in 21% of their sausage samples. However, Kök et al (2007) stated that they had isolated *L. monocytogenes* in 4% of the samples, *Salmonella* spp. in 5% and *E. coli* in 16% of the samples of sausage they analysed. The results of that study were similar to those we obtained in our investigation indicating that spontaneous fermentation could have health risks for the public. *C. perfringens* could not be identified in this study. Çon et al (2002) were unable to identify *C. perfringens* in 93.33% of the sausage samples, although they reported a probable finding of *C. perfringens* in 6.67% of the samples at a level of 101 cfu/g. Our findings were similar to those detected in the study mentioned above.

Meat products such as salami, unfermented sausage and fermented sausage are very conducive to fraudulent practices. Strict controls should be conducted during the manufacture of these products. In this study, different tissues were identified in the histological examination of the products that were analysed. Similarly, Atasever et al (1999) reported finding organ parts that were not supposed to be included in fermented sausage according to the Regulation and Standard in eighteen (37%) of the forty-eight fermented sausage samples they obtained from the market. In the fifty sausage samples examined by Erdoğrul (2002), cartilage and bone tissue was found in 24%, adipose tissue in 50%, connective tissue in 10% and nerve tissue in 16%. The manufacturing process of sausage makes the product susceptible to deception. In fact, both our findings and the other studies show that it is quite common to add improper additives like tissues other than muscle to sausage mixture to obtain unjustified benefit.

This study demonstrates that all samples fermented sausage and sausage-like meat products complied with the Standards in terms of fat content (Anonymous 2002, Anonymous 2007). Fat content has been a special focus of numerous studies investigating the market. One of the major fraudulent practices employed in sausage production is the use of more fat than is specified in the Turkish Food Codex, although the content is not indicated on the label. This is an economic loss for the consumer. Çon and Gökalp (1998) examined the fat content in 51 sausage samples and reported that the fat content exceeded the limit in 11 samples (21.57%).

Water content is the most important factor affecting shelf-life, texture and microbiological safety in sausage. It is also an important indicator of whether or not the sausage is adequately cured. According to the Standards, dry matter in fermented sausage and sausage-like products processed with heat must be at least 50-60%. It was determined that these samples contained between 31.3% and 52.1% dry matter and that the water levels in the samples exceeded 40%. This

data demonstrates that none of the fermented sausage samples and sausage-like meat products complied with the Standards in terms of water content (Anonymous 2002, Anonymous 2007). Research has also found that the water content is very high (Sancak et al 1996, Çon and Gökalp 1998, Doğu et al 2002). This fact demonstrates that most of the sausages were put on the market before they were properly cured.

It was determined that pH values, which have a significant influence on microbiological safety in cooked sausage, varied between 6.4 and 6.92. According to the TS 13297, the pH value must be less than 5.8 in cooked sausages. The study found that none of the cooked sausages complied with pH values. It was determined that pH values varied between 4.94 and 6.97 in fermented sausage. According to the TS 1070, the pH of fermented sausage must be less than 5.4. The study found that the pH in twenty-two (73.3%) of the fermented samples also failed to meet the TS 1070 standard. The results of various studies conducted on sausage have found that pH values are generally high (Sancak et al 1996, Atasever et al 1998, Çon and Gökalp 1998, Doğu et al 2002). A low pH value is very important in the production of sausage in terms of colour, taste, texture and microbial safety. A high pH value could be attributed to the slow operation of natural flora in connection with a failure to use starter culture and/or putting the sausage on the market before it is fully fermented. Gökalp et al (1999) found that the initial pH level of sausage mixture was 6.1-6.2, decreasing for the duration of ripening. They also declared that the pH level of a good quality sausage must be around 5.1-5.2. A high pH level could indicate spoilage and/or not using starter culture.

The Turkish Food Codex Regulation specifies that residual nitrite content in dried, uncooked and cured meat products at the sales point may not exceed 50mg/kg (100 mg/kg limit in TS 13297) and that residual sodium nitrate not exceed 250mg/kg (Anonymous 1997). The research determined that Nine (90%) of the sausage-like samples contained more residual nitrate than the limits given in the Turkish Food Codex. Eight (80%) sausage-like samples contained more residual nitrite than permitted. Nitrate values in the fermented sausage samples studied ranged from a low of 14.88mg/kg to a high of 943.71 mg/kg. The research determined that 19 (63.3%) of the fermented sausage samples contained more residual nitrate than the limits given in the Turkish Food Codex. Sixteen (53.3%) fermented sausage samples contained more residual nitrite than permitted. Even though the results of studies examining the levels of nitrates and nitrites in sausage vary, it has been determined that residual amounts still exceed the specified limits. Sancak et al (2008) reported nitrite levels in 2.5% of the samples they examined and nitrate levels in 5% of the samples were noncompliant, while Soyutemiz and Özenir (1996) found that 28% of the samples they examined contained nitrate and nitrite amounts that exceeded limits. In view of the fact that nitrate and nitrites pose a risk in terms of the carcinogenic nitrosamine compounds they may produce, both producers and consumers must be better informed regarding this important issue.

A number of studies have been conducted in Turkey to determine the quality of sausages produced and sold in different cities (Sancak et al 1996, Güven and Patır 1998, Atasever et al 1999, Çon et al 2002, Doğu et al 2002). The results of the analyses in these studies have resulted in a wide range of data. A number of factors, such as failure to use a standard technique in production, fermentation performed without controlling the environment and especially the sale of sausages before the curing and/or ripening process is completed can result in different values in terms of both physico-chemical characteristics and microbial loads.

Conclusions

Commonly, heat treated sausage-like meat products are considered to be safer in microbiological aspect in comparison to fermented sausages. In light of the findings of this study conducted to determine the quality and safety of fermented sausages produced using traditional methods in butcher shops in the province of Kars, none of the sausage samples and sausage-like samples met the requirements of the Sausage Standard and Sausage-Like Meat Product Standard in terms of microbiological, physico-chemical and histological criteria. This shows that controlled production and post-production inspection are very important. Considering that the consumption of these meat products is quite common, in order to protect public health, it is mandatory that they must be produced using proper technology in hygienic conditions, good quality raw material must be used, controlled fermentation that gives desired taste and texture must be applied, qualified personnel must be employed at every stage in the production and strict inspections and laboratory tests must be conducted regularly at both small and large-scale operations. It is also important that adequate heat treatment must be applied to sausage-like products and they must be protected from recontamination. Routine analysis by researchers would be useful to attract the attention of both producers and consumers to food safety.

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