Selcuk J Agr Food Sci, (2017) 31 (3), 94-100
ISSN: 2458-8377 DOI: 10.15316/SJAFS.2017.40

Selcuk Journal of Agriculture and Food Sciences

Determination of Some Physicochemical and Textural Properties of The Sucuk with Fat Content in Various Rates

Dilek Ceyda ÖVEN, Mustafa KARAKAYA, Kübra ÜNAL*, Ali Samet BABAOĞLU
Selcuk University Agriculture Faculty Food Engineering Department, Konya, Turkey

ARTICLE INFO

Article history:
Received date: 11.09.2017
Accepted date: 28.09.2017

Keywords:
Sucuk
Fat rate
Physicochemical
Textural properties

ABSTRACT

Appropriate raw material choice for sucuk production is one of the most influent factors on product quality. In the case that meat and fat features and their amounts are not suitable for sucuk production, it is not possible to get a quality end most of time product even if technological application during preparation of sucuk dough stuffing and fermentation period are at the desired level. In this study, it is compared to determine and differences between them physicochemical and textural properties of 7 different groups of sucuk that have different fat contents (%20, 25%, 30% , 35%, 40%, 45%, 50%). In sucuk samples that have different fat amounts in each group, analyses such as moisture, protein, fat, ash, pH, color, lactic acid content, water activity (a_w) determination, texture profile analyses (TPA) were made. At the same time, sucuk with 7 different fat contents (%20, 25% , 30%, 35%, 40%, 45%, 50%) are stored for 5 weeks. Thiobarbituric acid (TBA) values, pH and colour changes were made on the sucuk on the weeks 1^{st}, 2^{nd}, 3^{th}, 4^{th} and 5^{th}. In the samples on the first week, average moisture, protein, fat, ash, pH, water activity and lactic acid contents of sucuk samples were determined to range between 47.59-43.87 %, 20.47-30.78 %, 19.10-33.91 %, 2.73-2.77 %, 5.68-5.78, 0.8715- 0.8890 a_w, 0.581-0.757 %, respectively. Hardness, gumminess and TBA values of sucuk samples were determined to range from 45.25 to 64.13 N, 34.13 to 49.17 Nxmm, 0.31 to 0.38 mg MA/kg, respectively.

1. Introduction

Sucuk is a popular meat product produced from a mixture of meat, fat and some ingredients. After mixing, sucuk dough is filled into a natural casing, hung up at 22-23°C for fermentation (ripening period) by either naturally present microorganisms or added starter cultures and dried under climatic conditions until a semi or dry product is obtained.

The main component of sucuk production is fat after meat. Sucuk has high fat content approximately 30–40%. During ripening of sucuk, hydrolytic and oxidative changes occur in fats. These reactions influence product standart (Ordonez et al., 1999). The high fat content of dry fermented sausages is essential for sensory properties, such as hardness, juiciness and flavour (Wirth, 1988).

Fat also plays significant technological roles in sucuk manufacture. It contributes soften the dough, which helps continuous moisture release from inside of sucuk (Kayaardı and Gök, 2003).

* corresponding author: *ulusoy_kubra@hotmail.com*

Lipid stability of fermented sucuk is important property during production and storage. High fat contents increased lipolytic activity and lipid oxidation (Soyer and Ertaş, 2007). However, fat reduction in sucuk processing may affect the acceptability of the products (Muguerza et al., 2002) as Abiola and Adegbaju (2001) stated that the sensory properties of sausages decreases with decreasing fat content.

Animal fat for sucuk processing has higher saturated fatty acids. It was known that there is a relation between fatty acid consumption and cardiovascular diseases. Consumers need to reduce fat intake in the total diet because the amount of fat rich in saturated fatty acids bring about an increase in plasma low density lipoprotein (LDL) concentration. However, from a health point of view, excessive fat intake is not recommended. For this reason, some researchers have focused on the reduction and partial substitution of fat in dry fermented sausages (Liaros et al., 2009; Muguerza et al., 2003; Olivares et al., 2011; Olivares et al., 2010).

As fat is major flavour, quality and texturel component in sucuk, the level of fat can change product property. The aim of this study was to determine the effect of fat level on some properties such as pH, a_w, lactic acid, Thiobarbituric acid (TBA) value, color and texture profil analysis of sucuk.

2. Material and Method

2.1. Sucuk Production and Sampling

Two experiments were performed involving seven groups of sucuk with various fat (20%, 25%, 30%, 35%, 40%, 45% and 50%) ratios named as S20, S25, S30, S35, S40, S45 and S50.

Meat, fat and other additives were obtained from a local manufacturer (Yılet Meat and Meat Products Company) in Konya, Turkey. Fat ratios were standardized according to the weight of meat. Other additives were added as follows: 2% garlic, 2% NaCl, 1.8% cumin, 1.8% hot red pepper, 0.2% black pepper, 0.15% pimento, 0.1% thyme powder, 0.2% dextrose, 0.01% $NaNO_2$. The meat and frozen fat were minced in a grinder (Novicki Taurus, Poland) and mixed together with other ingrediensts in a mixer (Seydelman, Germany). Then they were filled into 34 mm diameter casings (Fibran, Turkey) using a filling machine (Vemag, Turkey). Samples were pre-fermented and then, they were exposed to heat treatment at 65 °C for 20-25 minutes gradually and cooled immediately to 17 °C with a water shower. After processing (4 days), sucuks were stored at 4 °C until analysis.

Sucuk samples with different fat contents were randomly taken for moisture, protein, fat, ash, water activity (a_w), pH, colour and texture profile analyses (TPA). At the same time, each sucuk group (S20, S25, S30, S35, S40, S45, S50) are stored. Thiobarbituric acid (TBA) numbers and colour changes were made on the sucuk on the weeks 1^{st}, 2^{nd}, 3^{th}, 4^{th} and 5^{th}. All analyses were carried out in duplicate.

2.2. Proximate analysis

Moisture, protein, ash and fat (ether-extraction) contents of the sucuk samples were determined using standard methods of (AOAC, 2000). pH values of samples were measured by pH meter (Mettler, Toledo) according to (Gökalp et al., 2012). Water activity of samples (Testo, Germany) was determined in accordance with the method of Troller and Christian (1978). Acidity of sucuk groups were determined by % lactic acid type (AOAC, 2000).

2.3. Color determination

Colour measurements were performed using a chromameter (model CR-400, Konica Minolta, Osaka, Japan) with illuminant D65 (*L**, *a** and *b** values), 2° observer, 8 mm illumination range, in mode Diffuse/O. Color coordinates *L** (luminance), *a** (redness, +60, red; -60, green) and *b** (yellowness, +60, yellow; -60, blue) were fixed in compliance with CIE *L*a*b** color coordinate system(CIE, 1976). The measurements were performed by applying 3 different readings on exterior surfaces of sucuk samples in each group and on cross sections of slices taken from every sucuk sample.

2.4. Texture profil analyses (TPA)

TA-XT plus texture analyzer with 50 kg load cell was used to determine texture profil analysis of sucuk samples using compression test. Each group of sucuk samples were cut cylindrical. Samples were analysed at 20 °C to hold for equilibration to room temperature. 36 mm diameter cylinder probe with radiused edge was used to texture measurement applying 50 % compression (strain). Hardness (N), adhesiveness (Nxsn), springiness (mm), cohesiveness, gumminess (N), chewiness (N×mm) and resilience of samples were done with software program of the device (Bozkurt and Bayram, 2007, Herrero et al., 2007) .

2.5. TBA values

The method described by Gökalp et al. (2012) was used to determine lipid oxidation of the samples in storage periods (1^{st}, 2^{nd}, 3^{th}, 4^{th} and 5^{th}). The TBA numbers were expressed as milligrams of malonaldehyde per kilogram samples (mg MA/kg sample).

2.6. Statistical analyses

Each parameter was tested in triplicate samples with two replications. Collected data were subjected to statistical analyses using the MINITAB for Windows Release 16.0 (MINITAB, 2000). The data obtained from stored samples were submitted to two-way analysis of variance.The mean values were analyzed using Tukey Multiple Comparison Test.

3. Results and Discussion

3.1. Proximate analyses

Moisture, protein, fat, ash contents, pH values and water activity of sucuk samples are given in Table 1. The moisture contents in the sucuk samples with 20%, 25%, 30%, 35%, 40%, 45% and 50% fat levels were in the ranges of 43.87-47.59%. Lactic acid number of sucuk groups were found between 0.57-0.72%. pH values of sucuk values were ranged between 5.67-5.79. Yalınkılınç et al. (2012) stated that the use of different fat levels (10, 15 and 20%) had no effect on the pH values of samples ($p>0.05$).

According to Turkish Food Codex Communiqué on Meat and Meat Products (2012), moisture content, moisture protein ratio (MPR) and fat protein ratio (FPR) of sucuk must be below 50%, 3.6 and 2.5, respectively. Protein content of sucuk must also higher 14 %. Table 1 indicated moisture, MPR, FPR and protein content of sucuk groups were in accordance with codex.

Soyer et al. (2005) found the fat and protein contents were ranged 13.54-32.57% and 10.55-18.52% for the 10, 20 and 30% formulations, respectively. Palamutoglu and Saricoban (2016) reported moisture, protein, fat, ash contents and pH values of sucuks were in the ranges of 52.02-53.58%, 18.42-23.13%, 20.60-28.08% and 1.33-1.74%, 4.81-5.90, respectively.

The water activity of the sucuk samples was found as 0.950 by (Coşkuner et al., 2010). In this study, moisture and a_w of sucuk samples were lower than above mentioned researches. It was probably high heating temperature in the sucuk processing decrease the moisture value of samples.

Table 1

Moisture, protein, fat, ash, pH, water activity contents, moisture protein ratio (MPR) and fat protein ratio (FPR) of sucuk samples

Samples	Moisture* (%)	Protein** (%)	Fat* (%)	Ash (%)	pH*	a_w**	MPR**	FPR**
S20	47.59±1.478^{a}	29.77±1.421^{a}	19.07±0.049^{d}	2.685±0.035	5.76±0.035^{ab}	0.8715±0.002^{d}	1.60±0.126^{d}	0.64±0.029^{c}
S25	47.41±1.690^{a}	25.53±1.739^{b}	23.74±0.749^{bc}	2.660±0.099	5.79±0.014^{a}	0.8765±0.001^{cd}	1.86±0.193^{cd}	0.93±0.093^{b}
S30	46.64±0.417^{ab}	24.48±0.191^{b}	22.85±1.052^{c}	2.745±0.078	5.77±0.028^{ab}	0.8810±0.004^{cd}	1.91±0.032^{bcd}	0.93±0.034^{b}
S35	46.00±0.106^{abc}	24.05±0.057^{b}	25.15±0.042^{b}	2.625±0.163	5.79±0.028^{a}	0.8830±0.004^{abc}	1.91±0.000^{bcd}	1.05±0.001^{b}
S40	46.09±0.827^{abc}	23.09±0.007^{b}	25.23±0.078^{b}	2.435±0.063	5.78±0.014^{ab}	0.8870±0.001^{ab}	2.00±0.035^{abc}	1.09±0.004^{b}
S45	43.87±0.381^{c}	19.31±0.700^{c}	33.50±0.346^{a}	2.740±0.198	5.67±0.000^{b}	0.8920±0.00^{a}	2.27±0.102^{ab}	1.74±0.081^{a}
S50	44.53±0.297^{bc}	18.75±0.403^{c}	33.44±0.657^{a}	2.680±0.056	5.72±0.049^{ab}	0.8890±0.001^{ab}	2.38±0.035^{a}	1.78±0.073^{a}

**p<0.01, *p<0.05

a-d: Mean values followed by different superscripts within the same column indicate a statistically significant difference between the mean values (p<0.01, p<0.05). Values represent the mean ± standard error

3.2. Texture profil analyses

Texture profile properties of sucuk samples with different fat levels are given in Table 2. Using different fat level significantly affect on the hardness and gummines of the sucuk samples (p<0.01).

Table 2

Effects of fat levels on hardness and gumminess of sucuk groups.

Samples	Hardness** (N)	Gumminess** (Nxmm)
S20	64.13±2.505^{a}	49.17±0.540^{a}
S25	60.91±0.253^{ab}	47.43±0.386^{a}
S30	59.29±0.597^{b}	45.98±3.288^{ab}
S35	52.61±0.508^{c}	39.70±1.309^{bc}
S40	49.08±0.529^{cd}	38.24±1.213^{c}
S45	48.16±1.065^{cd}	38.01±2.161^{c}
S50	45.25±1.082^{d}	34.13±0.404^{c}

**p<0.01

a-d: Mean values followed by different superscripts within the same column indicate a statistically significant difference between the mean values (p<0.01). Values represent the mean ± standard error.

As seen in Figure 1, hardness decreased from 64.13 to 45.25 N. Hardness value of S20 is higher than S50 which has maximum fat level. Fat has an important role to contribute to the texture of meat products (Serdaroğlu, 2006). In addition protein content makes important contribution to the texture of sucuk. Baker et al. (1969) informed sensory firmness increased as protein content was raised from 9% to 18% in chicken frankfurters formulated with beef fat. Simon et al. (1965) determined as protein content was increased, the hardness increased in beef and pork frankfurters. Bloukas and Paneras (1993) reported that hardness values positively correlated with protein content (10–14%) in low fat (10%) frankfurters.

However, the effect of the fat level on the adhesiveness, springiness, cohesiveness,chewiness and resilience of sucuk groups was not found to be statistically significant (p>0.05). A change in the fat level would decrease meat quality properties, especially juiciness and flavor, which are already impaired in some cases (Chizzolini et al., 1999). Animal fat in meat products plays important roles on textural characteristics of meat products such as hardness, gumminess, juiciness, and chewiness because of their hard structure (Fernandez-Gines et al., 2005; Ospina-E et al., 2012; Yıldız-Turp and Serdaroğlu, 2008)

Palamutoglu and Saricoban (2016) determined the hardness and gumminess values of encapsulated collagen hydrolysate added sucuk between 15.41 to 35.83 N, 12.91 to 37.32 N. But, there was no statistically significant difference for adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience values of sucuk samples.

Bozkurt and Bayram (2006) reported that the hardness and gumminess values of fermented sucuk increased from 352 to 8846 g and 226 to 5679, respectively during ripening. Szczesniak (2002) defined gumminess values change from short to pasty gummy. Increasing

gumminess values showed that sucuk samples became softer with increasing fat level.

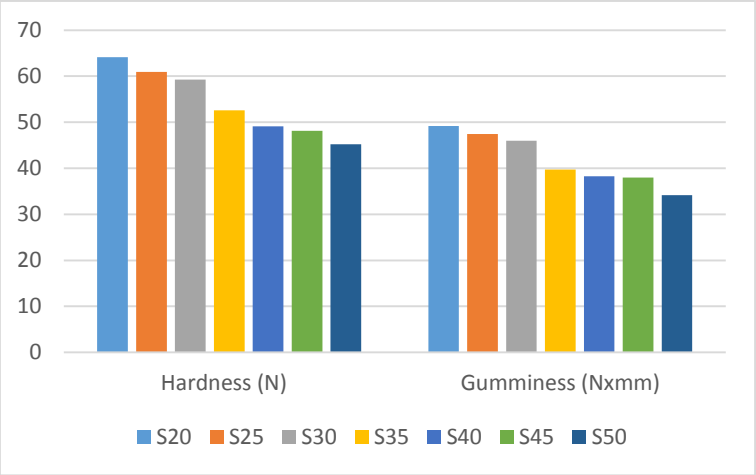

Figure 1

Hardness and gumminess values of sucuk with different fat level

3.3. TBA number and color properties

According to the varience analysis results, TBA numbers of sucuk samples were significantly affected by fat level, storage time and the interaction of storage time and fat level ($p<0.01$, $p<0.05$) (Table 3). TBA numbers of samples increased with storage time from 0.30 mg MA/kg sample to 0.51 mg MA/kg sample. As seen in Figure 2 the highest TBA number was found at the end of the storage time.

Table 3

Variance analysis results on the effect of fat level and storage time on TBA and color properties of sucuk

Parameters	Source of varience		
	F (%)	S (week)	FxS
TBA	10.60**	114.62**	8.09**
*L**	14.36**	15.98*	5.35**
*a**	5.92**	203.56**	3.61**
*b**	5.87**	99.35**	4.45

**:$p<0.01$; $p<0.05$.F: Fat level, S: Storage time

The effect of interaction of fat level and storage time on TBA numbers are given in Figure 3. The lowest TBA numbers (0.25 mg MA/kg sample) were shown in S20 on week 1. On the other hand the highest values were observed in S20 and S50 on week 5 as 0.66 and 0.60 mg MA/kg sample, respectively.

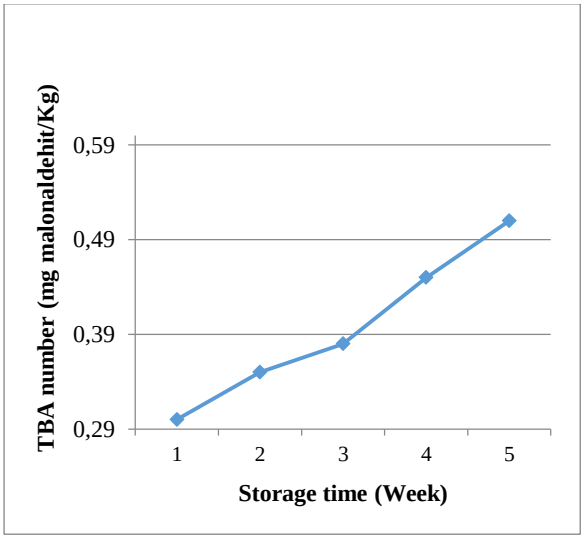

Figure 2.

TBA numbers of sucuk samples during storage time

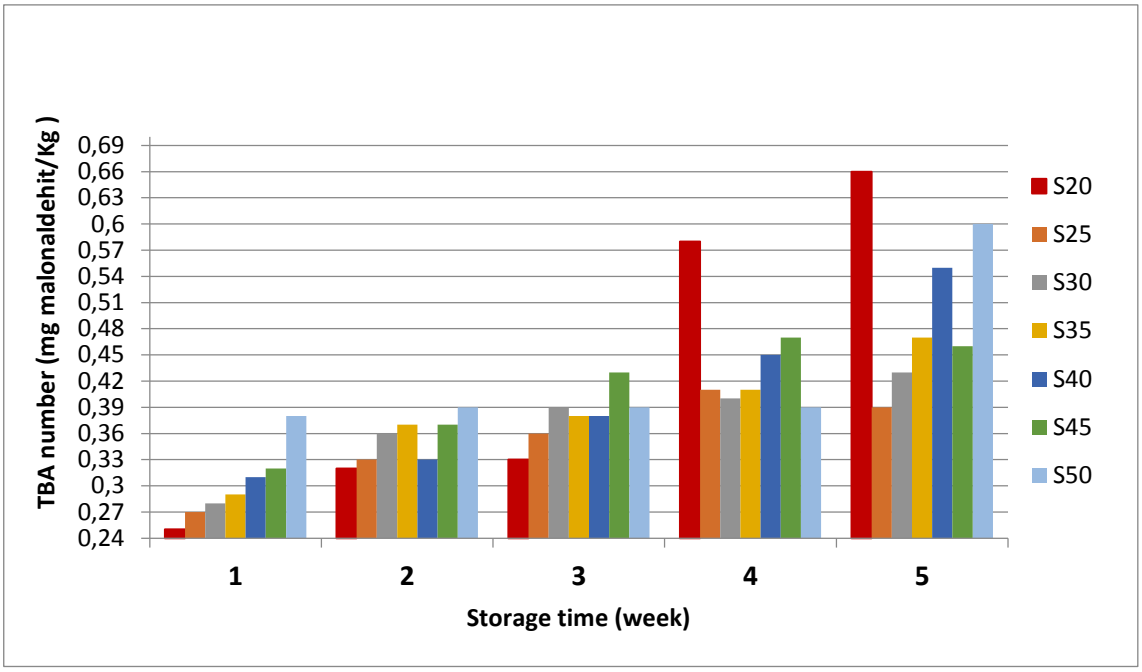

Figure 3
The effect of interaction of fat level and storage time on TBA numbers

Gökalp et al. (2012); Yıldız-Turp and Serdaroğlu (2008) reported that the highest TBA number of sucuk should be 1.0 mg MA/kg sample. Erkmen and Bozkurt (2004) determined that TBA numbers of industrial and butchers's sucuks were ranged 0.51-2.11 and 0.65-3.34 mg MA/kg sample, respectively. Many researchers stated that lipid oxidation caused to increase the TBA numbers. In our study, TBA numbers of sucuk groups were lower than 1.0 mg MA/kg sample.

The color characteristics (L^*, a^*, b^*) of sucuk samples were significantly affected by fat level, storage time and the interaction of fat level and storage time ($p<0.01$, $p<0.05$)(Table 3).

Papadima and Bloukas (1999) reported that increasing fat level caused higher lightness of Greek sausages. They also determined that storage time significantly affected L^*, a^* and b^* values of samples. Soyer et al. (2005) found that the effect of fat level, storage time and between the treatments on the lightness (L^*), redness (a^*) and yellowness (b^*) of the sausages was significant ($p<0.01$) and low fat content resulted in better colour development.

Effect of fat level and storage time on the lightness of sucuk groups was given in Figure 4. L^* values of sucuk samples were in the ranges of 34.67-40.82. Lightness of sucuk groups increased and decreased during storage for 5 weeks. Higher fat level caused in higher L^* values. Redness of sucuks were decreased during storage time (Figure 5). But the highest a^* value was shown in sample containing 45% fat level. a^* values of samples were between 9.73-15.94. Yellowness increased as fat level increased. According to the fat level, storage time the highest b^* value was observed in S45 and on week 1, respectively (Figure 6). Yellowness of samples were ranged 6.20-11.15. On the other hand, there was fluctuations about on b^* value of sucuk groups. Some researchers stated that L^*, a^* and b^* values of sucuks were ranges of 31.69-40.47, 5.4-16.58, 9.32-16.72 (Turhan et al., 2010); 38.22-43.93, 12.85-15.71, 17.46-21.83 (Çiçek and Polat, 2016), respectively.

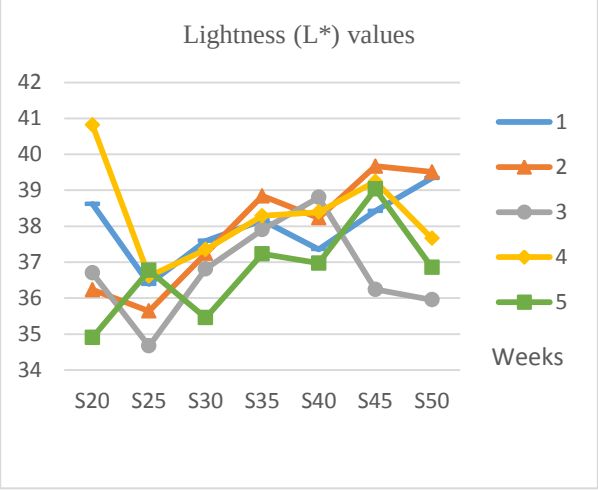

Figure 4
Effect of fat level and storage time on the lightness (L* values) of sucuk groups

Figure 5

Effect of fat level and storage time on the redness of sucuk groups

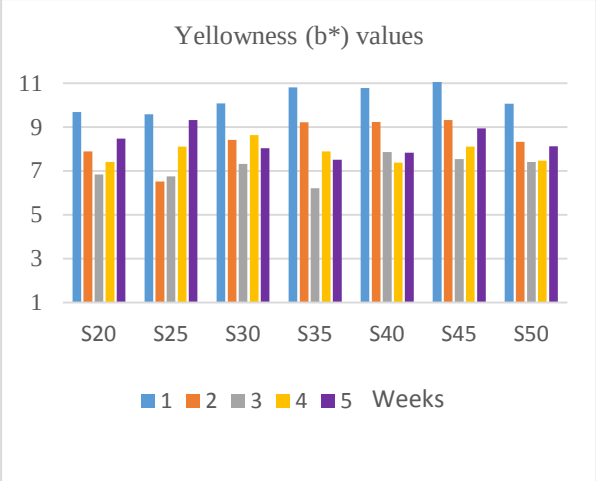

Figure 6

Effect of fat level and storage time on the yellowness of sucuk groups

4. Conclusion

From our analysis of samples with different fat content; decreasing the fat ratio in sucuk increases the hardness of the product. Increasing fat ratio results in decreasing the chewiness and gumminess of sucuks. As a result, we can recommend consuming in sucuk samples with 30-35% fat content. However, the number of TBAs did not reach the level that could create human health risks (1 mg MA / kg) during storage period.

5. References

Abiola SS, Adegbaju SW (2001). Effect of substituting pork backfat with rind on quality characteristics of pork sausage. *Meat Sci, 58*, 409-412.

AOAC (2000). *Official Methods of Analysis of AOAC Int. (17th ed.)*. 481 North Frederick Avenue Gaithersburg, Maryland 20877-2417 USA.: AOAC Int. Suite 500.

Baker RC, Darfler J, Vadehra DV (1969). Type and level of fat and amount of protein and their effect on the quality of chicken frankfurters. *Food Technology, 23*, 100-103.

Bloukas JG, Paneras ED (1993). Substituting olive oil for pork for pork backfat affects quality of low-fat frankfurters. *Journal of Food Science, 58*, 705-709.

Bozkurt H, Bayram M (2006). Colour and textural attributes of sucuk during ripening. *Meat Sci, 73*(2), 344-350.

Chizzolini R, Zanardi E, Dorigoni V, Ghidini S (1999). Calorific value and cholesterol content of normal and low-fat meat and meat products. *Trends Food Sci Technol, 10*, 119–128.

CIE (1976). *International Commission on Illumination*, Colorimetry: official recommendations of the International Commission on Illumination. . Paris, France: Bureau Central de la CIE.: Publication CIE No.15 (E-1.3.1)

Coşkuner O, Ertaş AH, Soyer A (2010). The effect of processing method and storage time on constituents of Turkish sausages (Sucuk). *J. Food Process Preserv, 34*, 125-135.

Çiçek Ü, Polat N (2016). Investigation of physicochemical and sensorial quality of a type of traditional meat product: Bez sucuk. *LWT - Food Science and Technology, 65*, 145-151.

Erkmen O, Bozkurt H (2004). Quality characteristics of retailed sucuk (Turkish dry-fermented sausage). *Food Technology and Biotechnology, 42*, 63-69.

Fernandez-Gines JM, Fernandez-Lopez J, Sayas-Barbera E (2005). Meat products as functional foods: A review. *J. Food Sci, 70*, 37-43.

Gökalp HY, Kaya M, Tülek Y, Zorba Ö (2012). *Et ve Et Ürünlerinde Kalite Kontrolü ve Laboratuvar Uygulama Kılavuzu*. Erzurum: Atatürk Üni. Yayın no: 751 Ziraat Fak. Yayın No: 318, Ders Kitapları Serisi No:69.

Herrero AM, Ordónez JA, Romero de Avila Herranz B, de la Hoz L, Cambero MI (2007). Breaking strength of dry fermented sausages and their correlation with texture profile analysis (TPA) and physico-chemical characteristics. *Meat Sci*, 77, 331-338.

Kayaardı S, Gök V (2003). Effect of replacing beef fat with olive oil on quality characteristics of Turkish soudjouk (sucuk). *Meat Sci, 66*, 249-257.

Liaros NG, Katsanidis E, Bloukas JG (2009). Effect of ripening time under vacuum and packaging film permeability on processing and quality characteristics of low fat fermented sausages. *Meat Sci, 83*, 589−598.

MINITAB (2000). Computer program, MINITAB release 13.0 for Windows. USA: Minitab Inc.

Muguerza E, Ansorena D, Bloukas JG, Astiasarán I (2003). Effect of fat level and partial replacement of pork back fat with olive oil on the lipid oxidation and volatile compounds of Greek dry fermented sausages. *Journal of Food Science, 68*(4), 1531-1536.

Muguerza E, Fista G, Ansorena D, Astiasarán I, Bloukas JG (2002). Effect of fat level and partial replacement of pork backfat with olive oil on processing and quality characteristics of fermented sausages. *Meat Sci, 61*, 397−404.

Olivares A, Navarro JL, Flores M (2011). Effect of fat content on aroma generation during processing of dry fermented sausages. *Meat Sci, 87*, 264-273.

Olivares A, Navarro JL, Salvador A, Flores M (2010). Sensory acceptability of slow fermented sausages based on fat content and ripening time. *Meat Science,, 86*(2), 251-257.

Ordonez JA, Hierro EM, Bruna JM, de la Hoz L (1999). Changes in the components of dry-fermented sausages during ripening. *Crit Rev Food Sci Nutr, 39*(4), 329-367.

Ospina-E JC, Sierra-C A, Ochoa O, Pérez-Álvarez JA, Fernández-López J (2012). Substitution of saturated fat in processed meat products: A Review. *Critical Reviews in Food Science and Nutrition, 52*(2), 113-122.

Palamutoglu R, Saricoban C (2016). The effect of the addition of encapsulated collagen hydrolysate on some quality characteristics of sucuk. *Korean J Food Sci Anim Resour, 36*(6), 807-818.

Papadima SN, Bloukas JG (1999). Effect of fat level and storage conditions on quality characteristics of traditional Greek sausages. *Meat Sci, 51*, 103–113.

Serdaroğlu M (2006). Improving low fat metaball characteristics by adding whey powder. *Meat Sci, 72*, 155–163.

Simon S, Field JC, Kramlich WE, Tauber FW (1965). Factors affecting frankfurter texture and a method of measurement. *Food Technology, 19*, 410-416.

Soyer A, Ertaş AH (2007). Effects of fat level and storage time on lipid and color stability of naturally fermented Turkish sausages (Sucuk). *J. Muscle Foods, 18*, 330-340.

Soyer A, Ertaş AH, Üzümcüoğlu Ü (2005). Effect of processing conditions on the quality of naturally fermented Turkish sausages (sucuks). *Meat Sci, 69*, 135-141.

Szczesniak AS (2002). Texture is a sensory property. *Food Quality and Preference, 13*, 215–225.

Troller JA, Christian JHB (1978). *Water Activity and Foods*. New York.

Turhan S, Temiz H, Üstün NŞ (2010). *Bez sucukların bazı fiziksel ve kimyasal ozelliklerinin belirlenmesi.* Paper presented at the 1st International Symposium on Traditional Foods from Adriatic to Caucasus

Wirth F (1988). Technologies for making fat-reduced meat products. *Fleischwirtsch, 68*(9), 1153−1156.

Yalınkılıç B, Kaban G, Kaya M (2012). The effects of different levels of orange fiber and fat on microbiological, physical, chemical and sensorial properties of sucuk. *Food Microbiology*, 29 (2), 255-259.

Yıldız-Turp G, Serdaroğlu M (2008). Effect of replacing beef fat with hazelnut oil on quality characteristics of sucuk – A Turkish fermented sausage. *Meat Sci, 78*, 447-454.