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

Paper Type: Research Article

**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 influential 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 1st, 2nd, 3rd, 4th and 5th. 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 standard (Ordóñez 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).

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).
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 (Yilet 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% NaNO₂. The meat and frozen fat were minced in a grinder (Novicki Taurus, Poland) and mixed together with other ingredients in a mixer (Seydelman, Germany). Then they were filled into 34 mm diameter casings (Fibran, Turkey) using a filling machine (Venmag, 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.

Sucuks 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 1st, 2nd, 3rd, 4th and 5th. 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 (Nxsnn), 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 (1st, 2nd, 3rd, 4th, and 5th). The TBA values 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. Yalınkılıç 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 code.
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 sucuk 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 (Coşkun et al., 2010). In this study, moisture and aw 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

<table>
<thead>
<tr>
<th>Samples</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>pH</th>
<th>aw</th>
<th>MPR</th>
<th>FPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>S20</td>
<td>47.59±1.478a</td>
<td>29.77±1.421a</td>
<td>19.07±0.049a</td>
<td>2.685±0.035</td>
<td>5.76±0.035ab</td>
<td>0.8715±0.002a</td>
<td>1.60±0.126a</td>
<td>0.64±0.029a</td>
</tr>
<tr>
<td>S25</td>
<td>47.41±1.690a</td>
<td>25.53±1.739b</td>
<td>23.74±0.749ab</td>
<td>2.660±0.099</td>
<td>5.79±0.014a</td>
<td>0.8765±0.001ab</td>
<td>1.86±0.193ab</td>
<td>0.93±0.093a</td>
</tr>
<tr>
<td>S30</td>
<td>46.64±0.417ab</td>
<td>24.48±0.191b</td>
<td>22.85±1.052a</td>
<td>2.745±0.078</td>
<td>5.77±0.028ab</td>
<td>0.8810±0.004ab</td>
<td>1.91±0.032abc</td>
<td>0.93±0.034a</td>
</tr>
<tr>
<td>S35</td>
<td>46.00±0.106abc</td>
<td>24.05±0.057b</td>
<td>25.15±0.042a</td>
<td>2.625±0.163</td>
<td>5.79±0.028b</td>
<td>0.8830±0.004bc</td>
<td>1.91±0.000cd</td>
<td>1.05±0.001b</td>
</tr>
<tr>
<td>S40</td>
<td>46.09±0.827abc</td>
<td>23.09±0.007b</td>
<td>25.23±0.078a</td>
<td>2.435±0.063</td>
<td>5.78±0.014b</td>
<td>0.8870±0.001ab</td>
<td>2.00±0.035bc</td>
<td>1.09±0.004b</td>
</tr>
<tr>
<td>S45</td>
<td>43.87±0.381b</td>
<td>19.31±0.700</td>
<td>33.30±0.346</td>
<td>2.740±0.198</td>
<td>5.67±0.000b</td>
<td>0.9020±0.00a</td>
<td>2.27±0.102bc</td>
<td>1.74±0.081b</td>
</tr>
<tr>
<td>S50</td>
<td>44.53±0.297bc</td>
<td>18.75±0.403</td>
<td>33.44±0.657</td>
<td>2.680±0.056</td>
<td>5.72±0.049bc</td>
<td>0.8890±0.001ab</td>
<td>2.38±0.035bc</td>
<td>1.78±0.073b</td>
</tr>
</tbody>
</table>

**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 gumminess of the sucuk samples (p<0.01).

Table 2
Effects of fat levels on hardness and gumminess of sucuk groups.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Hardness** (N)</th>
<th>Gumminess** (Nxmm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S20</td>
<td>64.13±2.505a</td>
<td>49.17±0.540a</td>
</tr>
<tr>
<td>S25</td>
<td>60.91±0.253ab</td>
<td>47.43±0.386a</td>
</tr>
<tr>
<td>S30</td>
<td>59.29±0.597b</td>
<td>45.98±3.288ab</td>
</tr>
<tr>
<td>S35</td>
<td>52.61±0.508c</td>
<td>39.70±1.309bc</td>
</tr>
<tr>
<td>S40</td>
<td>49.08±0.529d</td>
<td>38.24±1.213c</td>
</tr>
<tr>
<td>S45</td>
<td>48.16±1.065ed</td>
<td>38.01±2.161e</td>
</tr>
<tr>
<td>S50</td>
<td>45.25±1.082d</td>
<td>34.13±0.404c</td>
</tr>
</tbody>
</table>

**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) found 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; Yildiz-Turp and Serdaroglu, 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 variance 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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Source of varience</th>
<th>F (%)</th>
<th>S (week)</th>
<th>FxS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBA</td>
<td>10.60**</td>
<td>114.62**</td>
<td>8.09**</td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>14.36**</td>
<td>15.98*</td>
<td>5.35**</td>
<td></td>
</tr>
<tr>
<td>a*</td>
<td>5.92**</td>
<td>203.56**</td>
<td>3.61**</td>
<td></td>
</tr>
<tr>
<td>b*</td>
<td>5.87**</td>
<td>99.35**</td>
<td>4.45</td>
<td></td>
</tr>
</tbody>
</table>

**: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
Öven et al. / Selcuk J Agr Food Sci, (2017) 31 (3), 94-100

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 sucsuks were decreased during storage (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 sucsuks 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
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 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


