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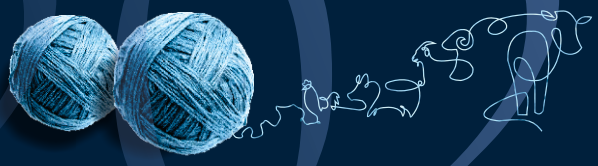
MODERN TRENDS IN LIVESTOCK PRODUCTION

2023



PROCEEDINGS

4 - 6 October 2023, Belgrade, Serbia

Institute for Animal Husbandry

Belgrade - Zemun, SERBIA

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CONTENT

POSTER SECTION

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EFFECT OF FAT LEVEL ON QUALITY CHARACTERISTICS OF TRADITIONAL SUCUK SAUSAGES. PART 1: PHYSICO-CHEMICAL CHANGES DURING PRODUCTION

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Invited paper

Abstract: This trial aimed to investigate changes in pH, proximate composition and fat rancidity parameters during the production of traditional Sucuk sausage (dry fermented sausage) with different fat levels. Three groups of sausages were produced from beef meat and fat: LF (low fat, with 10% added fat), MF (medium fat, with 20% added fat) and HF (high fat, with 30% added fat). The production was carried out in a traditional smoking house, and fermentation and ripening lasted 28 days. Samples were analysed after stuffing (day 0) and on days 7, 14, 21 and 28 of production. The higher fat content of the HF group probably influenced the lowest pH value at the beginning of production (day 0) ($p<0.05$). The HF group also had the mildest drop in pH ($p<0.05$), while the MF and LF groups had a similar trend in pH decline. Fat content had a significant effect on the proximate composition of the products, best reflected at the end of the production process, where the HF group had significantly higher fat and lower moisture and protein content ($p<0.05$). A higher total free fatty acids (FFA) content was obtained in the LF group, showing greater lipolysis than in MF and HF groups. Interestingly, sausages with higher fat content had lower peroxide values during production ($p<0.05$).

Key words: sucuk sausage, fat level, proximate composition, peroxide value, free fatty acid value

Introduction

Three types of traditional fermented sausages are most popular in Serbia: Sremski kulen, Sremska sausage and sucuk. Sucuk is a Turkish-style sausage, very

popular in several Middle East countries, as well as Europe *(Erkmen, 1997; Stanišić et al., 2012)*.

Sucuk and sausages of a similar type are spicy, typically dry fermented sausages made of beef, water buffalo meat or mutton *(Gökalp, 1986)*. In Serbia, they are traditionally produced in small plants or village households in autumn and winter when weather conditions (temperature and relative humidity) are favourable. They are made of smaller pieces of beef or sheep meat and tail fat, with meat:fat ratio around 75:25. The mixture is filled into natural beef casings and tied with rope. The product is then smoked and dried for approx—30 days under local weather conditions *(Stajić et al., 2013)*.

Due to a high-fat content rich in saturated fatty acids and cholesterol, consumption of meat products is associated with the risk of heart problems, obesity and various blood diseases *(WHO, 2003)*. Dry fermented sausages are high-fat and rich in saturated fatty acids. Sucuk usually contains approx-30% fat content in the form of small visible cubes. This high-fat content is essential for proper fermentation and ripening and also plays an important role in the overall sensory quality of the finished product *(Kayaardı and Gök, 2003)*. For these reasons, reducing this type of product's fat content to improve nutritional characteristics is very difficult *(Bloukas et al., 1997)*.

The scientific knowledge of traditionally produced sucuk sausages with reduced fat content is limited *(Kargozari et al., 2014)*. Additionally, due to the natural fermentation and uncontrolled climatic conditions, there is little uniformity in traditionally produced products' recipes and processing conditions, which makes published trials challenging to repeat. In order to improve the nutritional quality of dry fermented sausages, this trial was set to investigate the effect of different fat levels on a change in the quality characteristics of sucuk sausages during production.

Materials and Methods

Sausages were produced in a meat processing plant of the Institute for Animal Husbandry (Belgrade, Serbia) from February to March 2022. For the production of sausages, beef, ham meat and tail fat were used. Three groups of sausages with different fat levels were produced: LF (low fat) group was made of beef meat with the addition of 10% fat, MF (medium fat) group was made of beef meat with the addition of 20% fat and HF (high fat) group was made of beef meat with the addition of 30% fat. In all variants, the same amounts of the following ingredients were added: 1.8 % salt, 0.011% $NaNO_2$, 0.4% sucrose, 0.3% powdered black pepper, 0.2% garlic and 0.2% powdered red paprika.

The production process was as follows: beef ham meat and tail fat were frozen at -4°C and then minced in a meat grinder (Seydelman 114, Germany) to about 1 cm in diameter. Cutting and mixing with the rest of the dry ingredients was carried out in the cutter (Seydelman K60, Germany) to 3 mm particle size. The mixture was then filled in natural beef casings of 38 mm. Sausages were tied with rope and made into characteristic horseshoe shapes. After stuffing (day 0), the sausages were drained in a cold store (4 ± 1°C) for 12 h for the surface to dry, after which they were hung in a traditional smoking house (without the possibility to control the temperature or humidity), with the parameters varying between 5–10°C and RH 75–90%. They were then occasionally smoked for 28 days.

Sampling of all three variants of sucuk was carried out after filling (day 0) and on production days 7, 14, 21 and 28. Nine sausages were taken from each group to determine pH value and conduct chemical analyses. All samples were analysed after removing the outer casing and grounding in the mixer (Ultra Turrax T18, IKA, Germany).

pH value was measured by pH-meter Hanna, HI 83141 (Hanna Instruments, USA), equipped with a puncture electrode. The pH meter was calibrated using standard phosphate buffers *(ISO 2917, 1999)*.

The proximate composition of sausages was determined in the following manner: moisture content by drying samples at 105°C *(ISO 1442, 1997)*; protein content by Kjeldahl method and multiplying by factor 6,25 *(ISO 937, 1978)*; total fat content by Soxhlet method *(ISO 1443, 1973)*, and ash content by mineralisation of samples at 550 ± 25°C *(ISO 936, 1998)*.

Peroxide value was determined by the method described in *ISO 3960 (1977)*, and peroxide values were expressed as milliequivalents of active oxygen per kg of fat (mEq O_2/kg).

Free fatty acid content was expressed as g oleic acid/100 g fat after titration with 0.1N NaOH and determining the total acidity, as described in *ISO 660 (2011)*.

The results of pH value, proximate composition, peroxide and FFA value were processed by single factor analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the SPSS 20.0 software (IBM SPSS Statistics Version 20, IBM Corp, USA). The differences between individual averages were tested using Tukey's method, and significant differences were considered for $p<0.05$.

Results and Discussion

Changes in the pH values during the 28 days of production of three groups of sucuk sausages are presented in Fig.1.

During the production of dry sausages, as a product of bacterial fermentation, lactic acid is formed, which results in a pH drop *(Lücke, 1994)*. Multiple factors influence this drop in pH, with the most important being present microflora and the amount and type of added sugars *(Hiero et al., 1997)*. pH values of sausages from the MF and LF groups followed a similar pattern during the entire production process, while the ones from the HF group slightly differed. Initial pH values (day 0) were different between groups, with HF having the lowest values ($p<0.05$) compared to MF and LF sausages, with no significant difference between the latter. These findings disagree with *Gómez and Lorenzo (2013)*, who reported no significant differences in initial pH values for chorizo sausages produced with different fat levels. However, other authors have observed a similar effect of fat level on the initial pH of various dry fermented sausages *(Olivares et al., 2010; Lorenzo et al., 2011; Lorenzo and Franco, 2012)*.

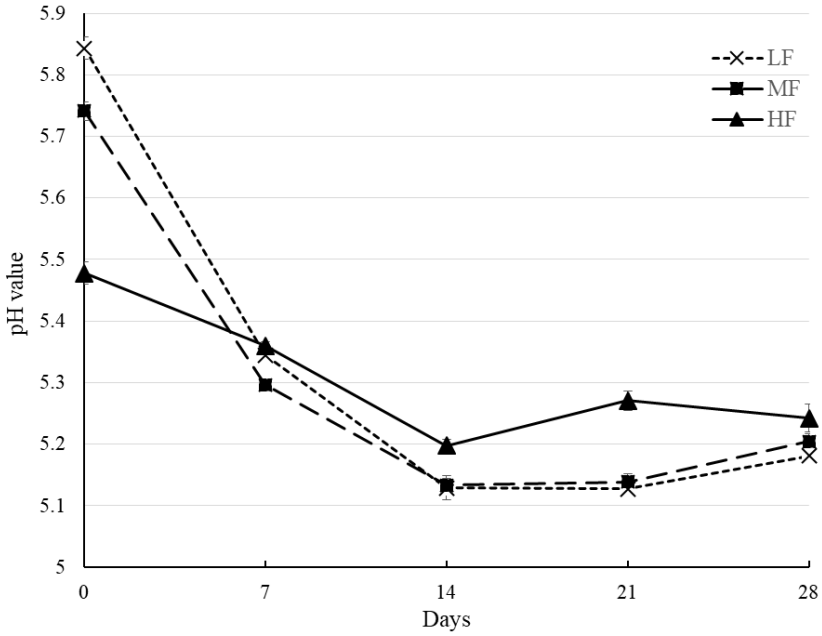


Figure 1. Changes in pH of the three groups of sucuk sausages during the 28 days of production. LF: low fat (10%); MF: medium fat (20%); HF: high fat (30%). Each symbol represents the mean value ± standard deviation.

The highest pH drop for all three groups of sausages was recorded on days 7 and 14, where all three groups had similar values. *Kayaardi and Gök (2003)* reported similar dynamics in pH drop for traditionally produced sucuk. The organic

acids production, due to the microflora activity, was probably the reason behind the fast pH decline in the first two weeks of production. Although after day 14, pH values slightly increased, they were similar at the end of ripening (day 28) and did not significantly differ between groups. As stated by *Spaziani et al. (2009)*, the traditional production of fermented sausages is characterised by a slow drop in pH (due to low temperatures and the absence of starter cultures), with the minimal values reached between the 20^{th} and 40^{th} days of production. In this trial, the fat reduction significantly impacted a pH drop, indicating that the medium and low-fat sausages will probably have a different flavour pattern compared to high-fat ones. This is in agreement with *Olivares et al. (2010)* and *Lorenzo and Franco (2012)*, who reported a more significant decrease in pH values in low-fat sausages. However, *Liaros et al. (2009)* did not find a significant difference in pH drop during the production of sausages with different fat levels. Similarly, investigating the quality of Greek sausages, *Papadima and Bloukas (1999)* reported no effects of fat level on final pH.

At the end of the production process, the pH of all three groups of sausages increased slightly and had similar value (around 5.2), which was lower compared to the ones reported by *Comi et al. (2005)* for naturally fermented dry sausages that ranged from 5.2 to 6.4. This increase in pH at the end of production was probably due to ammonia and amine production due to enzymatic activity *(Lücke, 1994)*.

The changes in proximate composition during the production process of sucuk are shown in Table 1. As expected, they are characterised by a decline in the moisture content and an increase in fat, protein and ash content during the 28 days of fermentation and ripening in all three groups ($p<0.05$). As stated by *Živković et al. (2011)*, the changes in the chemical composition of dry fermented sausages during ripening are characterised by a tendency to increase dry matter content.

In all groups of sausages, moisture content was constantly falling during the entire production process ($p<0.01$) due to temperature and humidity conditions. The initial differences between sausages in moisture content (day 0) were greater than at the end of the production process (day 28), probably due to more rapid water evaporation from sausages with lower fat content. In finished products, moisture content varied from 28.07% (HF) to 33.29% (LF). The moisture content of dry fermented sausages, around 30%, is typical for these products in Hungary, Greece and Croatia *(Kozacinski et al., 2008)*.

The fat content of sucuk significantly differ among groups ($p<0.01$), with mean values of 23.12% in LF, 32.71% in MF and 43.48% in HF sausages at the end of the production process, as expected. Sausages from the HF group had higher fat and lower protein content, followed by MF sausages initially and during the entire production process. Fat content at the end ripening of HF and MF groups was within the range for traditional sucuk *(Yaman et al., 1998)*.

Table 1. Changes in the proximate composition (%) of the three variants of sucuk sausage during the 28 days of the production process (means ± standard deviation)

Parameter / Group		Day					Sig.
		0	7	14	21	28	
Water	LF	67.12 ± 1.63^{aA}	60.17 ± 1.06^{bA}	52.02 ± 0.80^{cA}	37.34 ± 1.32^{dA}	33.29 ± 2.33^{eA}	**
	MF	60.82 ± 1.39^{aB}	53.95 ± 1.07^{bB}	42.45 ± 0.95^{cB}	32.97 ± 0.36^{dB}	31.49 ± 2.48^{eAB}	**
	HF	54.48 ± 1.36^{aC}	43.01 ± 0.87^{bC}	39.15 ± 1.14^{cC}	32.36 ± 0.62^{dB}	28.07 ± 1.05^{eB}	**
Sig.		**	**	**	*	*	
Protein	LF	20.69 ± 3.95^{dA}	26.14 ± 1.99^{cA}	28.97 ± 2.85^{bA}	34.30 ± 2.78^{aA}	36.90 ± 2.09^{aA}	**
	MF	18.09 ± 0.75^{dB}	21.82 ± 1.01^{cB}	23.12 ± 1.56^{cB}	29.51 ± 1.34^{bB}	32.48 ± 2.54^{aB}	**
	HF	15.20 ± 0.94^{cC}	19.77 ± 1.08^{bC}	20.24 ± 1.70^{bC}	27.76 ± 2.98^{aB}	30.94 ± 2.76^{aB}	**
Sig.		**	**	**	*	**	
Fat	LF	8.77 ± 0.20^{dC}	10.47 ± 0.49^{cC}	14.82 ± 0.48^{b}C	21.88 ± 1.14^{aC}	23.12 ± 0.91^{aC}	**
	MF	18.58 ± 0.39^{dB}	20.94 ± 1.00^{cB}	26.96 ± 0.91^{bB}	33.94 ± 1.16^{aB}	32.71 ± 1.53^{aB}	**
	HF	26.66 ± 1.58^{eA}	33.02 ± 0.95^{dA}	36.53 ± 1.58^{cA}	39.93 ± 1.53^{bA}	43.48 ± 1.39^{aA}	**
Sig.		**	**	**	**	**	
Ash	LF	3.45 ± 0.04^{eA}	4.30 ± 0.04^{dA}	4.76 ± 0.04^{cA}	5.65 ± 0.02^{bA}	6.36 ± 0.08^{aA}	**
	MF	3.42 ± 0.02^{eA}	3.87 ± 0.03^{dB}	4.88 ± 0.04^{cA}	5.48 ± 0.04^{bAB}	5.62 ± 0.04^{aB}	**
	HF	3.37 ± 0.02^{eA}	3.89 ± 0.03^{dB}	4.80 ± 0.04^{cA}	5.19 ± 0.04^{aB}	5.10 ± 0.02^{aB}	**
Sig.		ns	*	ns	*	*	

LF: low fat (10%); MF: medium fat (20%); HF: high fat (30%)
$^{a-e}$ Different letters within the same row denote significant differences between means
$^{A-C}$ Different letters within the same column denote significant differences between means
^{ns} non-significant ($p \geq 0.05$); * significant at $p < 0.05$; ** significant at $p < 0.01$

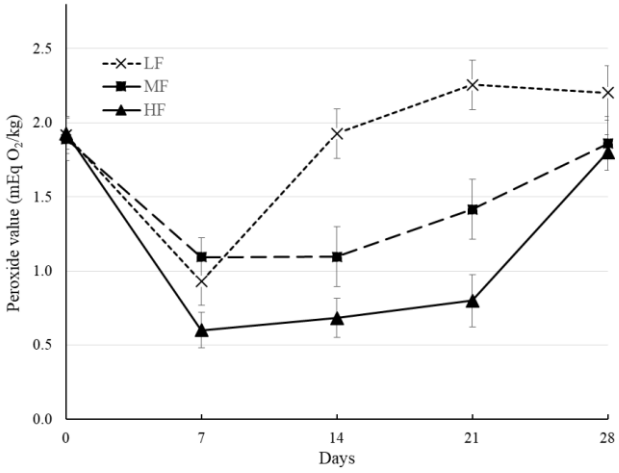
The ash content significantly decreased during ripening in all three groups of sausages ($p<0.01$). These findings disagree with *Salgado et al. (2005)*, who found no changes in ash content during the fermentation and ripening of Chorizo, a traditional Spanish fermented sausage. At the end of production, ash values were 6.36, 5.62 and 5.10 (for LF, MF and HF sausages, respectively), which is in the range reported by *Coppola et al. (1997)*, *Gimeno et al. (2000)*, *Lorenzo et al. (2000)* and *Franco et al. (2002)* for similar types of sausages.

The changes in fat rancidity indicators during fermentation and ripening of sucuk sausages were evaluated by peroxide and free fatty acid (FFA) values (Fig 2.)

The initial values for both indicators were approximately the same for all sausage groups. However, after seven days of production, the most significant drop in peroxide value was recorded for the HF group ($p<0.05$), while MF and LF

groups had similar values. After day 7, the LF group had a stip increase in peroxide values, with the biggest differences between groups recorded for days 14 and 21, where the LF group had the highest values and the HF group the lowest, while the MF group was intermediary ($p<0.05$). At the end of the production process, the MF group had the lowest peroxide value ($p<0.05$), while HF and LF were similar. In general, peroxide values of sausages in this trial were much lower compared to the ones reported by *Franco et al. (2002)* of 16 and 28 meq O_2/kg and *Salgado et al. (2006)* of 12.85 meq O_2/kg of fat.

A



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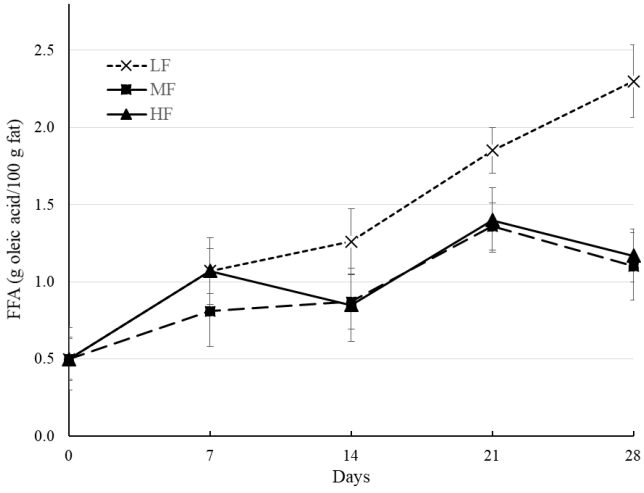

Figure 2. Changes in peroxide (A) and FFA (B) values of the three variants of Sremska sausage during the production process. LF: low fat (10%); MF: medium fat (20%); HF: high fat (30%). Each bar represents the mean value ± standard deviation.

As a result of lipolysis, free fatty acids are released during the production process of dry-fermented sausages *(Gandemer, 2002)*. Although the initial values were similar, the FFA (expressed as g of oleic acid per 100 g of fat) had the highest increase in the LF group of sausages ($p<0.05$). The increase in the FFA content of MF and HF groups followed a similar pattern and did not differ significantly. These results are in disagreement with the ones reported by *Soyer and Ertas (2007), Liaros et al. (2009), Olivares et al. (2011)* and *Lorenzo and Franco (2012)*, who found higher peroxide and FFA values in sausages with the higher fat content. However, these studies are based on pork subcutaneous fat, which is reacher in polyunsaturated fatty acids and more subject to oxidative changes than present beef tail fat *(Marco et al., 2006; Gómez and Lorenzo, 2013)*.

Conclusion

Decreasing the fat level in traditionally produced sucuk sausages significantly affected the proximate composition and lipolytic parameters during the 28 days of production. Sausages containing higher fat content had significantly lower water, protein and ash content throughout and at the end of the production process.

Fat content significantly affected peroxide and free fatty acid values. Interestingly, sausages containing higher fat content had lower lipolytic changes during and at the end of production. This can be correlated with a higher degree of saturated fatty acids in beef fat, which are less prone to oxidative changes.

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