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Research Article

Textural Properties of Fat - Reduced Sucuk with Orange Fiber

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Abstract

In this study, sucuk samples with different orange fiber (0%, 2% and 4%) and fat (sheep tail fat) levels (10%, 15% and 20%) were produced and textural parameters were investigated during ripening time. Use of orange fiber significantly affected hardness, chewiness, gumminess and resilience parameters in all groups (P<0.01). The highest hardness score was detected in samples containing 4% orange fiber. In contrast, no statistically significant effect of fat usage was observed on hardness (P>0.05). While textural parameters, adhesiveness, springiness, chewiness, gumminess and resilience, were affected (P<0.01) by fat level, cohesiveness was not significantly affected by fat level (P>0.05). However, ripening time was the most effective factor on all textural parameters (P<0.01). While a permanent increase was observed in hardness, adhesiveness, gumminess and chewiness values of all samples during ripening, the highest value (increase) was determined in hardness.

Keywords: *Sucuk, Orange fiber, Fat level, Texture*

Portakal Lifli Yağı - Azaltılmış Sucuğun Tekstürel Özellikleri

Özet

Bu çalışmada, farklı oranlarda portakal lifi (%0, %2 ve %4) ve yağ (koyun kuyruk yağı) (%10, %15 ve %20) kullanılarak sucuk üretilmiş ve tekstürel parametreler olgunlaştırma süresince incelenmiştir. Portakal lifi kullanımı tüm gruplarda sertlik, çiğnenebilirlik, sakızımsılık ve esneklik parametrelerini önemli seviyede (P<0.01) etkilemiştir. En yüksek sertlik değeri %4 portakal lifi içeren örneklerde belirlenmiştir. Buna karşın, yağ kullanımının sertlik üzerine istatiksel olarak önemli bir etkisi (P>0.05) belirlenmemiştir. Yapışkanlık, elastikiyet, çiğnenebilirlik, sakızımsılık ve esneklik yağ seviyesinden etkilenen (P<0.01) tekstürel parametreler iken, bağlayıcılık yağ seviyesinden (P>0.05) etkilenmemiştir. Bununla birlikte olgunlaştırma süresi tüm tekstürel parametreler üzerinde en etkili faktördür (P<0.01). Olgunlaştırma sırasında örneklerin sertlik, yapışkanlık, sakızımsılık ve çiğnenebilirlik değerlerinde sürekli bir artış gözlenirken, en yüksek değer (artış) sertlikte belirlenmiştir.

Anahtar sözcükler: *Sucuk, Portakal lifi, Yağ seviyesi, Tekstür*

INTRODUCTION

Textural properties of dry-fermented sausages play an important role on consumer preferences. In order to obtain best results for textural properties, all processing stages and ingredients should be controlled. However, attempts to bring functional properties to dry-fermented sausages with addition of dietary fibers bring new questions in controlling texture development. Because of their technological properties such as gel forming ability and water holding capacity, dietary fibers can strongly effect the textural properties during production and eventually causes a new product having different textural properties than the traditional one [1,2].

Fat is important for flavor, texture and aroma formation in meat products. However, to satisfy consumer health concerns, it is required to decrease the fat ratio in dry-fermented sausage formulation. But, decreasing fat in dry-fermented sausage formulation could cause some technological and sensorial problems. Hence, for minimizing the negative effects of fat reduction, plantal fibers have been used in dry fermented sausages [3,4].

Sucuk is a traditional dry fermented sausage produced and consumed in Turkey. Many important changes occur in biochemical and textural parameters of sucuk during processing. Changes in pH and moisture level during ripening are particularly important for sucuk production [5,6].

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In our scan of research conducted on sucuk, there is only one study dealing with the textural properties of sucuk [5]. On the other hand, there are only a few studies on the use of fruit fibers in sucuk manufacture [7-9]. However, there is no information about the effects of different fat and fiber levels on sucuk's textural attributes. Thus, the aim of the study was to investigate the effects of different levels of fat and orange fiber on textural properties of sucuk.

MATERIAL and METHODS

Production of Orange Fiber and Sucuk Manufacturing

Cooked and dried orange fiber was obtained according to a method offered by Fernandez-Gines et al.[10]. Two replicates (Experiment I and Experiment II) were carried out for the study. Nine sucuk batters were prepared for each experiment according to fat level (10% sheep tail fat + 90% lean meat, 15% sheep tail fat + 85% lean meat, and 20% sheep tail fat + 80% lean meat) and orange fiber level (0%, 2% and 4%). As a parallel research project to that of Yalınkılıç et al.[9], the ingredients (g/kg) and ripening conditions were used. *Staphylococcus xylosus* GM92 and *Lactobacillus plantarum* GM77 strains were used as starter culture [11]. Sucuk mixture was prepared in a laboratory-type cutter (MADO MTK 662, Schwarzwald) by mincing and mixing. Prepared mixture were filled into collagen casings (38 mm, Naturin Darm, Germany) using a laboratory-type stuffing machine (MADO MTK 591,Schwarzwald). Fermentation and ripening of sucuk samples were carried out in an automatic climate unit (Reich, Stuttgart).

Moisture Content and Texture Profile Analysis

Sampling was carried out by randomly selecting two sucuk samples of each group at certain days (1, 3, 5, 7 and 9 days) of fermentation and ripening. Moisture content of samples was measured according to Gökalp et al.[12]. Sucuk samples were evaluated using a texture analyser (TA-XTplus, Stable Micro Systems, Godalming, Surrey, UK) equipped with a cylindrical metal probe (50 mm) (P/25) using a 50 kg load cell. Five slices of each sample (17 mm height and 25 mm diameter) were compressed to 50% of their original height in two cycles. The TPA method was carried out under these conditions: pre-test speed: 1 mm/s, test speed: 2 mm/s, post-test speed: 3 mm/s, trigger type: outo-20 g and time: 5 s. The data obtained were processed by Texture Expert Software (Stable Micro System, London, United Kingdom) and expressed as hardness, adhesiveness, cohesiveness, springiness, gumminess, chewiness and resilience.

Statistical Analysis

All data from each experiment were subjected to variance analysis (two replications, complete randomized design) and differences between means were assessed by Duncan's multiple range test using the SPSS 13.0.0.246 for Windows (SPSS, Inc., Chicago, III., USA).

RESULTS

Overall effect of orange fiber, fat and ripening time on the moisture values of sucuk is shown in *Table 1*. No significant differences were observed between groups containing orange fiber ($P>0.05$). In contrast, increase in fat level had a very significant effect on the decrease of final moisture content ($P<0.01$) of the product. In the other hand, ripening time also had a very significant effect on moisture content ($P<0.01$) *(Table 1)*.

The effects of different levels of orange fiber and fat on textural parameters (hardness, adhesiveness, cohesiveness, springiness, chewiness, resilience and gumminess) were observed during ripening and results are given in *Table 1*. Significant differences in some textural parameters (hardness, gumminess, chewiness, and resilience) were observed between sucuk samples containing different fiber levels ($P<0.01$). In contrast, fiber level had no significance ($P>0.05$) on adhesiveness, cohesiveness and springiness values of samples *(Table 1)*. An increase in the amount of fiber in sucuk formulation increased the gumminess and chewiness parameters of samples and the highest mean scores were obtained in samples containing 4% fiber. Although the addition of orange fiber increased the resilience values, no statistically significant difference was found between 2% and 4% fiber levels. The interaction of fiber level and ripening time had a significant ($P<0.01$) effect on resilience values *(Fig. 1-A)*. Similarly, the interaction of fiber level and ripening time had very significant effect on springiness values of samples ($P<0.01$) *(Fig. 1-B)*.

In samples containing different fat levels, significant differences were observed in adhesiveness, springiness, gumminess, chewiness, and resilience values ($P<0.01$). The another factor, ripening time, had very significant effects on all textural parameters of sucuk ($P<0.01$) *(Table 1)*. Although reduced fat content resulted in increased hardness and cohesiveness, the differences were not statistically significant ($P>0.05$). The interactions of fat level×fiber level ($P<0.05$) and fat level×ripening time ($P<0.01$) had significant effects on springiness values of samples *(Table 1)*.

DISCUSSION

Moisture content in all groups were lower than 40% at the end of ripening time which is compatible with Communique of Meat and Meat Products of Turkish Food Codex (No: 2012/74) [13]. There are no significant differences between sucuk samples with or without fiber. Garcia et al.[14] stated that moisture loss during ripening in low fat dry fermented sausages containing fruit fiber slightly lower than those containing cereal fiber.

Dietary plant fibers are well-known ingredients used

Table 1. *Overall effect of orange fiber, fat and ripening time on the textural parameters and moisture values of sucuk*[1]
Tablo 1. *Portakal lifi, yağ ve olgunlaştırma süresinin sucuğun tekstürel parametreleri ve nem değerlerine etkileri*[1]

Parameter	Textural Parameters							
	Hardness	Adhesiveness	Cohesiveness	Springiness	Gumminess	Chewiness	Resilience	Moisture
Orange Fiber (O)								
0%	211.43±116.39a	-1.98±1.74a	0.46±0.1a	0.65±0.09a	99.50±49.46c	68.03±33.79c	0.14±0.05b	51.50±9.39a
2%	262.46±124.26b	-1.76±1.34a	0.45±0.08a	0.64±0.08a	123.42±57.78b	82.96±39.85b	0.15±0.05a	51.43±8.44a
4%	295.33±129.78c	-1.59±1.05a	0.45±0.06a	0.64±0.06a	134.65±58.07a	89.75±40.13a	0.15±0.04a	51.37±8.07a
Significance	**	NS	NS	NS	**	**	**	NS
Ripening Time (R)								
0	NA	NA	NA	NA	NA	NA	NA	61.81±2.68a
1	54.59±17.51e	-4.10±1.12c	0.34±0.03e	0.51±0.04d	19.22±7.49e	10.08±4.56e	0.06±0.01c	59.40±2.82b
3	221.38±43.95d	-1.62±0.48b	0.55±0.04a	0.71±0.03a	120.62±18.48d	85.10±11.36d	0.18±0.0a	54.70±3.38c
5	276.19±59.47c	-1.24±0.85ab	0.50±0.06b	0.69±0.03b	135.48±19.43c	93.81±12.6c	0.17±0.01a	48.05±3.27d
7	326.02±60.15b	-1.14±0.69ab	0.46±0.06c	0.66±0.02c	149.14±27.67b	99.61±18.04b	0.16±0.02b	45.05±4.83e
9	403.83±46.02a	-0.80±0.31a	0.42±0.03d	0.65±0.02c	171.47±22.56a	112.65±16.25a	0.16±0.01b	39.58±2.27f
Significance	**	**	**	**	**	**	**	**
Fat (F)								
10%	263.89±137.34a	-1.54±1.24a	0.47±0.09a	0.66±0.08a	126.17±61.07a	86.86±42.18a	0.158±0.05a	54.13±8.63a
15%	250.83±125.63a	-1.68±1.3a	0.45±0.08ab	0.65±0.08b	115.55±55.34b	78.21±38.5b	0.15±0.04b	51.57±8.52b
20%	254.49±121.61a	-2.12±1.61b	0.44±0.07b	0.63±0.06c	115.85±54.37b	75.68±35.54b	0.149±0.04b	48.60±7.85c
Significance	NS	**	NS	**	**	**	**	**
OxR	NS	NS	NS	**	NS	NS	**	NS
OxF	NS	NS	NS	*	NS	NS	NS	NS
RxF	NS	NS	NS	**	NS	NS	NS	NS

[1] *Presented values are means ±SD;* ***a-e*** *Any two means in the same column having the same letters in the same section are not significantly different (*P<0.05, **P<0.01);* ***NS:*** *not significant,* ***SD:*** *standard deviation,* ***NA:*** *not analyzed*

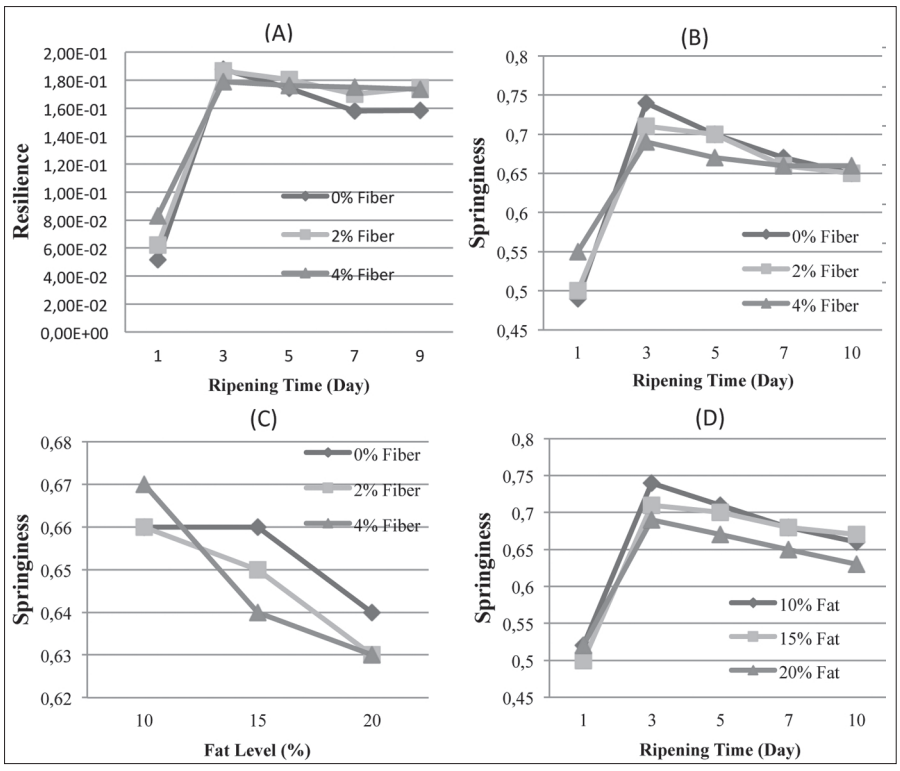

Fig 1. The effects of interactions between treatments on the textural parameters of sucuks

A- Fiber level × ripening time, **B-** Fiber level × ripening time, **C-** Fiber level ×f at level, **D-** Fat level × ripening time

Şekil 1. Sucuğun tekstürel parametrelerine muameleler arasındaki interaksiyonun etkisi

A- Lif seviyesi × olgunlaştırma süresi, **B-** Lif seviyesi × olgunlaştıma süresi, **C-** Lif seviyesi × yağ seviyesi, **D-** Yağ seviyesi x olgunlaştırma süresi

for improving technological properties of meat products with their health benefits in the last decade. Particularly, their properties such as water holding capacity and gel forming ability makes it important to clarify dietary fiber's impact on textural parameters [2]. The highest mean value for hardness was determined in samples containing 4% orange fiber. Similarly, Aleson-Carbonell et al.[1] reported that albedo type and content, significantly affected the textural characteristics of dry cured sausages and, in both types of albedo, the sausages with 5% added albedo showed the highest hardness value. In another study, it was reported that cereal fiber (3%) added sausages were harder, particularly in presence of wheat fiber. On the other hand, it was shown that addition of 1.5% orange fiber decreased hardness scores in both sausage containing 6% and 10% fat [14].

The level of fiber in sucuk formulation affected gumminess and chewiness values. The highest mean scores were determined in sucuk samples with 4% fiber. In a partly similar study, Aleson-Carbonell et al.[1] found that use of orange fiber in low fat (6-10%) dry fermented sausages decreased the gumminess values. In the same study, orange fiber slightly increased chewiness value in samples containing 6% fat, but a sharp decrease was observed in chewiness when the fat level reached to 10%. Springiness value was not affected by fiber level. However, the interaction of fiber level and ripening time was very significant on springiness. The highest springiness value was obtained in control group (fiber-free) on day 3 *(Fig. 1-B)*. In contrast, control group showed higher values than samples with 2% and 4% fiber in days 7 and 9 *(Fig. 1-A)*.

In the present study it was determined that fat level has an important effect on textural parameters (adhesiveness, springiness, gumminess, chewiness, and resilience). As indicated by Garcia et al.[14] decreasing fat to lower levels significantly affects the textural parameters. The effect of different fat levels on hardness value of sucuk samples was found close to those observed in chorizo de Pamplona by Gimeno et al.[15] and for cohesiveness in low-fat dry-fermented sausages [16]. Adhesiveness was directly related to fat content. This parameter decreased with a reduction in fat content and this difference was highest ($P<0.05$) between sucuk samples containing 10 and 20% fat. This also had been observed by Mendoza et al.[17]. The highest gumminess value was determined in samples containing 10% fat and no statistically significant difference was observed in samples containing 15 and 20% fat. The highest mean chewiness value was obtained in samples containing 10% fat. As amount of fat increased, score decreased in all samples. Salazar et al.[18] and Mendoza et al.[17] reported similar increases in gumminess and chewiness values when lower levels of fat were added to dry fermented sausage formulations. The increase in chewiness values could be explained by level of moisture loss during production [19]. The highest mean springiness value was observed in samples containing 10% fat. Increased levels of fat (15 and 20%) resulted in a decrease in springiness value *(Table 1)*. Similar results were found in breakfast sausages for springiness [20]. The highest springiness value was obtained in group 4% fiber and 10% fat *(Fig. 1-C)*. Springiness value increased until 3rd day and the highest value was observed in samples containing 10% fat. After 3rd day, the springiness value decreased until end of ripening time *(Fig. 1-D)*. As stated by Olivares et al.[21], fat reduction in dry fermented sausages causes significant changes in textural parameters.

Ripening time is one of the key steps in sucuk production with fermentation where significant moisture loss and changes in acidification, protein and fat level are observed. The major changes in hardness, chewiness and gumminess took place in the first three days. Hardness score which is the peak force of the first compression [20], increased from 54.59 to 221.38. This case may be explained by coagulation of protein at low pH and moisture loss, which took place during ripening [5]. Also, an increase in protein and decrease in moisture level during ripening can make product more denser, which results in higher hardness [20]. The same relationship between the ripening time and hardness was observed by Bozkurt and Bayram [5] in sucuk and by Lorenzo et al.[22] in dry-cured foal salchichon. For gumminess and chewiness scores of samples, a significant increase was observed during the progress of ripening. Similarly, Bozkurt and Bayram [5] reported that gumminess and chewiness increased during ripening of sucuk. Moreover, Lorenzo et al.[22] stated an increase in gumminess and chewiness scores during ripening of dry-cured foal salchichon. Cohesiveness and springiness values of samples showed a different pattern during ripening time. In the first three days, an increase was observed but after day 3, a regular decrease was detected in both parameters. However, final values of both parameters were higher than initial values *(Table 1)*. Increase in cohesiveness during ripening can be explained by pH decrease to isoelectrical point during ripening which favors gelification of proteins [23]. In contrast to our findings, Bozkurt and Bayram [5] detected a statistically insignificant decrease in cohesiveness and springiness values of sucuk samples during ripening. In another study, cohesiveness and springiness values was decreased during ripening significantly for cohesiveness and insignificantly for springiness [22]. During ripening, a strong decrease was observed in adhesiveness on day 1 and this decrease slightly proceeded for the following days similar to those obtained by Bozkurt and Bayram [5] in sucuk. The resilience values of samples changed by ripening. The lowest mean resilience value was observed in day 1 and the highest was in day 3. But just after that, a slight decrease was detected during the rest of the days of ripening *(Table 1)*. The values of springiness observed by Lorenzo et al.[22] in salchichon during ripening are very similar to ours. Decrease in adhesiveness score is good for cutting scores

of sucuk samples and makes it more sliceable. Moreover, an increase in springiness value which is related to elastic properties of sucuk shows a rise in elasticity probably due to moisture loss during ripening [5].

The main findings of the present study are proper for understanding the texture evolution of sucuk during ripening with different fat and fiber levels. Both fiber and fat levels significantly affected the many textural parameters which are important for consumer approval. Also, the importance of ripening time and moisture content on textural parameters were determined in detail. As can be understood from current study, its necessary to evaluate the textural parameters of sucuk when new ingredients are added to formulation for obtaining best results.

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