EFFECTS OF OLIVE OIL AS PARTIAL REPLACER OF ANIMAL FAT IN SUCUK DURING EARLY STAGES OF FERMENTATION

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Abstract – The objective of this study was to investigate the effects of partial animal fat replacement with olive oil on physical and chemical quality of sucuk during early stages of fermentation. 3 different formulations of sucuks were prepared as follows: C: control treatment formulated with 100% beef fat, O15: treatment formulated with 85% beef fat+15% olive oil, O30: treatment formulated with 70% beef fat+ 30% olive oil. No significant differences were recorded in moisture content. Replacing beef fat with olive oil had a significant effect in increasing pH drop rate and decreasing water activity ($p<0.05$). Increasing olive oil in the formulation resulted in lower weight losses ($p<0.05$). Significant changes were recorded in acidity by the effect of olive oil ($p<0.05$). Olive oil added samples had higher lightness, yellowness and redness values ($p<0.05$). The results showed that in early stages of fermentation of sucuk, olive oil had a significant effect on most of the quality attributes.

Key Words – olive oil, fat replacement, fermentation, sucuk, soujouk.

I. INTRODUCTION

Sucuk (a Turkish dried fermented sausage) is one of the most popular traditional meat products in Turkey, and mostly produced from beef, beef backfat, tail fat, salt, sugar, garlic, nitrite and/or nitrate and various spices [1, 2]. Fermented sausages are meat products that are rich in fat content. Fat plays a key role in many quality parameters of meat products, including nutritional value and sensory properties [3, 4]. However, health organizations all over the world have promoted reducing total dietary fat intake, saturated fatty acids and cholesterol. Recently, there has been an increase in the studies of reducing and substituting of fat content of meat products. Several studies have focused on replacing animal fat with various vegetable oils in order to achieve healthier meat products. The effects of replacement fat by olive oil [3, 5-11], soy oil [12], palm and cottonseed oils [13], hazelnut oil [14, 15] on quality of fermented meat products have been extensively investigated. Olive oil contains mostly monounsaturated fatty acids (56.3-86.5%), besides 8-25% saturated and 3.6-21.5% polyunsaturated fatty acids [16]. It is also a rich source of tocopherols and phenolic substances acting as antioxidants [17, 18]. Thus the incorporation of olive oil in meat products may have promising functional effects. The objective of this study was to research the effects of replacing beef fat with olive oil on some quality characteristics of sucuk during early fermentation.

II. MATERIALS AND METHODS

Fresh boneless lean beef, beef fat, olive oil and other additives were supplied from local market of İzmir. Beef was trimmed of visible fat and connective tissue. Lean and fat were minced through a 3 mm plate grinder (Arnica, Turkey). Three different formulations of sucuk, containing 0.5 kg meat each, were prepared. Each treatment was formulated to contain 20% total fat. Control **(C)** group was consisted of 100% beef fat. Olive oil was added to the formulations by replacing 15% **(O15)** or 30 % **(O30)** of beef fat. The other ingredients added to treatments were 10 g salt, 2 g saccarose, 1.25 g ascorbic acid, 0.75 g Na-nitrite mixture (90% salt, 10% nitrite), 13.75 g spices and 5 g garlic powder. After mixing all the ingredients by hand, sucuk doughs were stuffed into cellulose casings using a filling machine (Arnica, Turkey). Sucuk samples were allowed to stand at 4°C for 2 h before fermentation. Sucuks were placed in a fermentation cabin (DAIHAN SWGC-450, South Korea) and fermented at 24°C and 90% RH for 36 h. Samples were taken from each group on 0^{th} (initial), 4^{th}, 8^{th}, 12^{th}, 24^{th} and 36^{th}

hours of fermentation. Additionally, pH and weight loss were measured on 2nd and 6th hours of fermentation.

Moisture content of the samples was determined according to AOAC [19]. pH was measured from three different points by using a pH-meter (WTW pH 330i/SET, Germany) penetration probe. Weight loss was determined by measuring the differences in weight in time intervals and was expressed as percentage of the initial weight. Water activity (aw) was measured with a water activity measurement device (Testo AG 400, Lenzkirch, Germany), with a 0.001 sensitivity. Acidity was determined by titrimetric AOAC method and expressed as lactic acid % [19]. The surface color of the samples were measured by using a portable colorimeter (CR-300, Konica Minolta, Germany) from four different points and expressed as Hunter L* (lightness), a* (redness), b* (yellowness). The data was analyzed by one way ANOVA using the SPSS software version 21 [20].

III. RESULTS AND DISCUSSION

Changes in moisture content of sucuk samples during fermentation are presented in Table 1. Initial moisture values of samples containing olive oil were similar to values recorded by Muguerza *et al.* [9]. No significant differences were recorded between treatments, except the lowest value of O30 samples at 24th hour ($p<0.05$). During fermentation, in C and O15 samples moisture decrement was significantly important ($p<0.05$), while in O30 samples there was no significant changes.

Table 1 Moisture content (%) of sucuk treatments during fermentation period

Hours	C	O15	O30
0	57.94±3.87	59.47±1.89	59.28±0.13
4	61.16±0.28	59.30±2.50	59.79±0.38
8	60.94±1.05	60.44±3.65	59.18±1.84
12	59.70±0.70	56.38±2.31	58.40±1.37
24	57.64±1.05^{a}	55.79±0.33^{a}	51.05±8.67^{b}
36	52.68±2.74	49.00±2.96	53.02±2.17

Data are presented as the mean values of 3 replications ± SD. ab: Means with the different letter in the same row are significantly different ($p<0.05$).

Water activity (aw) of sucuk samples during fermentation could be seen in Table 2. Initial value was highest in O30 group ($p<0.05$), while within 12 hours, the values got closer to each other with drying. In all treatments, the changes in aw values with time were significant ($p<0.05$). At the end of fermentation O15 group had the lowest aw value ($p<0.05$).

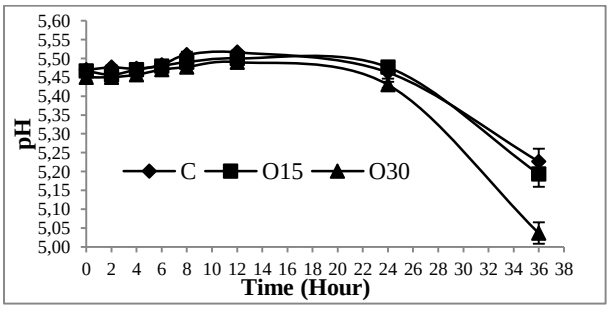
Table 2 Water activity of sucuk treatments during fermentation period

Hours	C	O15	O30
0	0.953±0.010^{a}	0.966±0.002^{a}	0.996±0,004^{b}
4	0.951±0.002^{a}	0.939±0.014^{a}	0.948±0,009^{a}
8	0.977±0.001^{a}	0.984±0.008^{a}	0.965±0,040^{a}
12	0.968±0.001^{a}	0,981±0.001^{b}	0.972±0,001^{c}
24	0.904±0.001^{a}	0.939±0.001^{b}	0.928±0,002^{c}
36	0.908±0.000^{a}	0.890±0.002^{b}	0.901±0,006^{a}

Data are presented as the mean values of 3 replications ± SD. ab: Means with the different letter in the same row are significantly different ($p<0.05$).

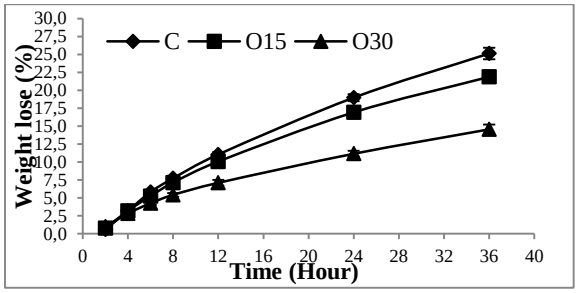
pH changes in treatments during fermentation is illustrated in Figure 1. According to Incze [21], organic acids, mainly lactic acid, are formed in high acid fermented sausages as a result of carbohydrate breakdown during fermentation, and pH drops below 5.3. The initial pH of samples ranged from 5.45 to 5.47 and final pH ranged from 5.04 to 5.23. Initial pH values coherent with the study of Yıldız-Turp and Serdaroğlu [14]. Fermentation time had a significant effect on pH ($p<0.05$). While initial pH values of treatments were similar, after 8 hours, pH decrement started to differ between groups ($p<0.05$). It could be concluded that replacing beef fat with olive oil had a significant effect in increasing the pH drop rate. Contrary to our results, in pork, the replacement of 20% pork back fat with olive oil did not affect pH [9].

Figure 1. pH changes in sucuk treatments during fermentation



Weight loss of sucuk samples during fermentation is illustrated in Figure 2. As a result of drying, all samples had weight loss. During fermentation, significant weight loss were recorded for all samples ($p<0.05$). Increasing olive oil in the formulation resulted in lower weight losses ($p<0.05$). At 36th hour, the highest weight loss was recorded in C samples ($p<0.05$). Similarly, Kayaardı and Gök [7], Yıldız-Turp and Serdaroğlu [14] reported lower weight losses in sucuks formulated with vegetable oil.

Figure 2. Weight loss in sucuk treatments during fermentation



Titratable acidity values of sucuk samples are presented in Table 3. During fermentation period acidity increased due to production of lactic acid by lactic acid bacteria. Acidity incensement was significantly important during fermentation for all groups ($p<0.05$). Although initial acidity values of the samples were close to each other, at 36th hour significant changes were recorded by the effect of olive oil ($p<0.05$).

Table 3 Acidity (lactic acid %) of sucuk treatments during fermentation period

Hours	C	O15	O30
0	0,129±0,005^{a,b}	0,117±0,007^{a}	0,136±0,008^{b}
4	0,144±0,018^{a}	0,133±0,007^{b}	0,125±0,007^{b}
8	0,129±0,004^{a}	0,138±0,003^{b}	0,129±0,003^{a,b}
12	0,128±0,001^{a}	0,129±0,004^{a}	0,132±0,002^{a}
24	0,169±0,010^{a}	0,158±0,007^{a}	0,169±0,001^{a}
36	0,167±0,002^{a}	0,172±0,002^{b}	0,161±0,001^{c}

Data are presented as the mean values of 3 replications ± SD. abc: Means with the different letter in the same row are significantly different ($p<0.05$).

L*, a* and b* values of treatments could be seen in Table 4. Olive oil replacement produced lighter colour ($p<0.05$). This finding coherent with Muguerza *et al.* [9], stating that both, higher fat level and inclusion of 20% olive oil produced lighter sausages. Fermentation period and olive oil replacement had a significant effect on the redness values of sucuk ($p<0.05$). Although redness of C samples decreased in time, incensements were recorded in redness of O15 and O30 samples. Replacing animal fat with olive oil produced more yellow sausages ($p<0.05$). Bloukas *et al.* [3] and Muguerza *et al.* [9] also found that replacing pork back fat with olive oil increased yellowness in fermented pork sausages. The yellowness of the sausages were significantly reduced during fermentation process ($p<0.05$).

Table 4 Colour (L*, a*, b*) of sucuk treatments during fermentation period

	L*		
Hours	**C**	**O15**	**O30**
0	45.42±1,35^{a}	50.87±1.33^{b}	56.32±1.00^{c}
4	45.07±0,63^{a}	40.93±0.67^{b}	49.17±1.41^{c}
8	41.90±0,87^{a}	45.41±0.59^{a}	51.91±0.94^{b}
12	39.97±1,40^{a}	45.60±0.60^{b}	47.70±1.05^{c}
24	38.76±0,83^{a}	44.87±0.57^{b}	37.60±4.38^{a}
36	37.21±0,50^{a}	42.37±1.20^{b}	48.53±0.63^{c}
	a*		
Hours	**C**	**O15**	**O30**
0	12.86±1.83^{a}	9.25±0.23^{b}	8.12±0.39^{b}
4	9.11±0.36^{a}	12.07±0.55^{b}	9.53±0.26^{a}
8	8.96±0.53^{a}	8.74±0.53^{a}	9.37±0.10^{a}
12	8.66±0.38^{a}	11.17±1.90^{b}	10.21±0.63^{a,b}
24	8.20±0.10^{a}	9.41±0.72^{b}	15.55±0.69^{c}
36	8.46±0.13^{a}	11.50±0.57^{b}	11.15±0.64^{b}
	b*		
Hours	**C**	**O15**	**O30**
0	11.79±1.21^{a}	16.31±1.20^{b}	15.84±0.57^{b}
4	11.22±1.05^{a}	11.34±1.16^{b}	15.97±0.89b
8	9.75±0.49^{a}	12.10±1.26^{b}	15.41±1.36^{c}
12	9.45±0.40^{a}	13.05±0.67^{b}	16.20±1.50^{c}
24	6.12±0.24^{a}	12.32±0.36^{b}	17.29±0.19^{c}
36	4.92±0.47^{a}	11.18±0.52^{a}	14.22±0.89^{b}

Data are presented as the mean values of 4 replications ± SD. abc: Means with the different letter in the same row are significantly different ($p<0.05$).

IV. CONCLUSION

The results of the study showed that partial replacement of beef fat with olive oil resulted in considerable changes in quality during fermentation. Further research should be performed with various vegetable oils and variable fermentation parameters.

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