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RESEARCH ARTICLE

Evaluation of Some Quality Characteristics of Fermented Sucuks Produced by Butchers with Traditional Methods in terms of Compliance with Standards

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ABSTRACT

This research was carried out to determine some microbiological and physicochemical characteristics of fermented sucuks produced by butchers in Siirt with traditional methods and reveal whether fraudulent practices were applied during production. It was determined that the mean total aerobic mesophilic microorganism count of sucuks was 7.06±0.47, coliform group microorganism count 4.66±1.50, *Escherichia coli* count 3.79±1.59, *Staphylococcus aureus* count 4.08±2.13, yeast and mold count 5.88±1.02 $\log_{10}$ cfu/g; moisture content 30.92%±8.20, pH value 5.41±0.45, water activity value 0.888±0.05. In addition, starch was encountered in twenty of the samples, putrefaction in twenty-eight, and blood presence in all of them. According to TS 1070, 6.67% of the examined sucuks were moisture content, 20% *E. coli*, 60% *S. aureus*, 93.33% coliforms, pH value and putrefaction, and according to Turkish Food Codex, 26.67% of them were not suitable in terms of pH value and 66.67% of starch presence. In conclusion, it was concluded that some samples with insufficient hygienic quality might pose a potential risk for public health. In order to obtain hygienic and standards-compliant products; producers should be made aware, hygienic measures should be taken at all stages from production to consumption, and inspections by competent authorities should be increased.

Keywords: Fermented Sucuk, Quality Characteristics, Traditional Production

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Kasaplar Tarafından Geleneksel Yöntemlerle Üretilen Fermente Sucukların Bazı Kalite Özelliklerinin Standartlara Uygunluk Yönünden Değerlendirilmesi

ÖZ

Bu araştırma, Siirt'teki kasaplar tarafından geleneksel yöntemlerle üretilen fermente sucukların bazı mikrobiyolojik ve fizikokimyasal özelliklerinin belirlenmesi, ayrıca üretim sırasında hile amaçlı uygulamaların yapılıp yapılmadığının ortaya konması amacıyla yapılmıştır. Sucukların ortalama toplam aerob mezofilik mikroorganizma sayısı 7.06±0.47, koliform grubu mikroorganizma sayısı 4.66±1.50, *Escherichia coli* sayısı 3.79±1.59, *Staphylococcus aureus* sayısı 4.08±2.13, maya-küf sayısı 5.88±1.02 $\log_{10}$ kob/g; rutubet miktarı %30.92±8.20, pH değeri 5.41±0.45, su aktivitesi değeri 0.888±0.05 olarak belirlenmiştir. Ayrıca, örneklerin yirmisinde nişastaya, yirmisekizinde kokuşmaya ve tamamında kan varlığına rastlanmıştır. İncelenen sucukların TS 1070'e göre %6.67'si rutubet miktarı, %20'si *E. coli*, %60'ı *S. aureus*, %93.33'ü de koliformlar, pH değeri ve kokuşma yönünden; Türk Gıda Kodeksi'ne göre ise %26.67'si pH değeri ve %66.67'si nişasta varlığı yönünden uygun bulunmamıştır. Sonuç olarak; yetersiz hijyenik kaliteye sahip bazı örneklerin halk sağlığı açısından potansiyel bir risk oluşturabileceği kanaatine varılmıştır. Hijyenik ve standartlara uygun ürünlerin elde edilebilmesi için; üreticiler bilinçlendirilmeli, üretimden tüketime kadar geçen tüm safhalarda hijyenik tedbirler alınmalı ve yetkili otoriteler tarafından yapılacak denetimler artırılmalıdır.

Anahtar kelimeler: Fermente Sucuk, Geleneksel Üretim, Kalite Özellikleri

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INTRODUCTION

Processing meats in different ways, especially conservation by fermenting it, has been practiced since ancient times (Anar 2015, Medić 2017, Demirok Soncu and Kolsarıcı 2019). Curing these meats also ensures the obtainment of reliable products in terms of chemical and microbiological properties (Ranken 2000, Öztan 2011, Gökalp et al. 2015b, Turantaş 2015, Leroy and De Vuyst 2016). According to the Turkish Food Codex Communique on Meat, Prepared Meat Mixtures, and Meat Products (Anonymous 2019); sucuk is defined as a fermented meat product that has a mosaic appearance and has not undergone heat treatment, after which bovine and/or ovine carcass meats and fats are minced, mixed with flavorings, and filled into natural or artificial casings, fermentation and drying processes under certain conditions. In other words, sucuk is a meat product produced with the minced meat of various animals or their mixtures (bovine, ovine, poultry) and fat after mincing through a meat grinder, mixed with salt, spices, and additives, filled into natural or artificial casings, kept in a certain temperature, moisture, and air circulation for a while, then drying by ripening (Bulduk 2013, Anar 2015, Medić 2017). The shelf life of fermented sucuks are more longer, furthermore, these products' taste, aroma, and texture properties become more pronounced due to the probiotic microorganisms and the biological substances formed (Anar 2015, Malo and Urquhart 2016, Lücke 2017, Ockerman and Basu 2017, Demirok Soncu and Kolsarıcı 2019).

The spices used in the production of sucuks have an antimicrobial effect, albeit limited, on the microflora that causes deterioration. At the same time, the development of lactic acid bacteria is supported by the effect of manganese ions in the spices (Turantaş 2015, Danilović and Savić 2017). Although fermented sucuks, which are unique to Turks, have similarities with sucuks produced in multiple European countries, the smoking process applied in production and the benefit from some molds in ripening (Nout 2007, Gökalp et al. 2015b) cause differences. Fermented sucuks can be processed industrially as well as can be produced by traditional methods. Therefore, depending on climatic conditions, socio-economic lifestyle, cultural differences, and consumer habits, different characteristic of sucuks are found in many parts of the world. While traditionally produced sucuks are only drying in Mediterranean countries, these in Middle and Northern European countries are applied drying and smoking process (Arslan 2013, Gökalp et al. 2015b, Lücke 2017, Medić 2017).

Sucuk, which is sold in natural or artificial casing in the forms of coil, baton, and finger is among they meat products have a high consumption rate in Türkiye (Arslan 2013, Tayar and Yıldırım 2020).

This meat product is classified as dry (<35%) and semi-dry (~50%) sucuks according to their moisture content (Gökalp et al. 2015b, Turantaş 2015) and heat-treated and untreated (fermented) according to temperature applications (Warriss 2010, Candoğan and Çarkçıoğlu 2015, Anonymous 2019, Tayar and Yıldırım 2020).

It has been reported in the TS 1070 fermented sucuk standard (Anonymous 2016) that sucuks should have maximum moisture of 40% by mass and pH values between 5.4-5.8, furthermore that there should be no pathogenic microorganisms and no putrefaction in the products. According to the Turkish Food Codex (Anonymous 2019), it is stated that the highest pH value in sucuks can be 5.4, also substances containing starch and non-meat-derived proteins cannot be added to the products (the sum of amount of spice-originated starch and herbal protein cannot exceed 1% by mass).

It has been reported in some studies on sucuks in Türkiye (Sancak et al. 1996, Atasever et al. 1998, Erdoğrul and Ergün 2005, Öksüztepe et al. 2011, Gürbüz and Çelikel Güngör 2018) that products with low microbiological quality and which may adversely affect public health were encountered in the productions made in technologically and hygienically unsuitable workshops. In addition, there are studies in sucuks that do not comply with the standards in terms of physicochemical properties were detected (Atala 1992, Yücel and Karaca 1993, Sancak et al. 1996, Pehlivanoğlu et al. 2015, Gürbüz and Çelikel Güngör 2018, İnce et al. 2018). This research was carried out to with the aim of some quality characteristics of fermented sucuks produced by traditional methods offered for consumption in butchers in Siirt, also to reveal whether there are fraudulent practices in production and determine whether these sucuks pose a risk in terms of public health. Thus, it is thought that raising the producers' awareness will contribute to the obtain of higher quality products, therefore consumers will be able to obtain healthier products.

MATERIAL AND METHODS

In this research, approximately 300-400 g thirty pieces fermented sucuks produced by traditional methods taken from the butchers in the city center of Siirt were used as material. Firstly, the microbiological analyses of fermented sucuks brought to the laboratory under cold conditions were made and the samples were kept at +4 ^{o}C until other analyses were complete

Microbiological Analyses

10 g of sample and 90 ml of buffered peptone water (Oxoid CM0509B) taken into sterile stomacher bags under aseptic conditions were homogenized in the stomacher (SJIA-04C, China) for two minutes, and decimal dilutions up to 10^{-8} were prepared (Harrigan 1998). Used in microbiological analyses the media, cultivation methods and incubation conditions are presented in Table 1. All colonies grown on Plate Count Agar (PCA) were counted as total aerobic mesophilic microorganism (TAMM). Purple/black color and colorless colonies grown on Eosin Methylen-Blue Lactose Sucrose Agar (EMBA) were defined as coliform group microorganisms, gas forming at 44.5 °C in EC Broth and metallic bright green colonies grown on EMBA were defined as *E. coli*. Brilliant black-colored colonies without halo (atypical) and halo (typical) growing on Baird-Parker Agar (BPA) were considered as *S. aureus* and colonies growing on Potato Dextrose Agar (PDA) were counted as yeast and mold (Harrigan 1998, Temiz 2010, Halkman 2019).

Physicochemical Analyses

The moisture amounts of the examined fermented sucuks was determined according to the method reported by Gökalp et al. (2015a). The pH values of the samples (Honikel 2014) were determined in the pH-meter (Mettler Toledo, SevenCompact™ S220, China) and the water activity (a_w) values (Welti-Chanes et al. 2007) were determined in the water activity device (Novasina, LabTouch®-a_w, Switzerland).

Biochemical Analyses

The presence of starch and indicate of putrefaction in sucuks were determined according to the method reported by Gökalp et al. (2015a), and the presence of blood was determined according to the method reported by Kayaardı et al. (2017).

Statistical Analyses

Statistical analyses of the findings obtained in the analyses were made in the SPSS 23.0 program (Anonymous 2015).

RESULTS

Microbiological analysis findings of fermented sucuks produced by traditional methods in butchers in Siirt were shown in Table 2, frequency distributions of microorganisms are in Table 3, physicochemical analysis findings are in Table 4, frequency distributions of the physicochemical findings are in Table 5, and biochemical analysis findings are in Table 6.

Table 1. Used in microbiological analyses the media, cultivation methods and incubation conditions

Microorganism	Medium	Cultivation	Incubation
TAMM	PCA (Oxoid, CM463)	Pouring	30 °C (24-48 h)
Coliforms	EMBA (Merck, 1.01347)	Pouring	37 °C (24 h)
E. coli	ECB (Merck, 1.10765), EMBA	Spreading	37 °C (24 h)
S. aureus	BPA (Merck, 1.05406)	Spreading	35-37 °C (18-24 h)
Yeast and mold	PDA (Oxoid, CM139)	Pouring	25 °C (4-5 day)

Table 2. Microbiological analysis findings of the examined fermented sucuks (log_{10} cfu/g)

Microorganism	Number of samples (n)	Minimum	Maximum	Mean±SD
TAMM	30	5.70	7.70	7.06±0.47
Coliforms	30	<1.00	6.30	4.66±1.50
E. coli	30	<2.00	4.60	3.79±1.59
S. aureus	30	<2.00	5.48	4.08±2.13
Yeast and mold	30	3.70	6.78	5.88±1.02

Table 3. Frequency distributions of microorganisms determined in the examined fermented sucuks

Number of microorganism (log_{10} cfu/g)	TAMM		Coliforms		*E. coli*		*S. aureus*		Yeast-mold	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
<1.00	-	-	2	6.67	-	-	-	-	-	-
1.00-1.99	-	-	-	-	-	-	-	-	-	-
<2.00	-	-	-	-	24	80.00	12	40.00	-	-
2.00-2.99	-	-	-	-	-	-	-	-	-	-
3.00-3.99	-	-	8	26.66	4	13.33	12	40.00	4	13.33
4.00-4.99	-	-	12	40.00	2	6.67	4	13.33	4	13.33
5.00-5.99	2	6.67	6	20.00	-	-	2	6.67	6	20.00
6.00-6.99	12	40.00	2	6.67	-	-	-	-	16	53.33
7.00-7.99	16	53.33	-	-	-	-	-	-	-	-

Table 4. Physicochemical analysis findings of the examined fermented sucuks

Physicochemical	Number of samples (n)	Minimum	Maximum	Mean±SD
Moisture (%)	30	12.93	42.82	30.92±8.20
pH	30	5.07	6.68	5.41±0.45
a_w	30	0.722	0.938	0.888±0.05

Table 5. Frequency distributions of physicochemical findings determined in the examined fermented sucuks

Moisture	**10.00-20.00**		**20.01-30.00**		**30.01-40.00**		**40.01-50.00**		**50.01-60.00**	
	n	%	n	%	n	%	n	%	n	%
	4	13.33	8	26.67	16	53.33	2	6.67	-	-
pH	**5.00-5.40**		**5.41-5.80**		**5.81-6.20**		**6.21-6.60**		**6.61-7.00**	
	n	%	n	%	n	%	n	%	n	%
	22	73.33	2	6.67	4	13.33	-	-	2	6.67
a_w	**0.700-0.750**		**0.751-0.800**		**0.801-0.850**		**0.851-0.900**		**0.901-0.950**	
	n	%	n	%	n	%	n	%	n	%
	-	-	2	6.67	2	6.67	10	33.33	16	53.33

Table 6. Biochemical analysis findings of the examined fermented sucuks

Biochemical	Negative		Less evident		Evident		Much evident	
	n	(%)	n	(%)	n	(%)	n	(%)
Starch	2	6.67	8	26.66	18	60.00	2	6.67
Putrefaction	2	6.67	22	73.33	6	20.00	-	-
Blood	-	-	16	53.33	8	26.67	6	20.00

DISCUSSION

Generally, total count of microorganism in foods is around 10^6-10^7 cfu/g is accepted as an indicator of the deterioration of these products. However, when the probiotics in fermented products are considered, this count can be up to 10^8 (Temiz 2015a, Danilović and Savić 2017, Nova et al. 2017). The mean count of total aerobic mesophilic microorganisms (TAMM) was determined as 7.06±0.47 $\log_{10}$ cfu/g in the fermented sucuks examined in this research (Table 2). The mean count of TAMM determined in traditionally produced these sucuks is similar to the findings of some researchers (Çon et al. 2002, Erkmen and Bozkurt 2004, Erdoğrul and Ergün 2005, Ed-dra et al. 2017). However, this value determined in fermented sucuks is higher than the values reported by Atasever et al. (1998) and Pehlivanoğlu et al. (2015), and lower than the values reported by Sancak et al. (1996), Öksüztepe et al. (2011), Gürbüz and Çelikel Güngör (2018), and Kaval et al. (2020). The fact that the count of TAMM was generally low in the sucuks examined in this research suggests that meat with antibiotic residues may have been used in production and that the sucuks were not sufficiently fermented according to the pH values determined in the samples. The differences between the studies may be due to the microbial load of the meat used as raw material and the act of different ripening processes applied to the sucuks.

The presence of coliforms group microorganisms in sucuks gives an idea about the hygiene of the enterprise and the reliability of these products (Erol 2007, Temiz 2015a). The mean count of coliform group microorganism in the samples examined in this research was determined as 4.66±1.50 $\log_{10}$ cfu/g (Table 2). This determined value is lower than the values reported by Pehlivanoğlu et al. (2015), Ed-dra et al. (2017), Gürbüz and Çelikel Güngör (2018) and Kaval et al. (2020), and higher than the values reported by Sancak et al. (1996), Çon et al. (2002), Erdoğrul and Ergün (2005), and Öksüztepe et al. (2011). It is thought to be important factors that the examined sample count in the studies, the hygiene approaches of the personnel during production, and the hygienic conditions of the enterprises are significant in the emergence of these differences. Along with these, it is also evaluated that preservatives may have been used during production in some enterprises. A significant correlation was determined between the count of coliform group microorganism in the sucuk samples with the count of *E. coli* and the amount of moisture at the level of $p<0.05$, and between the coliforms and the count of TAMM at the level of $p<0.01$. The amount of moisture available in foodstuffs and the mesophilic microorganisms in these foods affect coliform group microorganisms which are generally hygiene index, and therefore the count of *E. coli*. Since it is stated in the TS 1070 standard (Anonymous 2016) that there should be no pathogenic microorganisms in fermented sucuks, it is seen that 93.33% of the samples examined
in this research do not comply with this criterion (Table 3). This situation suggests that is not much attention to hygienic conditions during production. As a matter of fact, the detection of *E. coli* at the level of 3.00-3.99 $\log_{10}$ cfu/g in four samples and 4.00-4.99 $\log_{10}$ cfu/g in two samples (Table 3) supports this opinion.

The presence of indicator microorganisms in foods is evaluated as a sign of fecal contamination, and in this respect the most important microorganism is stated to be *E. coli* (Erol 2007, Laury et al. 2009, Temiz 2015a). The mean count of *E. coli* was determined as 3.79±1.59 $\log_{10}$ cfu/g in the samples examined in this research. This value; the mean values reported by Sancak et al. (1996) in Van (Türkiye) and Ed-dra et al. (2017) in Meknes (Morocco) as $4.6x10^3$ cfu/g and 3.69 $\log_{10}$ cfu/g, respectively were found similar. In terms of *E. coli*, it was observed that 20% of the samples examined did not comply (Table 3) with the criterion specified in the TS 1070 standard (Anonymous 2016). The detection rate of *E. coli* in fermented sucuks traditionally produced in Siirt was higher than the rate reported as 15% by some researchers (Erdoğrul and Ergün 2005, Öksüztepe et al. 2011), and lower than the rate reported as 30% by Kaynarca and Gümüş (2020). These differences in the detection rates of *E. coli* in studies, may have been caused by together with the hygiene of the enterprise and personnel, the facilities of the enterprises and the techniques used in the conservation of the products. Statistically, a significant correlation was determined between the count of *E. coli* and the count of yeast and mold at the level of $p<0.05$, between the count of *E. coli* with the presence of starch and putrefaction at the level of $p<0.01$. The starch in sucuks is broken down to simple sugars by microorganisms during fermentation. Pathogenic microorganisms such as *E. coli*, and yeast and mold also increase their activities by using these sugars. Also, compounds that cause putrefaction, such as sulfur, indole, and ammonia may arise especially depending on the proteolytic activity of microorganisms (Ranken 2000, Laury et al. 2009, Ünlütürk and Turantaş 2015). Because of these it is thought that the presence of starch determined in the samples examined supports the development of microorganisms and creates undesirable changes in the chemical composition of these sucuks.

In this research, the mean count of *S. aureus* in fermented sucuks was determined as 4.08±2.13 $\log_{10}$ cfu/g (Table 2), and eighteen of these sucuks were found non-compliant (Table 3) with the criterion specified in the TS 1070 standard (Anonymous 2016). This mean value determined in fermented sucuks is show similarities to the values specified in different sucuks by Sancak et al. (1996), Çon et al. (2002),

Öksüztepe et al. (2011), and Gürbüz and Çelikel Güngör (2018). Nevertheless, this count is higher than the value (3.33 $\log_{10}$ cfu/g) reported by Kaynarca and Gümüş (2020), and lower than the values reported as $3.2x10^5$ cfu/g and 4.85 $\log_{10}$ cfu/g, respectively, in some studies (Atasever et al. 1998, Pehlivanoğlu et al. 2015) where *Staphylococci/Micrococci* were detected together. As a result of the analyses, the detection rate (60%) of *S. aureus* determined in fermented sucuks; was higher than the rates reported by Erdoğrul and Ergün (2005) as 6.67% and by Öksüztepe et al. (2011) as 10%. The fact that the count of positive samples is very high in the sucuks examined in this research indicates that the necessary care is not given to the personnel and enterprise hygiene in the workshops where sucuk is produced in Siirt. The fact that a significant correlation ($p<0.01$) was determined between the count of *S. aureus* in fermented sucuks with the putrefaction, coliform group microorganisms, and the count of *E. coli* in the samples also supports this opinion. In addition, in parallel with the low TAMM count detected in the samples examined and the idea that the sucuks are not sufficiently fermented, it is evaluated that even if there are antibiotic residues in the meat used in production, *Staphylococci* resistant to these residues can reproduce. Therefore, it should not be forgotten that *S. aureus* and other pathogenic microorganisms will continue their activities under unsuitable hygienic conditions and pose potential hazards for public health, without being forgotten all enterprises should take finically necessary precautions. As a matter of fact, *S. aureus* found in meat products is one of the most important pathogens that cause food infections and poisonings in humans (Erol 2007, Nørrung et al. 2009, Ünlütürk and Turantaş 2015).

Except for some products (Italian type salami, roquefort cheese, camembert cheese, herbal-originated tempe, bogkrek, miso, soy sauce) produced using special molds (Perrone et al. 2015, Turantaş 2015, Magistà et al. 2017), mold growth in foods is an undesirable situation (Ünlütürk and Turantaş 2015, Kameník 2017, Lücke 2017, Halkman 2019). The yeast and mold count, which was determined as 5.88 ± 1.02 $\log_{10}$ cfu/g on mean in the sucuk samples examined in this research (Table 2), it was found similar to Sancak et al. (1996), Erdoğrul and Ergün (2005) and Pehlivanoğlu et al. (2015), but lower than the findings of some researchers (Atasever et al. 1998, Çon et al. 2002, Erkmen and Bozkurt 2004, Gürbüz and Çelikel Güngör 2018, Kaval et al. 2020). It is thought that the microbiological load of raw materials and additives used in production and also the ripening and storage conditions of sucuks may be effective in the differences between the studies. A significant correlation at the level of $p<0.05$ was determined between the yeast and mold count and presence of blood in fermented sucuks. However, this correlation between yeast and mold count with coliform group microorganism count, moisture content, a_w value and putrefaction were found at the level of $p<0.01$. The high moisture amount and a_w value in sucuks, together with the chemical composition of the blood support the development of microorganisms with proteolytic activity (Arslan 2013, Temiz 2015b, Danilović and Savić 2017, Kameník 2017). Therefore, also in the putrefaction determined in the samples examined in this research, it is thought that the low microbiological quality of the raw material used in the production and the presence of blood in the sucuks are effective.

The moisture content in meat and its products reveals the physical, chemical, microbiological and sensory quality and nutritional value of the product, also gives information about whether the ripening is done completely (Erol 2007, Warris 2010, Gökalp et al. 2015a). The mean moisture amount, which was determined as $30.92\%\pm8.20$ in this research (Table 4), is similar to the findings reported by Kuyumcu and Yuttagül (2000) and Erdoğrul and Ergün (2005). However, this amount was found higher than Atasever et al. (1998) findings, and lower than the findings of some researchers (Atala 1992, Sancak et al. 1996, Öksüztepe et al. 2011, Pehlivanoğlu et al. 2015, Gürbüz and Çelikel Güngör 2018). It is thought that, in the emergence of these differences, the use of high moisture content and undervalued in production of meat, the removal status of blood from these meats used in pieces, the amount of fat in the sucuk dough, and the drying, ripening and storage conditions during production may be effective. It was stated in the TS 1070 fermented sucuk standard (Anonymous 2016) that the maximum moisture amount in sucuks could be 40%, and it was observed that, in terms of moisture amount, two samples examined in this research (Table 5) did not comply with the criterion specified in the relevant standard.

The pH and a_w values of foods are the most important internal factors that affect the growth of microorganisms (Erol 2007, Warriss 2010, Temiz 2015b, Karastogianni et al. 2016). These values provide information regarding the freshness and quality of the food, also the suitability of the storage and conservation conditions applied to the food (Ranken 2000, Warriss 2010, Gökalp et al. 2015a). In this research, the mean pH value of fermented sucuks was determined as 5.41 ± 0.45 (Table 4), and it was seen that eight (26.67%) of the samples did not comply with the Turkish Food Codex (Anonymous 2019), and twenty-eight (93.33%) of them did not comply with TS 1070 (Anonymous 2016) (Table 5). The mean pH value determined in the traditionally produced fermented sucuks produced in Siirt was similar to the values reported by some researchers (Sancak et al. 1996, Erdoğrul and Ergün 2005, Gürbüz and Çelikel Güngör 2018, Kaynarca and Gümüş 2020). However, this value is higher than the values reported by Pehlivanoğlu et al. (2015), Poçan et al. (2015) and Kara et al. (2021), and lower than the values reported by Erkmen and Bozkurt (2004) and

Kaval et al. (2020). The determination of different pH values in the studies on sucuks may have resulted from the microbiological quality of the meat used in production and therefore the sucuks, their moisture amount, and the fermentation conditions in the ripening of the products. As a matter of fact, in this research the detection of high blood levels in samples with low pH values, which adversely affects the microbiological quality, supports this idea.

The mean a_w value of 0.888±0.05 in fermented sucuks (Table 4) was lower than the findings reported by Sancak et al. (1996) and Kaval et al. (2020). Generally, a_w values are between 0.850-0.920 in dried and cured fermented sucuks, and 0.930-0.970 in moist sucuks. When a_w value in foods is >0.800, yeast and molds increase their activity, causing foods to deteriorate and putrefaction more quickly (Ranken 2000, Bulduk 2013, Temiz 2015b). In this research, a statistically significant correlation at the level of $p<0.05$ was determined between the a_w value and putrefaction in the fermented sucuks. In addition, in some of the samples with high a_w values, the count of yeast and mold was observerd to be high, and a significant correlation ($p<0.01$) was also found between the a_w value in the samples with the number of yeast and mold, the amount of moisture and the pH value. In this research on the traditionally produced fermented sucuks in Siirt, the a_w value was determined ≤0.800 in two (6.67%) examined samples (Table 5). When this situation and statistical analysis results were evaluated together, it was concluded that most of the sucuks examined were not sufficiently dried, and ripening was done under unsuitable conditions. Because of these, also products with low economic value and poor quality can be encountered in the market.

Presence of starch was not found in only two of the samples examined in this research, and in eight of the samples, in less evident level presence of starch, which is thought to be caused by the spices used in production, was detected (Table 6). In the studies on sucuks in Izmir and Bursa, it was reported that starch was encountered in 2% (Atala 1992) and 28.5% (Yücel and Karaca 1993) of the samples examined, respectively. The incidence rate of starch (66.67%) in fermented sucuks in this research was higher than the findings of the relevant researchers. In the Turkish Food Codex (2019), it has been stated that non-meat proteins, starch and starch-containing substances, soy and soy products cannot be added in the production of sucuks, however the total amount of starch and herbal protein originating from spices cannot exceed 1% by mass. Accordingly, it was observed that 66.67% of fermented sucuks produced by traditional methods by butchers in Siirt did not meet the relevant criterion in terms of presence of starch (Table 6). Especially in emulsified products such as sausage and salami, to bind absorb excess water and give the product a good texture, starch, different grain flours, some protein products, and skimmed milk powder can be added in certain proportions (Anar 2015, Gökalp et al. 2015a, Leroy and De Vuyst 2016, Medić 2017, Anonymous 2019). According to the findings obtained and these properties that starch can add to the product, it is thought that this additive detected in the examined samples may have been used for fraudulent purposes.

Only two of fermented sucuks (6.67%) produced by the butchers in Siirt with traditional methods did not encounter any putrefaction. However, it was determined that twenty-two of the samples (73.33%) had less evident and six of them (20%) had evident putrefaction (Table 6). It was observed that 93.33% of the samples examined did not comply with the relevant standard (Table 6) since it is stated in the TS 1070 fermented sucuk standard (Anonymous 2016) that the putrefaction tests on sucuks should be negative. In addition, the detection of indicates of putrefaction in most of the fermented sucuks examined in this research does not coincide with the researchers' (Yücel and Karaca 1993, Erdoğrul and Ergün 2005) findings, who stated that no putrefaction was found in any of the products they examined. This situation suggests that meat with indicates of putrefaction and poor hygienic quality may have been used to produce sucuks or that the produced sucuks were stored under non-appropriate conditions. As a matter of fact, in meat products, which are easily decomposition as a result of physical and chemical reactions, begin to rot rapidly, especially with the effect of proteolytic microorganisms (Paramithiotis et al. 2009, Gökalp et al. 2015a, Ünlütürk and Turantaş 2015).

In order to ensure standard and quality sucuk production, pale, soft, and exudative (PSE), and dark, firm and dry (DFD) meats should be used at a maximum of 20%, the meats should be rested at 4 °C for 24-48 hours (rigor mortis), and the meats to be processed in pieces should be kept in steel strainers, and the blood is required to be drained thoroughly (Warriss 2010, Arslan 2013, Anar 2015, Gökalp et al. 2015b). Although, in the literature review, no research was found examining the presence of blood in sucuks, blood presence was observed less evident in 53.33%, evident in 26.67%, and much evident in 20% of fermented sucuks in this research. In addition, a significant correlation ($p<0.01$) was determined between the presence of blood in the samples examined with the putrefaction and the presence of starch. This situation suggest that starch and similar products, offal with high blood content and low value (head meat, lung, spleen, heart meat, diaphragm muscle) or unrested meat may have been added to sucuks.

CONCLUSION

As a result, it was determined that some fermented sucuks traditionally produced in Siirt do not comply with the criteria specified in the relevant standards in terms of coliform group microorganism, *E. coli* and *S. aureus* count, moisture amount, pH value, presence of starch, and putrefaction. Moreover, in all of the examined sucuk samples, the presence of blood was encountered at an extent that is enough to cause negativities in terms of food hygiene and technology. According to the findings, it has been evaluated that unhygienic and non-standard manufactured these products can pose potential public health problems. However, it has been concluded that some manufacturers are trying to gain an unfair advantage by means of poor-quality products. Because of these, technological conditions in the region should be improved and this product with high economic value production should be provided in a standard way. In addition, awareness-raising activities should be increased for the butchers manufacturing in sucuk production and the personnel working in the enterprises, and together with the inspections made by the authorized institutions should be contribute to expanded to preventive medicine.

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