Fatty acids composition of Croatian and Slovenian traditional dry-cured meat products

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SUMMARY

The aim of this study was to investigate the fatty acids composition of traditional dry-cured meat products from Croatia and Slovenia. With analyses of basic chemical properties in six types of representative traditional meat products (three from Croatia and three from Slovenia) fatty acids composition were determined and compared according to groups of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids, as also according to ratios n-6/n-3 and PUFA/SFA. Oleic acid (C18:1n9c) was found generally in the highest amounts, ranging from 36.23±0.19% in "Kraški zašink" to 47.44±0.36% in Istrian sausage and similar value of 47.41±0.24% in "Zgornjesavinjski želodec". Palmitic acid (C16:0) was the major SFA found from 23.68±0.16% to 27.50±0.17%, and then stearic acid (C18:0) ranged from 12.21±0.21% to 18.61±0.15%. According to groups, MUFA were the major constituents of Croatian product Istrian sausage (50.07%) and Dalmatinski pršut (49.92%) as also of the Slovenian product Zgornjesavinjski želodec (51.97%) and Kraški pršut (48.03%) whereas SFA were the major constituents of Buđola (49.40%) and Kraški zašink (45.86%). Obtained values of n-6/n-3 ranged from 7.52 to 25.30 and of PUFA/SFA from 0.19 to 0.31, were in agreement with earlier published data for other European traditional dry-cured meat products that also shown the higher ratios than suggested by international health organizations. Taking into account recommendations for these nutritional ratios, traditional dry-cured meat products from Croatia and Slovenia would not be within the desirable limits, but at the same time it is important to take into account the fact that these products are produced and consumed as specialties and hence usually in moderate quantities.

Keywords: *fatty acid composition, traditional dry-cured meat products, Croatia, Slovenia, SFA, MUFA and PUFA*

INTRODUCTION

In the European countries there is a growing trend of production and consumption of traditional meat products. Consequently, intense researches of their dietary and nutritional value are performed. It is known that manufacturing of traditional meat products is not standardized and is generally monitored subjectively without strict control of the characteristics required for these products, for instance casing size, processing parameters, such as temperature, relative humidity, and airflow rates, as also smoking conditions (Fernández-Fernández et al., 2002).

Hundreds of European meat products are nowadays protected with one of three signs: PDO (Protected Designation of Origin), PGI (Protected Geographical Indication) and TSG (Traditional Speciality Guaranteed), established to promote and protect the names of quality products. Researches of traditional meat products contribute to the standardization, quality assurance of these products and therefore protection of consumers. Because of geographical and climatic specifics, history and various cultural influences Croatia and Slovenia also have a large number of traditional meat products, which in last few decades become recognizable brands and an integral part of specific tourist offer. Among them frequently produced and consumed are prosciuttos, hams, fermented sausages and other dry-cured meats, produced in different regions of these countries according to traditional receipts in the households as also by the meat industries.

From the nutritional point of view, dry-cured meat products are an important source of proteins of high biological value (Beriain et al., 2000) but at the same time it is known that this type of products present some

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negative aspects as a consequence of their high animal fat content. The relatively high cholesterol level and low polyunsaturated/saturated fatty acid ratio are risk factors for some disorders such as coronary diseases (Muguerza et al., 2004; Cordain et al., 2005). Data show that nutritional composition of dry-cured traditional meat products in terms of fatty acid composition is affected by many factors, from breeds selection, feeding and farming of animals to technological processes and parameters implemented during production (Jiménez-Colmenero et al., 2001; Siciliano et al., 2013; Pleadin et al., 2015). Since meat and meat products are rich in fat, especially saturated fatty acids, consumers today are advised to consume moderate quantities of these products (Valsta et al., 2005; Fernández et al., 2007), while producers are trying to influence on the fatty acids profile in order to get them closer to nutritionally acceptable values (Valencia et al., 2006; Pelser et al., 2007; Pleadin et al., 2014a).

The pork products generally contain a high proportion of saturated fatty acids (SFA) and lower proportion of monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids in relation to the recommended levels (Wood et al., 2004; Wood et al., 2008; Woods and Fearon, 2009; Pleadin et al., 2014a; Pleadin et al., 2015). Due to the application of various technological processes during production, lipids in traditional meat products undergo a series of transformations which include hydrolytic processes, the release of short-chained fatty acids, and the latter oxidation of the acids together with the formation of peroxides and volatile compounds, contributing to the aroma of the final product (Toldrá, 1998; Jiménez-Colmenero et al., 2001; Siciliano et al., 2013; Barbir et al., 2014).

In this study, basic nutritional parameters and fatty acids composition of Croatian and Slovenian traditional meat products representatives from the categories of dry-fermented sausages, prosciuttos and dry-cured meats, were investigated. Given the lack of data for traditional meat products, the aim of study was to determine and compare fatty acids profiles according to groups of SFA, MUFA and PUFA as also nutritional ratios n-6/n-3 and PUFA/SFA for the Croatian and Slovenian products, as also to compare them with data published for traditional dry-cured meat products from the other European countries.

MATERIALS AND METHODS

Samples and sample preparation

The study was conducted on three types of the dry-cured traditional meat products originating from Croatia (Istrian sausage, Buđola and Dalmatinski pršut) and three types of the products from Slovenia (Zgornjesavinjski želodec, Kraški zašink and Kraški pršut). From each type of sample three parallel samples (in total 18 samples) were taken for analyses of the basic chemical composition and fatty acids profile.

All these samples/products are produced from the first and second meat categories (excluding offal), according to traditional recipes and technologies, which are for the Dalmatinski pršut as a product protected with geographical indications at the national level, or for Kraški pršut, Kraški zašink, Zgornjesavinjski želodec as products protected with the geographical indication on the EU level (European Commission, 2011, 2012a,b), described in details in the Specifications (2012a,b; 2013a,b) and the Istrian sausages and Buđola in the literature (Kovačević, 2001; Kovačević, 2014; Bratulić et al., 2011). The raw products were subjected to the process of fermentation, drying and long-time ripening in darkened chambers (only Dalmatinski pršut and Buđola are smoking). Ripening takes place at average temperatures 12 - 18 °C and relative humidity of 70 - 80%, with a slow flow of air, for a period longer than 3 months (Kraški zašink, Zgornjesavinjski želodec, Istrian sausage, Buđola) and longer than 12 months (Dalmatinski and Kraški pršut).

Representative samples of meat products were prepared for analysis in accordance with ISO 3100-1:1991. The samples were homogenized at 5000-6000 rpm for 20 s using a homogenizer Grindomix GM 200 (Retch, Germany) and stored in plastic vials at 4 °C until determination of the basic chemical composition parameters and fatty acids composition.

Standards, reference materials and reagents

Standard solution of fatty acids methyl esters (37 fatty acids), concentration of 10 mg/mL, was prepared by resolving standard SupelcoTM 37 Component FAME Mix (Bellefonte, Pennsylvania, SAD) in hexan. The solution thus prepared was stored in a freezer at -20 °C and used for identification of fatty acid methyl esters with each analysis. Hexane and methanol used in the analysis of fatty acids were HPLC grade (J.T. Baker, Derventer, Netherland). Ultra-pure water with electrolytic conductivity of ≤ 0.05 S/cm was obtained using Milipore Direct-Q 3 UV (Merck, Darmstadt, Germany). All other chemicals used in the analysis were of analytical grade (Kemika, Zagreb, Croatia).

Determination of basic chemical composition

Water content was determined by gravimetric analysis (ISO 1442:1997) by use of thermostat Epsa 2000 (Ba-Ri, Velika Gorica, Croatia). Content of the total proteins was determined by Kjeldahl method (HRN ISO 937:1999) with the use of the block for the destruction

Unit 8 Basic (Foss, Höganäs, Sweden) and the automated device for the distillation and titration Kjeltec 8400 (Foss, Höganäs, Sweden). Total fat was determined by Soxhlet (HRN ISO 1443:1999) by digestion of the samples by acid hydrolysis, followed by extraction of the fats by means of petroleum ether on Soxtherm 2000 Automatic (Gerhardt, Munich, Germany). Ash content was determined according to ISO 936:1998 and use of furnace Nobertherm LV9/11/P320 (Lilienthal, Germany). Carbohyrates was obtained by calculation method. Results of analysis are expressed as the mean of three parallel determinations per sample, in percent of weight (%), with an accuracy of 0.01%.

Determination of fatty acids

Sample preparation for analysis of fatty acids methyl esters was earlier described in study by Pleadin et al. (2014a). Methyl esters of fatty acids were analysed by gas chromatography (GC) according to HRN EN ISO 5508:1995. Gas chromatographer 7890BA with flame ionization detector (FID), capillary column HP88 of 100 m length, internal capillary diameter 0.25 mm and thickness of stationary phase of 0.20 µm (Agilent Technologies, Santa Clara, USA) was used. The components were detected by FID at the temperature of 280 °C, hydrogen flow of 40 mL/min, air flow of 450 mL/min and nitrogen flow of 30 mL/min. Initial column temperature was 120 °C and after 1 min its rate increased for 10 °C/min until 175 °C and maintaining for 10 min. Then the temperature increased rate of 5 °C/min until 210 °C and maintaining for 5 min and again increased rate of 5 °C/min until column final temperature of 230 °C which was maintained for 5 min. One mL of sample was injected in a split-splitless injector with temperature of 250 °C with a partition coefficient 1:50. Carrier gas was helium (99.9999%) with a constant flow rate of 2 mL/min. Fatty acids methyl esters were identified by comparison with retention time of fatty acid methyl esters of the standard mixture as described earlier by Pleadin et al. (2015). Results are expressed as a percentage (%) of particular fatty acid on total fatty acids, with an accuracy of 0.01%.

Statistical data analysis

Statistical analysis was performed using program SPSS 20.0 (SPSS Inc., Chicago, USA). Results are expressed as mean ± SD. Shapiro Wilks test was conducted to determine whether the results of the analysed parameters have a normal distribution ($p > 0.05$). In determination of the differences between the groups in the shares of the basic chemical parameters and fatty acids composition, one way ANOVA and Kruskal Wallis test were used, with significance defined at $p < 0.05$.

RESULTS AND DISCUSSION

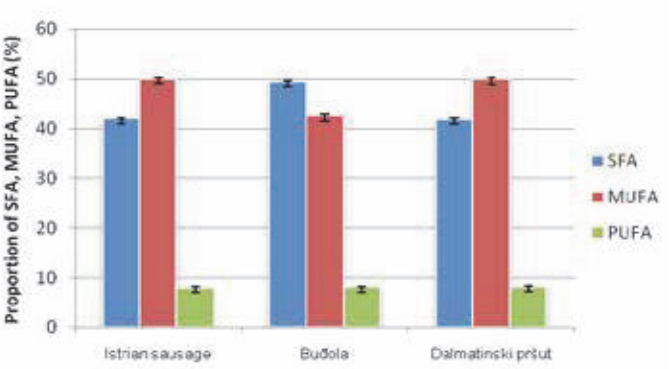
Determined basic chemical composition of traditional meat products from Croatia (Istrian sausage, Buđola and Dalmatinski pršut) and Slovenia (Zgornjesavinjski želodec, Kraški zašink and Kraški pršut), are shown in Table 1.

Table 1. Basic chemical composition of Croatian and Slovenian traditional meat products

Origin of product	Meat product	Mass fraction mean value (n = 3) ± SD (%)			
		Water	Total protein	Total fat	Ash
Croatian	Istrian sausage	17.40±1.15	33.37±0.92	44.00±1.09	5.34±0.20
	Buđola	41.70±1.44	20.93±0.21	31.20±0.44	6.03±0.29
	Dalmatinski pršut	34.50±0.72	36.38±0.46	21.70±0.82	7.42±0.19
Slovenian	Zgornjesavinjski želodec	36.00±1.22	34.23±0.38	24.00±0.56	6.10±0.11
	Kraški zašink	41.00±1.14	35.42±1.15	16.70±0.78	7.20±0.11
	Kraški pršut	42.80±0.56	27.12±0.89	23.20±1.16	7.10±0.36

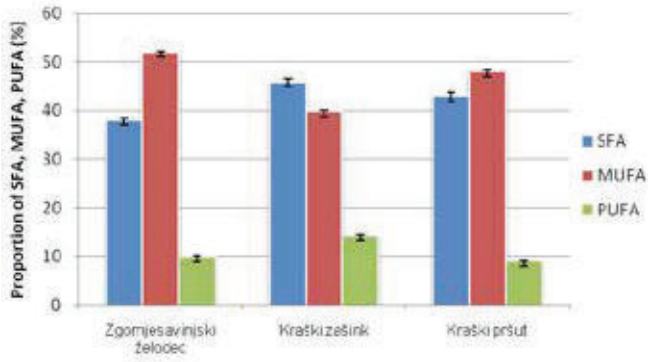
Determined values of the chemical composition are characteristic and comparable with the data published earlier for these product types (Kovačević, 2001; Kovačević, 2014; Prevolnik et al., 2012; Andronikov et al., 2013; Pleadin et al., 2014b). Water content ranged from 17.40±1.15% in Istrian sausage to 42.80±0.56% in Kraški pršut. The share of total fat ranged from a minimum value in Kraški zašink (16.70±0.78%) to the highest in Istrian sausage (44.00±1.09%). Proteins content was the lowest in Buđola (20.93±0.21%) and the highest in Dalmatinski pršut (36.38±0.46%) but generally high proportion of the total proteins (> 20%) in all products shows that they present the high-quality meat products. Carbohydrates content in all Croatian and Slovenian products was lower than 0.10%. Basic chemical properties (except for carbohydrates and ash content) mostly show significant differences ($p < 0.05$) in their composition but at the same time characteristic for these meat products.

Fatty acid composition of the analysed Croatian and Slovenian traditional dry-cured meat products is presented in Table 2. Proportions of SFA, MUFA and PUFA for these products per country of origin are shown in Figure 1 and Figure 2, respectively.



SFA - saturated fatty acids; PUFA - polyunsaturated fatty acids; MUFA - monounsaturated fatty acids

Figure 1. Proportion of SFA, MUFA and PUFA obtained in Croatian traditional dry-cured meat products



SFA - saturated fatty acids; PUFA - polyunsaturated fatty acids; MUFA - monounsaturated fatty acids

Figure 2. Proportion of SFA, MUFA and PUFA obtained in Slovenian traditional dry-cured meat products

Literature data has revealed that the main fatty acids present in dry-fermented sausages and dry-cured hams are MUFA (41-59%), SFA (30-45%) and PUFA (9-18%). The most prevalent MUFA are oleic (C18:1n9) (38-42%) and palmitoleic (C16:1n7) (2-3%) fatty acid. The principal SFA are palmitic (C16:0) (23-24%) and stearic (C18:0) (10 -15%) acids (Casaburi et al., 2007; Fernández et al., 2007; Visessanguan et al., 2006; Pleadin et al., 2014a; Pleadin et al., 2015). The main PUFA component is linoleic acid (C18:2n-6) with shares of up to 6-16%, generally lower in dry-cured hams (7-10%) in comparison to dry-fermented sausages (10-16%) (Moretti et al., 2004; Karolyi, 2006; Jiménez-Colmenero et al., 2010; Olivares et al., 2011; Jurado et al., 2008).

In this study, per particular fatty acid, oleic acid (C18:1n9c) was also found in the highest amounts, ranging from 36.23±0.19% in Kraški zašink to 47.44±0.36% in Istrian sausage and similar value of 47.41±0.24% in Zgornjesavinjski želodec. Palmitic acid (C16:0) was the major saturated fatty acid found from 23.68±0.16% in Zgornjesavinjski želodec to 27.50±0.17% in Buđola, and then stearic acid (C18:0) from 12.21±0.21% to 18.61±0.15% in Zgornjesavinjski želodec and Buđola, respectively. According to groups of fatty acids, MUFA were the major constituents of Croatian products Istrian sausage (50.07%) and Dalmatinski pršut (49.92%) as also of the Slovenian products Zgornjesavinjski želodec (51.97%) and Kraški pršut (48.03%), whereas SFA were the major constituents of Buđola (49.40%) and Kraški zašink (45.86%). Obtained MUFA content can be comparable with data of dry-cured meat products reported in the literature: 42% (Muguerza et al., 2004), 51% (De Campos et al., 2007), 44% (Rubio et al., 2007) and 47% (Del Nobile et al., 2009). The similar trend for PUFA and SFA as observed in this study was also determined in mentioned studies.

In the products from Slovenia in relation to those from Croatia, slightly higher proportion of PUFA was determined (higher n-6 and lower n-3) resulting in a higher n-6/n-3 ratio. Share of groups of fatty acids in the descending order for mostly all products was MUFA > SFA > PUFA, except for Buđola and Kraški zašink as technologically similar pro-

Table 2. Fatty acid composition of the Croatian and Slovenian traditional dry-cured meat products

Fatty acids	Mass fractions of fatty acids (%)[a] Mean value (n=3) ± SD					
	Croatian products			Slovenian products		
	Istrian sausage	Buđola	Dalmatinski pršut	Zgornjesavinjski želodec	Kraški zašink	Kraški pršut
C10:0	0.09±0.02	0.09±0.01	0.12±0.00	0.06±0.00	0.08±0.01	0.10±0.01
C12:0	0.09±0.00	0.12±0.03	0.09±0.02	0.08±0.01	0.09±0.01	0.08±0.01
C14:0	1.42±0.01	2.04±0.05	1.47±0.00	1.42±0.02	1.46±0.02	1.36±0.04
C15:0	n.d.	0.22±0.04	n.d.	n.d.	n.d.	n.d.
C16:0	25.51±0.32	27.50±0.17	25.43±0.27	23.68±0.16	25.92±0.24	26.25±0.20
C17:0	0.26±0.05	0.62±0.10	0.35±0.05	0.35±0.03	0.67±0.04	0.24±0.02
C18:0	13.86±0.23	18.61±0.15	13.77±0.25	12.21±0.21	17.45±0.18	14.72±29
C20:0	0.43±0.03	0.22±0.03	0.28±0.07	0.24±0.03	0.19±0.01	0.19±0.03
C14:1	n.d.	0.12±0.02	n.d.	n.d.	n.d.	n.d.
C16:1	2.48±0.02	2.35±0.01	3.17±0.04	2.96±0.04	2.22±0.02	2.86±0.02
C18:1n9t	0.15±0.01	0.31±0.00	0.16±0.01	0.47±0.11	0.47±0.09	n.d.
C18:1n9c	47.44±0.36	39.06±0.15	46.31±0.22	47.41±0.24	36.23±0.19	44.36±0.22
C20:1	n.d.	0.67±0.05	n.d.	1.14±0.02	0.86±0.02	0.80±0.01
C22:1n9	n.d.	n.d.	0.28±0.04	n.d.	n.d.	n.d.
C18:2n6c	6.82±0.11	7.14±0.12	7.49±0.15	8.60±0.12	12.83±0.09	8.26±0.09
C18:2n6t	n.d.	n.d.	n.d.	0.15±0.01	n.d.	n.d.
C18:3n6	0.23±0.02	n.d.	0.16±0.02	n.d.	n.d.	n.d.
C20:2n6	n.d.	0.28±0.03	n.d.	0.52±0.02	0.62±0.03	0.42±0.01
n-6	7.05±0.07	7.42±0.11	7.65±0.15	9.47±0.11	13.76±0.14	8.69±0.13
C18:3n3	0.94±0.03	0.67±0.01	0.61±0.02	0.52±0.01	0.59±0.03	0.34±0.03
n-3	0.94±0.03	0.67±0.01	0.61±0.02	0.52±0.01	0.59±0.03	0.34±0.03

[a] Mass fraction of fatty acid is expressed as the total proportion of fatty acids; n.d. - not detected; limit of detection (LOD) = 0.05%

ducts, for which the order was SFA > MUFA > PUFA. Due to a higher share of PUFA in the Slovenian products, the ratio of PUFA/SFA for these products is also higher although not statistically significant ($p > 0.05$).

Nutritional ratios per groups of the products originating from Croatia and Slovenia, are given in Table 3.

Table 3. Nutritional ratios of Croatian and Slovenian traditional dry-cured meat products

Meat product	Nutritional ratio		
	n-6/n-3	PUFA/SFA	MUFA/SFA
Istrian sausage	7.52	0.19	1.19
Buđola	11.11	0.16	0.86
Dalmatinski pršut	12.54	0.20	1.19
Zgornjesavinjski želodec	18.17	0.26	1.37
Kraški zašink	23.31	0.31	0.87
Kraški pršut	25.30	0.21	1.12

SFA - saturated fatty acids; PUFA - polyunsaturated fatty acids; MUFA - monounsaturated fatty acids

According to recommendations, daily intake of fat should not exceed estimated 15 - 30% of total energy intake, among which SFA should represent up to 10%, PUFA 6 - 10% (n-6: 5 - 8%; n-3: 1 - 2%), MUFA 10 - 15%, and trans fatty acids less than 1% of total daily energy intake (Whitney and Rolfes, 2005). Investigations have shown that dietary fat has health implications on humans, resulting from the presence of SFA, MUFA and PUFA n-6 and n-3 fatty acids, and their proportions. Ratio of n-6/n-3 is associated with disorders of a number of physiological processes that increase the incidence of so-called chronic diseases related to diet (Cordain et al., 2005), including cardiovascular disease (CVD), cancer, and inflammatory and autoimmune diseases, whereas an increased level of n-3 (a low n-6/n-3 ratio) exerts suppressive effects (Simopoulos, 2008). Accordingly, the recommended n-6/n-3 ratio should not exceed 4 (WHO, 2003).

The PUFA/SFA ratio is one of the major parameters currently used to assess the nutritional quality of the lipid fraction of foods. Nutritional guidelines recommended PUFA/SFA ratio above 0.4, although several researchers reported that this ratio must be considered together with n-6/n-3 ratio due to the beneficial effect of linoleic acid (n-6) on health that is produced only when PUFA/SFA ratio is no greater than 1.5. SFA are considered to raise plasma cholesterol, except for stearic acid which reduces total and LDL cholesterol; therefore, the content of this fatty acid (stearic) is subtracted from the SFA fraction when the association between food saturated fatty acids and risk of heart diseases is studied. Moreover, MUFA have hypocholesterolemic effect, but they do not decrease HDL cholesterol, which protects against cardiovascular diseases (Kris-Etherton, 1999).

In this study for all products significantly higher values than recommended were obtained both for n-6/n-3 and PUFA/SFA ratios. In earlier studies of Dalmatinski pršut obtained ratios of PUFA/SFA and n-6/n-3 were 0.2 and 14.7 in study by Marušić et al. (2013) and 0.17±0.05 and 8.38±4.59 in study by Pleadin et al. (2015), which is comparable with rations of 0.20 and 12.54, respectively, determined for Dalmatinski pršut in this study. For other types of Croatian and Slovenian traditional meat products investigated in this study there is lack of published data about fatty acids composition and their nutritional ratios according to our knowledge.

In Slovenian dietary tables for meat and meat products (Golob et al., 2006) was found that dry cured ham of Carst type on average contained SFA of 2812 mg/100 g (40.10% of total fatty acids), MUFA of 3001 mg/100 g (42.79%) and PUFA of 1200 mg/100 g (17.11%), as well as that calculated n-6/n-3 and PUFA/SFA ratios were 9.7 and 0.43. These data are not in precisely agreement with our results, especially for ratios (25.30 and 0.21). Data on the fatty acid composition of Kraški pršut in our study can be compared also to data on Vipavski pršut produced in nearby region at similar conditions (Žlender et al., 2008); this hams show characteristics very similar to the Kraški pršut: 38.0% SFA, 50% MUFA and 11.8% PUFA and comparable ratios of 14.1 and 0.31 for PUFA/SFA and n-6/n-3.

Results of fatty acids composition per groups of SFA, MUFA and PUFA as also nutritional ratios n-6/n-3, PUFA/SFA and MUFA/SFA, published for the products of the same categories originating from different European countries, are shown in Table 4.

Table 4. Fatty acid composition of particular traditional dry-cured meat products from different European countries

Meat product	SFA[a]	MUFA[a]	PUFA[a]	PUFA/SFA	n-6/n-3	Reference
Chorizo	35.9-37.3	47.6-48.6	13.9-16.2	0.4-0.5	11.5-15.1	Jiménez-Colmenero et al., 2010
Sicilian salami	36.3	55.1	8.5	0.2	7.8	Moretti et al., 2004
Serrano ham	32.6-33.4	52.8-54.1	9.1-10.5	0.2	18.3-18.6	Santos et al., 2008 Campo and Sierra, 2011
Teurrel ham	35.7-37.4	54.6-54.7	7.4-8	0.1-0.2	17.4-17.6	Campo and Sierra, 2011
Iberian ham	32.5-35.2	51.4-59.4	67.8-13.4	0.2-0.4	9.4-28.2	Fernández et al., 2007; Ventanas et al., 2007
Bayonne ham	36.5	52.9	10.7-15.3	0.3-0.4	14.1-29.6	Gandemer, 2009
Corsican ham	34.9-35.0	53.8-55.4	9.7-11.2	0.3	8.7	Gandemer, 2009
Parma ham	30.4-37.9	50.2-54.6	7.3-17.8	0.2-0.6	12.3-39.9	Lo Fiego et al., 2005; D'Evoli et al., 2009
Cinta Senese ham	33.3	51.4	15.4	0.5	14.2	Pugliese, 2009

[a] *Values are given as mass fractions of fatty acids (%)*

SFA - saturated fatty acids; PUFA - polyunsaturated fatty acids; MUFA - monounsaturated fatty acids

Results obtained in this study are comparable with data obtained for prosciuttos and other pork meat products originating from the other European countries (Table 4). In these products values ranged from 0.2 to 0.6 for PUFA/SFA and from 7 to 40 for n-6/n-3 ratios, generally pointing to significantly high variations of values per type of the traditional meat product (Fernández et al., 2007; Santos et al., 2008; Jiménez-Colmenero et al., 2010; Campo and Sierra, 2011; Pugliese, 2009; Pleadin et al., 2015). Jiménez-Colmenero (2007) explained unfavourable nutritional ratios as the consequence of very low levels of n-3 fatty acids generally present in pork meat products (often less than 0.15 g/100 g). Taking into account recommendations given by international health organizations (WHO, 2003), dry-cured meat products from Croatia and Slovenia also would not be within the desirable limits both when it comes to n-6/n-3 ratio (7.52 - 25.30) and PUFA/SFA ratio (0.19 - 0.31) (Table 3), but are in agreement with earlier published values that also pointing to the higher ratios than suggested.

As studies revealed that according to recommendations traditional dry-cured meat products are not within the desirable limits for both ratios, producers are therefore trying to modify meat products fatty acids profile in order to get them closer to nutritionally acceptable values (Muguerza et al., 2004; Pelser et al., 2007; Fernández et al., 2007; Valencia et al., 2006). Jiménez-Colmenero et al. (2001) concluded that in meat production modification of carcass composition, the manipulation of raw materials and reformulation of the products, are the three fundamental strategies to achieve healthier meat products. Modifications of the fatty acid profile of pork products are mostly achieved with genetic selection in combination with feeding practices (Ansorena and Astiasarán, 2007). However, production of protected traditional dry-cured meat products often doesn't allow modifications in this sense as technologies of production are strictly given in specifications of these products.

CONCLUSION

In all analysed products oleic acid was found in the highest amounts, then palmitic and stearic acid. MUFA represented the major constituents of Croatian products Istrian sausage and Dalmatinski pršut as also of the Slovenian products Zgornjesavinjski želodec and Kraški pršut, whereas SFA were the major constituents of Buđola and Kraški zašink as cured meat products. Obtained values for nutritional ratios n-6/n-3 and PUFA/SFA were in agreement with earlier published data for other European traditional dry-cured meat products that also pointing to their higher ratios than international health organizations suggested. Taking into account recommendations for n-6/n-3 and PUFA/SFA, traditional dry-cured meat products from Croatia and Slovenia would not be within the desirable limits, but at the same time it is important to take into account the fact that these products are produced and consumed as specialties and hence usually in moderate quantities.

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