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Fermented *Cyprinus carpio* L . Sausage

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Abstract: This study was carried out to investigate the appropriateness of carp (*Cyprinus carpio* L.) meat in the making of fermented sausage. Carp were obtained from Keban Dam Lake. Four groups of sausages were produced. The first group was made from carp meat alone, the second from mixtures of 67% carp meat and 33% red meat, the third from mixture of 50% carp meat and 50% red meat and the fourth from mixtures of 33% carp meat and 67% red meat.

Samples of sausage were analysed for sensory properties, and microbiological and chemical characteristics on day 1 of production and days 7, 15 and 30 of ripening.

In sensory analyses, it was observed that the quality of sausage during conservation was medium on days 1 and 7 in group I. The same group was found to be of good quality on days 15 and 30. Group II was of good quality during all periods. Group III was of medium quality on day 1 but good on other days. On the other hand, on days 1 and 7 group IV was of medium quality and on days 15 and 30 of good quality.

In microbiological analyses, it was found that all groups contained coliform microorganisms on day 1. The numbers of coliform microorganisms were 1.0×10^2 cfu/g, 2.0×10^2 cfu/g, 3.0×10^2 cfu/g and 1.1×10^3 cfu/g in groups I, II, III and IV, respectively. Staphylococcus-micrococcus was detected as 1.4×10^4-2.7×10^4 cfu/g in group I, 1.4×10^4-8.0×10^4 cfu/g in group II, 1.2×10^4-3.1×10^4 cfu/g in group III and 8.5×10^3-2.3×10^4 cfu/g in group IV. The numbers of mould and yeast as cfu/g were 6.5×10^3-3.9×10^4, 1.3×10^4-7.7×10^4, 3.4×10^3-6.3 x 104 and 1.3×10^4-4.0×10^4 for groups I, II, III and IV, respectively.

In the chemical analyses, moisture contents were 50.20%-38.02% in group I, 50.51-39.68% in group II, 51.58%-39.26% in group III and 50.94%-39.45% in group IV. Fat contents were determined to be 26.25%-30.76%, 26.43%-29.92%, 24.02%-30.08% and 24.51%-30.10% in groups I, II, III and IV, respectively. Protein contents were 21.02%-29.53%, 21.63%-28.97%, 22.22%-28.34% and 23.54%-28.30% in groups I, II, III, and IV, respectively. Calcium levels were 33.82-37.26 mg/100 g in group I, 26.04-30.80 mg/100 g in group II, 22.16-25.52 mg/100 g in group III and 19.86-23.71 mg/100 g in group IV. Phosphorus levels were 84.56-87.42 mg/100 g, 77.12-79.93 mg/100 g, 74.75-77.14 mg/100 g and 72.22-75.11 mg/100 g in groups I, II, III and IV, respectively. pH values were 5.77-5.46 in group I, 5.71-5.50 in group II, 5.76-5.51 in group III and 5.80-5.58 in group IV.

In conclusion, these results indicate that it is possible to produce high quality fermented sausage from carp meat using permitted food additives and good technology.

Key Words: Fermented, sausage, carp.

Fermente Aynalı Sazan Sucuğu

Özet: Bu çalışma aynalı sazan etinin (*Cyprinus carpio* L.) sucuk üretimine uygunluğunu araştırmak amacıyla yapıldı. Balıklar Keban baraj gölünden avlanmıştır. Çalışmada 4 grup sucuk üretilmiştir. I. grup sadece balık etinden, II. grup %67 balık eti ile %33 kırmızı et karışımından, III. grup %50 balık eti ile %50 kırmızı et karışımından ve IV. grup ise %33 balık eti ile %67 kırmızı et karışımından yapılmıştır.

Bu sucuk grupları olgunlaşmayı takiben 1., 7., 15. ve 30. günlerde duyusal, mikrobiyolojik ve kimyasal yönlerden incelenmiştir.

Muhafaza süresince sucuk gruplarında saptanan duyusal değerlerin genel beğeni itibariyle I. grubun 1. ve 7. günlerinde orta, 15. ve 30. günlerinde iyi; II. grubun bütün dönemlerinde iyi; III. grubun 1. gününde orta diğer günlerinde iyi; IV. grubun 1. ve 7. günlerinde orta, 15. ve 30. günlerinde ise iyi kalitede olduğu gözlenmiştir. Koliform grubu mikroorganizmalar bütün gruplarda yalnız 1. gün tespit edilmiştir. Koliform grubu mikroorganizmalar kob/g olarak I. grupta $1,0 \times 10^2$, II. grupta $2,0 \times 10^2$, III. grupta $3,0 \times 10^2$ ve

IV. grupta 1,1 x 10^3 miktarında saptanmıştır. Stafilokok-mikrokok sayıları kob/g olarak I. grupta 1,4 x 10^4-2,7 x 10^4, II. grupta 1,4 x 10^4-8,0 x 10^4, III. grupta 1,2 x 10^4-3,1 x 10^4 ve IV. grupta 8,5 x 10^3-2,3 x 10^4; maya-küf sayıları ise sırasıyla 6,5 x 10^3-3,9 x 10^4, 1,3 x 10^4-7,7 x 10^4, 3,4 x 10^3-6,3 x 10^4 ve 1,3 x 10^4-4,0 x 10^4 olarak tespit edilmiştir.

Kimyasal analizlerin sonucunda, rutubet içeriğinin I. grup sucukta %50,20-38,02, II. grup sucukta %50,50-39,68, III. grup sucukta %51,58-39,26 ve IV. grup sucukta %50,94-39,45 arasında; yağ içeriğinin sırasıyla %26,25-30,76, %26,43-29,92, %24,02-30,08 ve %24,51-30,10 arasında; protein içeriğinin I. grupta %21,02-29,53, II. grupta %21,63-28,97, III. grupta %22,22-28,34 ve IV. grupta %23,54-28,30 arasında olduğu belirlenmiştir. Kalsiyum düzeyinin I. grupta 33,82-37,26, II. grupta 26,04-30,80, III. grupta 22,16-25,52 ve IV. grupta 19,86-23,71; fosfor düzeyinin ise sırasıyla 84,56-87,42, 77,12-79,93, 74,75-77,14 ve 72,22-75,11; pH değerinin I. grupta 5,77-5,46, II. grupta 5,71-5,50, III. grupta 5,76-5,51 ve IV. grupta 5,80-5,58 arasında olduğu tespit edilmiştir.

Sonuç olarak, aynalı sazan etinden yasaların öngördüğü katkı maddeleri ve iyi bir teknoloji ile kaliteli sucuk üretiminin mümkün olabileceği vurgulanabilir.

Anahtar Sözcükler: Fermente, sucuk, aynalı sazan.

Introduction

Since fish is a good source of protein and is a dietetic food, it is of importance for human consumption. Fish meat is richer than red meat in terms of inorganic substances. In particular, since it contains high levels of calcium and phosphorus it plays an important role in bone and teeth development in humans: 100 g of fish meat contains approximately 79 (19-88) mg calcium and 100 (68-550) mg phosphorus. Freshwater fish have high levels of phosphorus while marine fish have high levels of calcium (1,2). Although Turkey has adequate water sources, fish consumption is low because of a lack of knowledge about diet as well as specific smell of fish meat, quicker spoilage compared to other meat, the presence of heavier fishbones in some species and the smell due to mud, silt and mosses. Therefore, it is necessary to encourage the public to consume fish through extended activities and by producing attractive half-ready or ready products that save labour and time and the have a longer shelf-life and can be found throughout the year.

Canned food from Engraulis encrosicholus (3), tuna-type canned carp (4), fish meatballs (5), fish sausage (6), fried carp fillets (7), salmon (8) and carp pastrami (9,10) were produced as ready and half-ready food for consumption produced experimentally and examined in terms of chemical, microbiological and sensory properties in Turkey.

Carp in Keban Dam Lake have 52.10% meat yield in males, 51.89% meat yield in females, 78.69-78.99% moisture content, 17.77-17.83% protein content, 2.20-2.60% fat content and 0.92-0.95% ash (11). It has been reported that the production of carp in Keban Dam Lake was about 200 tons in 1998 (12).

Production of good quality sausage needs good hygiene, good quality food additives, and suitable ripening, packing and storage conditions. It has been reported that food additives, especially spices, are significant sources of contamination (13-15).

Glutamic acid and its salts are commonly used in foods. A sodium salt, monosodium glutamate (MSG), is often used as aroma and flavour enhancer and smell remover in sheep, pig and fish meat. It was reported that levels of 0.5-1 g/kg are acceptable in European countries (16,17) while the maximum is 10 g/kg in Turkey (18). Citric acid has effects on the colour, aroma, flavour and storage time of products by decreasing the pH. It has antioxidant effects and shows a synergistic effect when used with other antioxidants (17,19).

A number of studies have been carried out on the effects of different food additives, different combinations of starter culture and ripening conditions on fermented sausage made from red meat (13,20-27). The survival times of some pathogens (such as staphylococcus, salmonella and bacillus species, E. coli, C. perfringens and V. parahaemolyticus) in fish sausage with and without starter have been reported (28).

According to the TS 1070 sausage standard (Institute of Turkish Standards) (29), the maximum moisture content in sausage is 40% and pH values must be between 5.4 and 5.8. The maximum fat contents in first, second and third class sausages are 30%, 40% and 50%, respectively. The minimum protein contents in first, second and third class sausage are 22%, 20% and 20%, respectively.

Sensory properties, in terms of odour and smell, should be specific, and the colour should be normal in the

first and second classes and should be different in the third class. Texture in the first class should be medium-soft and in second and third classes soft. The cross-sectional surface of first and second class sausage should have a mosaic-like appearance, but in the third class it should bee a mixture. There should be air cavities in first class sausage, in the second class there should be cavities and third class sausage should be sponge-like.

Macroscopically, there must be no mould in any of the classes. There must be no stickiness in the first and second classes and there must be slight stickiness in the third class.

Microbiologically, the maximum levels of S. aureus, coliform and yeast-mould are 10^2 cfu/g, MPN 10/g and 10^2 cfu/g, respectively (29).

This study was carried out to investigate the appropriateness of carp (*C. carpio* L.) meat in the production of fermented sausage.

Materials and Methods

Materials

Carp from Keban Dam Lake were used. After the fish were caught they were immediately transferred to the laboratory and filleted. These fillets were cut into hand-sized pieces and left to drain in a sieve at 4°C for 24 hours. Four groups of sausage were made. Group I was made from 100% fish meat, group II from 67% fish meat and 33% red meat, group III from 50% red meat and 50% fish meat and group IV from 33% fish meat and 67% red meat. Ripened beef fillets (m. longissimus dorsi and m. multidus dorsi) were used as the red meat. The formula in TS 9298 was modified and used to make fermented sausage as shown below (30).

Meat	8000 g
Tail fat	2000 g
Dextrose	50 g
Garlic	150 g
Hot red pepper (powder)	60 g
Sweet red pepper (powder)	10 g
Cumin	90 g
Allspice	60 g
Black pepper (powder)	100 g
$NaNO_2$	0.005 g
$NaNO_3$	0.015 g
Monosodium glutamate	8 g
Ascorbic acid	4 g
Citric acid	9 mg
Salt (rock salt)	500 g

The meat and fat were minced in a mincer. Smashed garlic was added and mixed. Then salt and other food additives were added and mixed until homogenised. The mixture was stored in a refrigerator at 2°C for 24 hours. Sausages were made by filling 10 cm long and 25 mm in diameter cellulose covers with paste. Then they were ripened under the conditions described below.

Time (day)	Relative Humidity (%)	Temperature (°C)	Air circulation (m/s)
1	95	24	1-2
2 and 3	85	22	1-2
4	85	20	1-2
5 and 6	80	18	1-2

Ripening sausages were kept in the refrigerator at 4°C. Following ripening, five samples in each group were taken on days 1, 7, 15 and 30 and examined in terms of microbiological, chemical and sensory properties.

Methods

Chemical analysis

Levels of moisture and fat were determined as indicated in TS 1743 (31) and TS 1744 (32), respectively. The microkjeldahl method (33) was used to determine the protein content, and phosphorus levels were analysed colorometrically using the ascorbic acid method (34). Calcium levels were determined using the methods described by Gündüz (35) with a flame spectrophotometer, and pH values were measured by pH meter at 25°C (36).

Microbiological Analysis

Enumeration of coliform group microorganisms

Violet red bile agar medium (Oxoid) was used to count this group of microorganisms. Plates were incubated at 30±1°C for 24 hours. After incubation, degrading colonies were revealed as coliform group microorganisms (37).

Enumeration of staphylococcus-micrococcus

Mannitol salt agar medium (Oxoid) was used to count this group of microorganisms. Plates were incubated at 37±1°C for 48 hours and colonies counted after incubation (37).

Enumeration of yeast and mould

Potato dextrose agar medium with pH adjusted to 3.5 with 10% tartaric acid was used. Plates were incubated at 22±1°C for five days and the colonies were counted (37).

Sensory analysis

Sausage samples were tested by five people in terms of colour, cross-sectional surface, texture, flavour and smell by scoring from 1 to 5 points: 1 for very bad, 2 for bad, 3 for medium, 4 for good and 5 for very good (38).

Statistical analysis

The significance of differences between and within groups was investigated (39).

Results

The sensory values, number of microorganisms and chemical values during storage are given in Tables 1, 2 and 3 respecively.

In terms of sensory values, the general acceptance in groups I, II and IV was medium on days 1 and 7 and good on days 15 and 30 of storage. Values of colour in group I, cross-sectional surface in group III and texture and air cavities in group IV were found to be lower compared to other features. Group II sausages were found to be of good quality in all periods of evaluation (Table 1).

Coliform group microorganisms were detected in all groups only on day 1 of storage. They were found to be 1.0×10^2 cfu/g in group I, 2.0×10^2 cfu/g in group II, 3.0×10^2 cfu/g in group III and 1.1×10^3 cfu/g in group IV (Table 2). Staphylococcus-micrococcus were determined to be 1.4×10^4-3.5×10^4 cfu/g in group I, 1.4×10^4-1.0×10^5 cfu/g in group II, 1.2×10^4-5.0×10^4 cfu/g in group III and 8.5×10^3-7.3×10^4 cfu/g in group IV during storage (Table 2).

The number of yeast and mould colonies varied from 1.4×10^4 to 3.5×10^4 cfu/g in group I, from 1.4×10^4 to 1.0×10^5 cfu/g in group II, from 1.2×10^4 to 5.0×10^4 cfu/g in group III and from 8.5×10^3 to 7.3×10^4 cfu/g in group IV.

Moisture levels decreased periodically during storage. They varied from 50.10% to 38.02% in group I, from 50.50% to 39.68% in group II, from 51.58% to 39.26% in group III and from 50.94% to 39.45% in group IV.

Fat, protein, calcium and phosphorus contents increased during storage. Protein levels were found to be 21.02%-29.53% in group I, 21.63%-28.97% in group

Table 1. Sensory values in sausage group during storage

Group	Day	Colour	Cross-sectional surface	Texture	Flavour-Smell	Air cavities	General acceptance
I	1	2.8	3.0	3.0	3.0	3.0	2.96
	7	2.8	3.2	3.6	3.0	3.6	3.24
	15	3.0	3.4	4.4	3.4	3.6	3.56
	30	3.4	3.6	4.4	3.6	4.0	3.80
II	1	3.4	3.2	4.4	3.0	4.4	3.68
	7	3.6	3.4	4.6	3.4	4.4	3.88
	15	3.8	3.6	4.8	3.4	4.8	4.12
	30	4.0	3.6	4.8	3.4	4.8	4.12
III	1	3.4	3.2	3.4	3.6	3.8	3.48
	7	3.4	3.6	3.4	3.4	3.8	3.52
	15	4.0	3.4	3.8	3.8	4.0	3.80
	30	4.0	3.8	4.0	3.8	4.4	4.00
IV	1	4.4	3.8	2.8	3.4	3.0	3.48
	7	4.4	3.8	2.8	3.4	2.8	3.44
	15	4.8	4.0	3.4	3.8	3.4	3.88
	30	5.0	4.2	3.6	4.4	4.0	4.24

Table 2. Microrganisms numbers in fermented sausage groups during storage (log10/g)

Group	Day	Coliform	Staph.-Micr.	Yeast and mold
	1	2	4.14	3.81
I	7	0	4.54	4.23
	15	0	4.50	4.60
	30	0	4.43	4.59
	1	2.30	4.14	4.11
II	7	0	4.81	4.46
	15	0	5.00	4.85
	30	0	4.90	4,88
	1	2.47	4.07	3.53
III	7	0	4.69	4.61
	15	0	4.54	4.81
	30	0	4.49	4.79
	1	3.04	3.92	4.11
IV	7	0	4.86	4.50
	15	0	4.30	4.62
	30	0	4.36	4.60

II, 22.22%-28.34% in group III and 23.54%-28.30% in group IV. Fat content was 26.25%-30.76% in group I, 26.43%-29.92% in group II, 24.02%-30.08% in group III and 24.51%-30.10% in group IV. Levels of calcium were 33.82-37.26 mg/100 g in group I, 26.04-30.80 mg/100 g in group II, 22.16-25.52 mg/100 g in group III and 19.86-23.71 mg/100 g in group IV. Levels of phosphorus were 84.56-87.42 mg/100 g in group I, 77.12-79.93 mg/100 g in group II, 74.75-77.40 mg/100 g in group III and 72.22-75.11 mg/100 g in group IV.

A slight decrease was observed in pH levels in all groups during storage. It was determined to be 5.46-5.77 in group I, 5.50-5.71 in group II, 5.51-5.76 in group III and 5.58-5.80 in group IV.

Discussion

Sensory quality increased in all groups in parallel with the length of storage. This may have resulted from increasing numbers of micrococcus-staphylococcus and the effects of spices and food additives due to decreasing moisture. The insufficiency of colour in group I can be explained by the fish meat used in the production of this group and the good colour in group IV can be explained with production from sole red meat alone. Slight insufficiency in colour can be overcome by using starter cultures, antioxidants and food additives given by standards.

Table 3. Chemical values in fermented sausage groups during storage

		(%)			(mg/100g)		
Group	Day	Moisture	Fat	Protein	Ca	P	pH
	1	50.20	26.25	21.02	23.82	74.56	5.77
I	7	45.73	27.82	25.45	24.23	74.93	5.48
	15	40.08	29.75	28.96	25.84	76.04	5.50
	30	38.02	30.76	29.53	27.26	77.42	5.46
	1	50.50	26.43	21.63	23.04	74.12	5.71
II	7	45.15	27.00	26.90	23.85	74.86	5.54
	15	41.17	29.12	28.20	25.16	76.00	5.53
	30	39.68	29.92	28.97	26.80	76.93	5.50
	1	51.58	24.02	22.22	22.16	73.75	5.76
III	7	46.32	27.15	25.58	23.07	74.65	5.59
	15	41.45	29.25	27.98	23.74	75.68	5.51
	30	39.26	30.08	28.34	25.52	76.14	5.51
	1	50.94	24.51	23.54	21.86	73.22	5.80
IV	7	45.60	27.96	25.14	22.30	74.26	5.61
	15	41.40	30.05	27.13	23.41	75.16	5.59
	30	39.45	30.10	28.30	24.71	76.11	5.58

There were no significant differences between groups but differences were found within groups in terms of sensory quality ($p<0.05$).

Macroscopically, no mould or stickiness was observed in any of the groups during the storage period.

Moisture content in all groups on days 1 and 15 of storage were higher than values shown in TS 1070 sausage standards. It was consistent with the standards on day 30 of storage (29).

On day 1 of storage, group I and II sausages were considered to be second class, while on the other days they were first class in terms of protein content, according to the standards. Group III and IV sausages were first class in all periods of storage (29). Fat content analyses showed that on days 1, 7 and 15 of storage, group I, III and IV sausages were first class. Group I, III and IV sausages were in second class with a slight variation on day 30 of storage.

Calcium and phosphorus levels increased in all groups depending on the moisture decrease during storage. These values are within the limits given for fish (1,2). Fish sausage, which is a good source of calcium and phosphorus, plays an important role in the diets of children and the elderly.

In chemical analyses, the decrease in pH during storage may be explained by the activity of lactobacillus. pH levels measured in this study were within the limits given in TS 1070 sausage standard (29). The differences in pH and moisture between groups and only in pH within groups were significantly different ($p<0.05$). The differences in other parameters within or between groups were not significant ($p>0.05$).

The disappearance of coliform microorganisms in all groups after day 1 of storage may be due to decreased humidity, increase in effects of food additives and decrease in pH. All four groups conformed to the standard, except on day 1 (29). The numbers of micrococcus-staphylococcus increased on day 7 of storage in groups I, III and IV, and on day 15 in group II. The differences between groups were found to be significant only on day 1. Slight decreases in the number of micrococcus-staphylococcus were observed during the remaining period of storage. This can be explained by partial decreases in moisture, pH and oxygen. There were significant differences in the numbers of micrococcus-staphylococcus between and within groups ($p<0.05$).

The numbers of yeast and mould colonies increased on day 15 and decreased slightly on day 30 in all groups. There were significant differences in the numbers of yeast and mould colonies between and within groups ($p<0.05$). The excessive numbers may be due to the growing ability of yeast and mould in wide ranges of pH, temperature and moisture (40) and contamination from food additives, particularly spices (13-15).

In conclusion, it is possible to produce high quality sausage from carp meat by using food additives and good technology. Thus, consumption of fish meat can be increased by transforming it into a product which has a longer shelf-life and is more dietetic, is easy to carry and store, and is available throughout the year.

References

1. Gülyavuz, H. ve Ünlüsayın, M.: Su Ürünleri İşleme Teknolojisi. Süleyman Demirel Üniv. Eğirdir Su Ürünleri Fak. Yayını, 1999.
2. Göğüş, A.K. ve Kolsarıcı, N.: Su Ürünleri Teknolojisi. Ankara Üniv. Ziraat Fak. Yayınları, 1992.
3. Mutluer, B.: Hamsi Balıklarında Çeşitli Kutu Konservesi Yapılması Üzerine Teknolojik Araştırmalar. Doktora Tezi. Ankara Üniv. Sağlık Bil. Enst., 1981.
4. Kaya, A.: Keban Baraj Gölü Aynalı Sazanlardan (*Cyprinus carpio* L.) Ton Tipi Konserve Üretimi. Doktora Tezi. Fırat Üniv. Sağlık Bil. Ens., 1996.
5. Damarlı, E., Varlık, C. ve Pala, M.: Su Ürünlerinde Kalite Kontrolu. Su Ürünleri Avlama İşleme Teknolojisi Seminer Tebliğleri. 1992; 90-97.
6. Gülyavuz, H. ve Timur, M: Balık Etinden Sosis Yapım Teknolojisi. Ege Üniv. Su Ürünleri Fak. Su Ürünleri Sempozyumu. 1991.
7. Arslan, A., Ateş, G., Gönülalan, Z., Kaya, A. ve Çelik, C.: Kızartılmış ve Vakumlanmış Aynalı Sazan (*Cyprinus carpio* L.) Filetolorının Buzdolabında Muhafaza Edilmesi. Fırat Üniv. Sağlık Bil. Enst. Derg. 1996; 10(2): 269-271.
8. Yapar, A.: Balık Pastırması Üretimi ve Kalite Parametrelerinin Belirlenmesi. Fırat Üniv. Fen Bil. Enst. Doktora tezi. 1993.
9. Arslan, A., Çelik, C., Gönülalan, Z., Ateş, G., Kök, F. ve Kaya, A: Vakumlu ve Vakumsuz Aynalı Sazan Pastırmalarının Mikrobiyolojik ve Kimyasal Kalitesinin İncelenmesi. TÜBİTAK, Türk Veterinerlik ve Hayvancılık Derg. 1997; 21: 23-29.

10. Arslan, A., Gönülalan, Z. ve Çelik, C.: Market Sıcaklığında Muhafaza Edilen Aynalı Sazan (*Cyprinus carpio* L.) Pastırmalarında Muhafaza Süresinin Etkisi. TÜBİTAK, Türk Veterinerlik ve Hayvancılık Derg. 1997; 21: 215-220.

11. Arslan, A.: Keban Baraj Gölü Aynalı Sazanlarının (*Cyprinus carpio* L.) Mikrobiyolojik ve Kimyasal Kaliteleri. TÜBİTAK, Türk Veterinerlik ve Hayvancılık Derg. 1993, 17: 251-259.

12. Anonymous: D.S.İ. 9. Bölge Yıllık Stok Raporu, 1998.

13. Yıldırım, Y.: Yerli sucuklarımıza Uygulanan Değişik Teknolojik Yöntemlerin Mikroflora ve Kalite Üzerine Etkileri. Fırat Üniv. Veteriner Fak. Derg. 1977; 4(1-2): 52-79.

14. Mutluer, B. ve ark.: İyonize Radyasyonla Baharatların Sterilizasyonu. I- Gamma Işınlarının Karabiber ve Kırmızı Biberin Mikrobiyel Flora, Uçucu Yağ ve Duyusal Niteliklerine Etkisi. A.Ü. Vet. Fak. Derg. 1986; 33(3): 464-476.

15. Tekinşen, O.C. ve Sarıgöl, C.: Elazığ Yöresinde Tüketime Sunulan Bazı Öğütülmüş Baharatın Mikrobiyel Florası. F.Ü. Vet. Fak. Derg. 1982; VII(1-2): 151-162.

16. Yentür, G. ve Bayhan, A.: Gıdalarda Monosodyum Glutamatın Katkı Maddesi Olarak Kullanılması. Gıda. 1989; 14(1): 39-42.

17. Çakmakçı, S. ve Çelik, İ.: Gıda Katkı Maddeleri. Atatürk Üniv. Ziraat Fak. Ders Notu No: 164. 1995.

18. Sağlam, Ö.F.: Türk Gıda Mevzuatı. AB Ofset, Ocak 1999.

19. Gökalp, H.Y., Kaya, M. ve Zorba, Ö.: Et Ürünleri İşleme Mühendisliği. Atatürk Üniv. Ziraat Fak. Ders Kitapları Serisi No:70, 1994.

20. Yıldırım, Y., Ülgen, M.T. ve Özeren, T.: Yerli Sucukların Üretim Yöntemleri Üzerine Araştırmalar. Ankara Üniv. Veteriner Fak. Derg. 1978; XXV(1): 85-89.

21. Tekinşen, O.C., Dinçer, B., Kaymaz, Ş. ve Yücel, A.: Türk Sucuğunun Olgunlaşması Sırasında Mikrobiyel Flora ve Organoleptik Niteliklerindeki Değişimler. Ankara Üniv. Veteriner Fak. Derg. 1982; 29(1-2): 111-130.

22. Nazlı, B.: Researches on the Ripening of Turkish Fermented Sausage Using a Local Starter Culture Combination. Tr. J. of Veterinary and Animal Sciences. 1998; 22: 393-397.

23. Lücke, F.K. and Hechelman, H.: Starter Cultures for Dry Sausages and Raw Ham, Composition and Effect. Die Fleischwirtschaft. 1987; 67(3):307-314.

24. Uğur, M.: Starter Kültür Kullanılarak Türk Sucuklarında Kalitenin Geliştirilmesi Üzerine Araştırmalar. İstanbul Üniv. Veteriner Fak. Derg. 1984; 10(1): 41-52.

25. Nazlı, B., ve Şenol, A.: Researches on Microbiological Decomposition of Turkish Fermented Sausages. Tr. J. of Veterinary and Animal Sciences. 1997; 21(6): 487-492.

26. Aytekin, H.: Konya'da Üretilen ve Konya Piyasasında Satılan Sucukların Bazı Mikrobiyolojik ve Kimyasal Analizleri Üzerine Araştırma. Etlik Veteriner Enst. Mikrobiyoloji Derg. 1986; 5(10-11-12): 69-105.

27. Alkan, M.: Elazığ ve Kayseri Bölgesinde İmal Edilen Fermente Sucukların Mikrobiyolojik, Organoleptik, Fiziksel ve Kimyasal Kaliteleri Üzerinde Araştırmalar. Doktora tezi. Selçuk Üniv. Sağlık Bil. Ens., 1989.

28. Aryanta, R.W., Fleet, G.H. and Buckle, K.A.: The Occurrence and Growth of Microorganisms During the Fermentation of Fish Sausage. Int. J. of Food Microbiology. 1991; 13(2): 143-155.

29. Türk Standardları Enstitüsü. T.S.1070. Türk Sucuğu Standardı. (Teknik Kurulun 28.Mart.1997 Tarihinde Tadil Ettiği Şekliyle), 1983.

30. Türk Standardları Enstitüsü. T.S.9298. Türk Sucuğu Yapım Kuralları. 1991.

31. Türk Standardları Enstitüsü. T.S.1743. Et ve Et Mamülleri Toplam Rutubet Miktarı Tayini. 1974.

32. Türk Standardları Enstitüsü. T.S.1744. Et ve Et Mamüllerinde Yağ Miktarı Tayini, 1974.

33. Anonymus. Official Methods of Analysis of the Association of Official Analytical Chemists. Ed. William Horwitz. 12th Ed., 1975.

34. American Public Health Agency (APHA)-AWWA-WPCF. Standard Methods for Examination of Water and Wastewater. 14th Edition. 1975; PP. 466-483.

35. Gündüz, T.: Kantitatif Analiz Laboratuar Kitabı. 4. Baskı. 1990; 222-226.

36. Türk Standardları Enstitüsü. T.S.3136. Et ve Et Mamüllerinde pH Tayini, 1978.

37. I.C.M.F.S.: Microorganisms in Foods. 1. Their Significance and Methods of Enumeration. Univ. of Toronto Press., 1982.

38. Altuğ, T., Ova, G., Demirbağ, K. ve Kurtcan, Ü.: Gıda Kalite Kontrolu. Ege Üniv. Basımevi, 1995.

39. Düzgüneş, O., Kesici, T. ve Gürbüz, F.: İstatistik Metodları I. Ankara Üniv. Ziraat Fak. Yayınları, 861. Ders Kitabı : 229, 1983.

40. Ünlütürk, A. ve Turantaş, F.: Gıda Mikrobiyolojisi. Mengi Tan Basımevi, 1998.