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Fermented dry Sremska sausages made of pork meat from various breeds — chemical content and sensory properties

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ABSTRACT

In this study, the fatty acid composition, sensory qualities, and cholesterol levels of fermented dry Sremska sausages were examined. Pork meat and fat from three different pig breeds — autochthonous Mangalitsa, Moravka, and commercial Swedish Landrace — were used to create Sremska sausages. The sausage with the most cholesterol was created from Swedish Landrace meat and fat. On the other hand, compared with other sausage types, the sausage made from Mangalitsa pork included more monounsaturated fatty acids (MUFA) and unsaturated fatty acids (USFA) and less saturated fatty acids (SFA). Sausages made from Swedish Landrace pig meat had much greater PUFA content than other kinds. These differences were mostly due to higher overall n-6 PUFA contents. The health lipid markers for atherogenicity (IA) and thrombogenesis (IT) were lower in Mangalitsa pork sausage than in the two other sausage types. The Mangalitsa pork used for manufacturing Sremska sausage was exceptional in terms of appearance, flavor, aftertaste, and overall approval. The chemical and sensory qualities of dry-fermented Sremska sausages are modified by pig breed, according to this study.

1. Introduction

Autochthonous pork products made from regional pig breeds that passed through intensive, sustainable breeding programs are becoming increasingly popular in Europe, particularly in Mediterranean nations. Traditional breed meat and meat products usually have positive public and media perceptions and are frequently seen to be superior than meat and meat products from newer pig breeds and crossbreeds in terms of taste and quality. The carcass sides of Mangalitsa pigs are usually composed of between 65–70% fat and 30–35% meat (*Egerszegi et al.*, 2003). The Mangalitsa pig's meat was darker in color, its fat was whiter, and it included significantly more intramuscular fat and back fat than meat from other pig breeds. From the perspective of human nutrition, the meat from these fat pig breeds is preferable because it contains less saturated fatty acid (SFA) and a larger proportion of unsaturated fatty acid (USFA) than meat from other fat pig breeds (*Holló et al.*, 2003; *Parunović et al.,* 2012).

However, native meat products manufactured from regional breeds are becoming more popular in keeping with contemporary trends aimed at recovering

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and developing traditional food production procedures. Additionally, a lot of research has been performed to identify the features of regionally traditional and naturally fermented sausages (*Di cagno* et al., 2008; *El Malti & Amarouch*, 2009; *Parunović et al.*, 2014).

The aim of this study was to analyze the chemical composition and sensory quality, and to detect potential differences in traditionally fermented dry Sremska sausage manufactured from the meat and fat of three pig breeds: Mangalitsa, Moravka and Swedish Landrace. Mangalitsa and Moravka breeds were selected as autochthonous Serbian pig breeds, while Swedish Landrace was chosen as the most common commercial meat/fattening pig breed in Serbia.

2. Materials and methods

All of the animals were reared on the Institute for Animal Husbandry's experimental farm in Belgrade, Serbia. With the addition of a feed concentrate made of maize and wheat, the pigs had unlimited access to green forages including pasture and clover. At a nearby slaughterhouse, animals were stunned before being slaughtered and exsanguinated. Twenty-four hours after slaughter and chilling, the meat was processed.

The Sremska sausage varieties that were under investigation (Table 1) were produced in the Animal Husbandry Institute's processing department. For all studies, three sausages of each variety were used, and each assay was carried out twice. The Sremska sausage varieties under examination were made on the same day and in the same way. A cutter (Seydelman K60, Germany) was used to grind the meat and fat (85:15) to an 8 mm size. Variations of the sausage were made using the same proportions of the following ingredients: 2.3% salt, 0.011% $NaNO_2$, 0.3% dextrose, 0.20% garlic, and 0.5% sweet red paprika. Pork small intestines with a diameter of around 32 mm were filled with the mixture. Following filling, the sausages were hung on poles and allowed to mature in a controlled environment (Maurer, Germany).

Total lipids were extracted using the accelerated solvent extraction technique on the Dionex ASE 200 to ascertain the content of fatty acids. By using a flame ionization detector and capillary gas chromatography, fatty acids were identified as methyl esters. According to *Maraschiello et al.* (1996), cholesterol content was assessed using an HPLC/PDA on a Waters 2695 Separations Module with a Waters 2996 Photo Diode Array Detector.

The following calculations were made using the information on the fatty acid composition:

1) Index of atherogenicity (IA): This statistic compares the total of the main groups of saturated and unsaturated fatty acids [8, 9].

The following equation was applied:

$$IA = [(4 \times C14{:}0) + C16{:}0 + C18{:}0] / [\Sigma MUFA + \Sigma PUFA\text{-}n6 + \Sigma PUFA\text{-}n3]$$

2) Index of thrombogenicity (IT): This measurement illustrates the propensity for blood clots to develop. This is referred to as the interaction between the pro-thrombogenic (saturated) and the anti-thrombogenic (MUFA, PUFA-n6 and PUFA-n3) fatty acids (*Ulbritch & Southgate*, 1991; *Senso et al.*, 2007).

The following equation was applied:

$$IT = \frac{C14{:}0 + C16{:}0 + C18{:}0}{0.5 \times MUFA + 0.5 \times PUFA\text{-}n6 + 3 \times PUFA\text{-}n3 + PUFA\text{-}n3/PUFA\text{-}n6}$$

Two samples of each type of dry fermented sausage were utilized for the analysis. Each parameter was determined using six repeats for each sample. The taste of Sremska sausages was evaluated using quantitative descriptive analysis. The sensory properties of Sremska were examined by ten experienced assessors who were carefully chosen and competent. Assessors were asked to rate the Sremska sausage's nine distinct characteristics, including appearance, cross-section, color intensity, odor intensity, taste, consistency, acidity, aftertaste, and overall accepta-

Table 1. The percentage of meat originating from specified pig breeds in different types of fermented dry Sremska sausages

Pig meat	Fermented dry Sremska sausage types		
%	SM	SMM	SL
Mangalitsa	100	50	-
Moravka	-	50	-
Swedish Landrace	-	-	100

bility, on a numeric-descriptive scale ranging from 1 (extremely unacceptable) to 7 (extremely acceptable). Each Sremska sausage sample was offered to the testers one at a time.

Means and standard error for descriptive statistics were determined. ANOVA with a single factor was used to process the findings. Tukey's approach was used to compare the differences between the various sausage varieties. Statistica 7.0 (Statsoft Inc.) was used to do the calculations.

3. Results

Sremska sausages manufactured from Swedish Landrace pork meat had considerably higher PUFA contents (P<0.001) than other varieties (Table 1). Higher overall n-6 PUFA content was the primary factor causing these changes (P=0.001). In sausages of type SM (Mangalitsa pigs), lower n-6/n-3 ratios were established. Despite this, the SM sausage type's n-6/n-3 ratio of unsaturated fatty acids was 17 and

Table 2. Different fermented dry Sremska sausages were studied for their fatty acid composition (%), cholesterol content (mg/100g), index of atherogenicity (IA), and index of thrombogenicity (IT) (LSM standard error).

Traits	Fermented dry sausage types			
	Swedish Landrace	Mangalitsa	Mangalitsa and Moravka	P[1]
C14:0	1.04±0.02 ^{b}	1.20±0.04 ^{a}	1.08±0.03 ^{ab}	**
C16:0	23.93±0.06^{c}	25.86±0.06^{a}	25.23±0.07^{b}	***
C16:1	1.72±0.07 ^{c}	3.83±0.07^{a}	2.11±0.07^{b}	***
C17:0	0.31±0.03	0.28±0.03	0.32±0.02	NS
C18:0	14.17±0.07^{a}	10.85±0.06^{b}	14.07±0.06^{a}	***
C18:1c9	37.76±0.07^{c}	43.44±0.06^{a}	38.73±0.05^{b}	***
C18:1c11	2.93±0.06^{a}	4.56±0.06^{b}	3.19±0.06^{a}	***
C18:2n6	14.42±0.08^{a}	6.57±0.07^{c}	11.93±0.07^{b}	***
C18:3n6	ND	ND	ND	
C18:3n3	0.45±0.04	0.46±0.04	0.36±0.05	NS
C20:0	0.23±0.03	0.18±0.02	0.18±0.02	NS
C20:1	0.73±0.04	0.86±0.04	0.72±0.04	NS
C20:2	0.92±0.04^{a}	0.55±0.04^{b}	0.84±0.04^{a}	***
C20:3n6	1.05±0.05^{ab}	1.14±0.04^{a}	0.92±0.05^{b}	*
C20:3n3	ND^{b}	0.14±0.03^{a}	0.08±0.05^{ab}	*
C22:1/C20:4	0.36±0.02^{a}	0.15±0.02^{c}	0.25±0.03^{b}	***
SFA	39.68±0.12^{b}	38.43±0.10^{c}	40.95±0.13^{a}	***
MUFA	43.53±0.14^{c}	52.76±0.15^{a}	45.07±0.145^{b}	***
PUFA	16.77±0.14^{a}	8.73±0.14^{c}	14.02±0.13^{b}	***
USFA	60.26±0.21^{b}	61.46±0.22^{a}	59.06±0.20^{c}	**
MU/PU	2.56±0.05^{c}	6.07±0.04^{a}	3.23±0.05^{b}	***
MU/SF	1.12±0.00^{b}	1.36±0.00^{a}	1.10±0.00^{b}	***
PU/SF	0.43±0.00^{a}	0.22±0.00^{c}	0.34±0.00^{b}	***
n-3	0.45±0.04	0.46±0.05	0.36±0.05	NS
n-6	15.44±0.08^{a}	7.67±0.08^{c}	12.83±0.08^{b}	***
n-6/n-3	38.93±3.88^{b}	17.34±3.86^{a}	37.37±3.86^{b}	**
Cholesterol	64.94±0.16^{a}	59.66±0.17^{b}	53.46±0.16^{c}	***
IA	0.72±0.01^{b}	0.67±0.00^{c}	0.75±0.00^{a}	***
IT	1.26±0.01^{b}	1.21±0.01^{c}	1.36±0.01^{a}	***

[1]NS-not significant (P>0.05); *:Statistical significance at the level of P<0.05; **:Statistical significance at the level of P<0.01; ***:Statistical significance at the level of P<0.001;

[a-c]Means in the same row with different letters are significantly different (P<0.05).

higher, above the advised range of 1:1–5:1 (*Simopoulos*, 2004). In independent studies, *Hoz* (2004) and Valencia (2006) both discovered lower ratios of n-6/n-3 fatty acids (12.05 and 13.86, respectively) in their control groups of fermented dry sausages than our findings. Linoleic acid, an important PUFA, was present in sausage types SM and SL in differing amounts (6.58% to 14.40%; $P<0.001$). Mangalitsa pork meat sausages had greater MUFA levels than other varieties ($P<0.001$) of sausages. Higher quantities of oleic acid, cis-vaccenic acid (C18:1 cis-11), and palmitic acid (C16:1) in these sausages were the key contributors to these differences. Significant differences were found for specific fatty acids in respect to the SFA percentage, leading to comparable levels for the overall fraction. Sausage type SM had the lowest overall SFA level, whereas sausage type SMM (mixed Mangalitsa and Moravka) had the highest. Stearic acid (C18:0), one of the main SFAs, was present in considerably different amounts in the various sausage varieties ($P<0.001$).

In our investigation, fermented sausages manufactured from Mangalitsa pork meat were found to have the lowest PUFA/SFA ratio (0.23). With notable variations amongst the samples ($P< 0.001$), the mean cholesterol levels in fermented sausages ranged from 53.47 mg/100g (SMM) to 64.92 mg/100g (SL). For an Italian-style salami, *Baggio and Bragagnolo* (2006) discovered that the cholesterol level ranged from 48 to 57 mg/100g. According to *Pleadin et al.,* (2010), in researching fermented sausages in Croatia, the average cholesterol amount in commercially produced fermented sausages ranged from 58.48 to 105.24 mg/100g, whereas home-made fermented sausages had a maximum cholesterol content of 75.07 mg/100g. From a nutritional perspective, the fatty acid composition of lipids is significant, particularly the ratio between PUFA and SFA, the ratio between "bad" and "good" fatty acids (IA and IT), and the n-6/n-3 ratio. Foods with lower IA and IT have reduced atherogenic and thrombogenic potential. In stark contrast to other sausages produced, the IA and IT were lower in Sremska sausages produced from Mangalitsa pork meat. Pork has an IA of 0.60, poultry 0.50, and beef 0.72 (*Žlender & Gapšerlin*, 2005).

Table 3 presents the findings of professional trained assessors' sensory evaluations. The Sremska sausage SMM (mixed Mangalitsa and Moravka) received the lowest cross-sectional scores and consequently had the least acceptable appearance. The fermented dry sausage type SL was considered to be the best. The most reliable sausage was of type SL, whereas SMM sausage received the lowest consistency rating. The color of the meat used in the manufacturing of the product had a connection to this. Relationships between physical meat quality traits and sensory traits, such as muscle fiber and overall softness, as well as between the amount and composition of intramuscular fat and taste, have been documented (*Hoffman et al.*, 2007; *Muchenje* et al., 2008; *Calkins & Hodgen,* 2007). The sensory indication most impacted by pig breed was odor. The Mangalitsa breed's meat was used to make the most traditional and finest sausage. Sremska sausage SM received the top ratings from expert judges for both flavor and aftertaste. The Sremska sausage of type SM had the most stable quality, according to the total sensory acceptance scores of the goods under examination.

Table 3. Professional assessors' evaluations of the sensory qualities of three types of fermented dry Sremska sausages (scale test rating)

	Fermented dry sausage types		
Sensory properties	**SL***	**SM**	**SMM**
Appearance	6.06	5.52	4.68
Cross-section	5.24	5.35	3.74
Consistency	5.43	5.18	4.85
Color	5.51	5.76	5.07
Odor	5.65	6.34	6.35
Taste	5.26	6.07	5.06
Acidity	4.57	4.93	4.02
Aftertaste	5.26	5.32	5.26
Overall acceptability	5.26	5.53	4.84

*SL, Swedish Landrace; SM, Mangalitsa; SMM, Mangalitsa and Moravka

4. Conclusion

The findings of this study showed that the chemical and sensory properties of dry-fermented Sremska sausages are influenced by pig breed. According to the findings of the current study, Sremska sausages can be produced with the right proportion of meat and fat from native pig breeds alone. These sausages will have a respectable chemical content, a good and reasonably healthy fatty acid composition, and sensory qualities that will appeal to discerning consumers. These outcomes ought to help encourage the farming and conservation of endangered Mangalitsa pigs, assuming there are markets for Sremska sausage.

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