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Estimation of dietary fat intake via the consumption of traditional meat products

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Summary

Fat content of 137 traditional meat products from Mediterranean and Continental part of Croatia was analysed. Consumption data were obtained on national representative sample of 2002 participants. Obtained results showed traditional meat products to vary in their fat content (10.90%- 52.50%), with significant differences ($p < 0.05$) within same product group but not within regions. About 16% of the respondents were traditional meat products' consumers, with an average consumption of 51.64 g/day (12.45g/day of fat). The lower portion of consumers was from Mediterranean region. Products most popular among consumers were bacon and dry-fermented sausages, which provide 5-10% recommended daily energy intake.

Keywords: traditional meat products, sausage, cured meat, consumption, fat intake

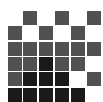
Introduction

Meat and meat products are generally recognized as a nutrient-rich food, good sources of high-value proteins, fat-soluble vitamins, minerals, trace elements and bioactive compounds (Mehta *et al.* 2015). However, energy-dense diets rich in meat and fats and further supported by sedentary lifestyle have been implicated in the growing epidemics of obesity and diet-related chronic diseases namely, cardiovascular diseases, hypertension, *Diabetes mellitus* and cancer. Inflammation and oxidative stress have also been linked to meat intake and recognised as health risk (Mente *et al.* 2009), the most abundant data thereby being collected on the link between red and processed meat intake and colorectal cancer (World Cancer Research Fund 2007).

Fat is considered to be the most variable ingredient in meat products, whose quantity and quality influence not just nutritional value but also organoleptic properties and health implications depend on several factors such as species, sex, age, breed selection, feeding and farming of farm animals, but also technological processes and parameters implemented during the production (Jiménez-Colmenero *et al.* 2001; Marušić *et al.* 2011). Despite generally unfavourable beliefs about, and attitudes towards, meat and meat products, this kind of food plays an important role in dietary regimens pursued by many

countries from both social and cultural standpoint. According to Grunert (2006), this apparent contradiction may partially be explained by the distinction between the roles of individuals as consumers and as citizens: we may hold a negative attitude towards meat production and consumption (i.e. based on environmental and animal welfare issues), but these attitudes often only vaguely mirror in our behaviour as consumers. In general, consumers tend to view upon meat as a healthy and important dietary component (Verbeke *et al.* 2010).

As recently reviewed by Furnols and Guerrero (2014), consumers' preferences, behaviour and perception about meat and meat products are under the influence of psychological issues (such as attitudes, beliefs and expectations), sensory meat properties (such as appearance, texture, flavour and odour), and marketing-related aspects (such as price and brand). It was confirmed that better education and increased consumers' purchasing power affect autochthonous food demand. Nowadays, autochthonous meat products are a vital part of regional culture and tradition of many European countries that increasingly attract consumers and therefore become a subject to an ever more intense research of their nutritional value. In Croatia, traditional autochthonous pork meat products are mostly produced in households and are characterized by a non-standardized quality and production technology (Kovačević *et al.* 2009; Pleadin *et al.* 2013).



In view of the above, this study had the following aims: (i) to analytically determine the fat content contained by traditional meat products produced in households seated in different Croatian regions; (ii) to estimate the dietary intake of traditional meat products based on the results of the first Food Consumption Survey (iii) to assess the fat intake of Croatian adult population via traditional meat products based on the results of chemical analysis and dietary intake data.

Materials and methods

Meat product samples

Fat content was analysed in a total of 137 Croatian traditional meat products originating from family farms established in two Croatian regions: Mediterranean-which include Istria and Dalmatia, and Continental one- which include North-Western, North, Eastern part and city of Zagreb (capital city). The products were classified according to the Croatian Regulations on Meat Products (OG 2012a) and fell into the categories of sausages, cured meat products, bacon and cracklings.

Out of the total of 137 samples, 51 were sausages ("Kulen" and dry-fermented homemade sausages), 53 were cured meat products (dry-cured: prosciutto, dry ham, dry shoulder blade and dry picnic shoulder, and semi-dry: cured smoked shoulder blade), 28 were bacons (semi-dry: ham and bacon; dry: pancetta), while 5 were cracklings.

Samples were homogenized in a Grindomix GM 200 homogenizer (Retsch, Haam, Germany) and then stored at +4 °C in plastic containers filled to the top.

Determination of total fat

Total fat content was determined according to the ISO 1443 (1973) using the Soxhlet gravimetric method which involves a digestion of a sample in an acidic milieu, filtration, fat extraction using an organic solvent, and drying in a thermostat. The analysis by use of a Soxtherm 2000 automated extraction device (Gerhardt, Bonn, Germany), an EPSA 2000 thermostat (Bari, Velika Gorica, Croatia) and chemicals of an analytical grade (Kemika, Zagreb, Croatia). The results obtained with different meat products were expressed as weight percentages (%) and as the mean value, the accuracy thereby being 0.01%.

Verification of the method was carried out with each analysis using the Certified Reference Material (CRM) T0149 (FAPAS, York, England) and checked for falling into the assigned range (2.12-2.87%).

The survey on dietary habits of the Croatian population

In order to determine dietary habits of the adult Croatian population, the Croatian Food Agency conducted the National Food Consumption Survey. The Survey was carried out in accordance with the guidelines issued by the European Food Safety Agency (EFSA) (2009). The Survey was conducted across the adult (18-64 years old) population on two separate occasions (in autumn 2011 and summer 2012) in a representative sample of 2,002 respondents. The Survey made use of the 24-Hour Recall and was conducted on two non-consecutive working days (at least two weeks apart) and one

weekend day. Data were collected by trained personnel at the participants' homes; in total, three face-to-face interviews were conducted with each examinee.

The representative adult population sample was composed so as to cover for different socio-demographic parameters (regional coverage, level of education, employment and family status and the level of physical activity). Additionally, the questionnaire on the frequency of traditional meat products' consumption, offering answers from "several times a day" to "once a year" (a 10-point scale), was used to determine chronic exposure (the Croatian Food Agency, unpublished data).

The Manual authored by Senta *et al.* (2004) was used to help participants to specify the amount of consumed food. The household measurement followed by weighing was used with food not included in the Manual. Data are presented *per capita* (for all participants) and *per consumer* (for those reporting traditional meat products consumption).

Statistical data analysis

Statistical analysis was performed using the SPSS Statistics Software (SPSS Statistics 2011). The results were tested for the normality of their distribution using the Shapiro-Willk test ($p > 0.05$). In order to determine the statistical significance of the differences in shares of fat established between the groups, the one-way ANOVA, the Kruskal-Wallis test and the Independent Sample T-test were used, the statistical significance thereby being set at $p < 0.05$.

Results and discussion

The primary motif to consume traditional meat products is consumers' attitude towards, and beliefs about, autochthonous food that represents a part of Croatian heritage and tradition. On the other hand, fat content of meat products is one of the most important quality parameters that affect their acceptability. For nutritional health reasons, it is beneficial to assess dietary fat intake related to this group of products. Average fat content of traditional Croatian meat products analysed in this study ranged from 14.39% (dry ham) to 38.31 % (homemade sausage) (Table 1).

Table 1: Total fat share (Mean±SD) determined in traditional Croatian meat products

Group of product	Type of product (n)	Total fat (%)	Range
Dry fermented sausages	Homemade sausage (38)	38.31±6.24 ^a	27.69-52.50
	"Kulen" (13)	22.08±1.30 ^b	19.43-23.62
Dry cured meat products	Prosciutto (24)	13.85±2.06 ^a	10.91-20.30
	Dry ham (21)	14.39±1.65 ^a	10.90-17.12
	Dry shoulder blade (2)	19.31±0.00 [*]	19.31-19.31
	Dry picnic shoulder (4)	18.13±1.10 ^b	16.55-19.13
Semi-dry cured meat products	Smoked shoulder blade (2)	17.99±0.81 [*]	17.42-18.56
Semi-dry bacon	Bacon (15)	45.28±3.72 ^a	39.11-50.13
	"Špek" (9)	42.57±4.59 ^{ab}	37.11-48.15
	Cracklings (5)	44.51±2.54 ^a	41.56-48.43
Dry bacon	Pancetta (4)	36.16±4.47 ^b	30.66-41.56



Letters used within the same product category signify a statistically significant difference ($p < 0.05$)

*Meat products are not included in the statistical analysis due to the insufficient number of samples

The highest average fat content was determined in bacon and cracklings, since these products are made from pork fat tissue. Previous research has shown that meat products vary in their fat content depending on the animal used recipe used, and the production process (Jiménez-Colmenero *et al.* 2001). In dry-fermented homemade sausages, the average fat content was 38.31% which is consistent with literature data (Kovačević *et al.* 2009; Pleadin *et al.* 2013; Perši *et al.* 2013) and was statistically significantly higher ($p < 0.05$) as compared to “Kulen”, the most representative Croatian traditional fermented pork sausage with PGI (Protected Geographical Indication) status. The mass proportion of fat found in Croatian sausages is to be attributed to the recipes used with their production, according to which, on top of intramuscular fat already present in the muscle tissue, adipose tissue gets to be added into stuffing in the amount of 25 do 30%, the baseline amount thereby being further increased during drying and due to the development of production-generated mire, which, when it comes to fermented sausages, ranges from 40 to 45%. The highest fat content determined in “Kulen” within the frame of this research was lower than 25%. Other researchers reported values in range from 8.60 to 28.84% (Kovačević *et al.* 2010; Marušić Radovčić *et al.* 2014; Pleadin *et al.* 2013). Wide ranging of fat contents across products falling into the same product category can be explained by the choice of (more or less fatty) meat or by different preparation procedures exercised before stuffing.

Among dry-cured meat products, the average fat content ranged from 13.85% (in prosciutto) to 19.31% (in dry shoulder blade). Prosciutto and dry ham had statistically lower fat contents ($p < 0.05$) as compared to dry picnic shoulder. The results obtained by other researchers reporting on fat content in dry-cured meat products spanned from 7.38 to 31.20% (Marušić *et al.* 2011; Perši *et al.* 2013; Pleadin *et al.* 2013; Pleadin *et al.* 2015; Pleadin *et al.* 2016]. Dry-cured meat production is traditional for the Mediterranean countries, especially Spain, Italy, France and Croatia. Fat content found in Croatian dry-cured hams is similar to that found in Iberian dry-cured hams (19.2%) (Jiménez-Colmenero *et al.* 2010).

Pancetta was found to have the lowest fat content (36.16%) compared to bacon and cracklings probably due to the higher share of muscle tissue ($p < 0.05$). However, statistically significant difference between pancetta and “špek” failed to be found. Pancetta is thinner, drier, harder and fleshier compared with “špek” which is thicker, softer and has more fat and a more distinctive flavour. Pancetta fat content found in this research was somewhat higher than reported by other researchers (less than 30%) (Pleadin *et al.* 2013; Perši *et al.* 2013), probably due to the differences in muscle tissue content that varies across the producers.

When the analysed products were grouped based on their region of origin, it could be seen that prosciutto, smoked shoulder blade and pancetta mostly came from the Mediterranean region while “Kulen” represents a typical product from Continental part of Croatia. Homemade sausages are produced in all parts of Croatia under investigation.

Although fat *per se* is considered to be the most variable ingredient of these types of meat products, no differences ($p > 0.05$) in fat content of the same type of product coming from different investigated regions were witnessed.

Data about the consumption of traditional meat products collected in a representative sample of Croatian adult population were served as the basis for the evaluation of total fat intake via traditional meat products available on the Croatian market (Table 2).

Table 2: *Socio-demographic profile of the overall study sample (n=2002) and of traditional meat products' consumers (n=325)*

Parameter		Total study respondents (n=2002)		Traditional meat products consumers (n=325)	
		Number (n)	Percentage (%)	Number (n)	Percentage (%)
Gender	Male	971	48.50	211	64.92
	Female	1031	51.50	114	35.08
Age (years)	18-29	515	25.72	62	19.08
	30-44	673	32.62	98	30.15
	45-54	448	22.38	93	28.62
	55-64	363	18.113	70	21.54
	N/A	3	0.15	2	0.62
Education level	Elementary school or lower	254	12.69	50	15.39
	Secondary school	1363	68.08	218	67.09
	University degree or higher	342	17.08	52	16.00
	N/A	43	2.15	5	1.54
Working status	Employed	1055	52.70	145	44.62
	Unemployed	405	20.23	77	23.69
	Pupil. student	135	6.74	15	4.62
	Pensioner	296	14.78	71	21.85
	Housewife	97	4.84	11	3.39
	N/A	14	0.71	6	1.85
Marital status	Married	1301	64.98	230	70.77
	Unmarried	504	25.18	70	21.54
	Divorced	90	4.49	8	2.46
	Widow	77	3.85	10	3.08
	N/A	30	1.50	7	2.15
Household size (persons)	1-2	521	26.02	89	27.39
	3-4	916	45.75	130	40.00
	More than 5	438	21.88	88	27.08
	N/A	127	6.35	18	5.54
Physical activity	Very active	438	21.88	94	28.92
	Moderately active	1230	61.44	192	59.08
	Non-active	283	14.14	31	9.54
	N/A	51	2.54	8	2.46

N/A – no answer

Diet is influenced by many factors, such as social and economic factors, cultural traditions, geographical and environmental factors and individual preferences (Doko Jelinić *et al.* 2009; Linseisen *et al.* 2002). Dietary regimens



observed in Croatia, revealed by the Croatian Health Survey, are characterized by energy imbalance, excessive intake of fat and refined carbohydrates, and an insufficient consumption of vegetables and fruit (Doko Jelinić *et al.* 2009). Out of the total number of participants from national representative samples, 16.23% were identified as traditional meat products' consumers (Table 2), quite similar to other European countries. Namely, EFSA data confirmed that the representation of dry- and semi-dry sausages' consumers in other European countries reads as follows: 9.8% in Slovenia; 24.4% in Italy; 34.7% in Germany, 38% in France and 17.1% in Sweden (EFSA Database 2008). Germany and Nordic countries are traditionally known for high sausage consumption (Linseisen *et al.* 2002).

Meat products were predominantly consumed by middle aged (30-54 years old) male population. Literature provides reports, according to which women are generally more health-oriented and more familiar with dietary recommendations as compared to men (Linseisen *et al.* 2002; Lea & Worsley 2001). Lower meat intake, particularly that of red and processed meat, witnessed in adult age and better educated individuals, may reflect the awareness on the impact of diet on general health and/or the adoption of dietary practices that allow for the prevention or management of chronic diseases (Daniel *et al.* 2011). The results of the Croatian Health Survey showed that 15.9% of adult population has inadequate dietary habits and is prone to an excessive meat intake. In all Croatian regions, men had less favourable dietary habits as compared to women (OG 2012b). When it comes to consumers' age, most of the ham, bacon and sausage consumers in other European countries, such as France, Italy, Spain, Germany, but apparently also Korea, have been shown to be 30-50 (Cho *et al.* 2003; Linseisen *et al.* 2002).

Most of the consumers interviewed within the frame of this study are employed, have secondary education, are married and live with 3-4 family members. As for physical activity, almost 60% of meat products' consumers are moderately physically active. The research by Linseisen *et al.* (2002) showed meat intake to be decreased in older age (50+), as well as in better educated and more physically active persons. Average daily consumption of traditional meat products, and the share of fat originated from it in a representative sample of Croatian adult population (*per capita*) and in meat products' consumers (*per consumer*) is summarized in Table 3.

Table 3. Average consumption of different types of traditional meat products (g/day), and the intake of fat (g/day) originated from it, compared with recommendations, established for all participants (consumption *per capita*) and for meat products' consumers (*per consumer*)

Type of product	Participants (n)	Consumption (g/day)	Fat intake (g/day)	Portion of recommendation (%)
Homemade sausages	<i>Per capita</i> *	1.96±13.09		
	<i>Per consumers</i> (92)	42.55±44.97	16.30±2.81	7.34±1.27
	<i>Per capita</i>	0.87±12.27		
"Kulen"	<i>Per consumers</i> (30)	58.33±83.21	12.88±1.08	5.80±0.49

Type of product	Participants (n)	Consumption (g/day)	Fat intake (g/day)	Portion of recommendation (%)
Prosciutto	<i>Per capita</i>	0.67±6.68		
	<i>Per consumers</i> (45)	29.79±33.75	4.13±0.69	1.86±0.31
Dry ham	<i>Per capita</i>	0.86±8.00		
	<i>Per consumers</i> (39)	44.25±37.39	6.37±0.62	2.87±0.28
Dry shoulder blade	<i>Per capita</i>	0.05±1.27		
	<i>Per consumers</i> (7)	14.70±16.94	2.84±0.00	1.28±0.00
Bacon	<i>Per capita</i>	2.07±16.79		
	<i>Per consumers</i> (100)	41.48±63.64	18.77±2.36	8.45±1.06
"Špek"	<i>Per capita</i>	1.00±8.14		
	<i>Per consumers</i> (58)	34.56±33.81	14.71±1.55	6.62±0.70
Cracklings	<i>Per capita</i>	0.14±2.95		
	<i>Per consumers</i> (12)	23.60±31.26	10.50±0.79	4.73±0.36
Pancetta	<i>Per capita</i>	0.74±7.86		
	<i>Per consumers</i> (29)	51.29±41.64	18.55±1.86	8.35±0.84
Total	<i>Per capita</i>	8.38±32.51		
	<i>Per consumers</i> (325)	51.64±65.49	12.45±6.64	5.60±2.99

**Per capita* = 2002 participants

The total *per capita* consumption of traditional meat products was shown to be 8.38 g/day with average daily consumption established among consumers was 51.64 g. Traditional meat products most popular among consumers were bacon (41.48 g/day) and home-made dry-fermented sausages (42.55 g/day). The least popular products were shoulder blade (14.70 g/day) and cracklings (23.60 g/day) (Table 3). Sausages represent a well-known food product popular amongst many consumers because of their high palatability. However, from the nutritional standpoint, sausages do not normally contribute to a healthy diet, since they contain up to 20–25 g fat per 100 g mass and are therefore energy-dense products. Energy content is often associated with the taste of the product, fat content thereby contributing to a distinctive mouth-feel (Szczeniak 2002).

According to the EFSA database (2008), in European countries mentioned previously (Slovenia, Italy, Germany and France), sausage consumption equals to 103.6 g/day, 28.7 g/day, 52.1 g/day and 20 g/day, respectively. The consumption of bacon registered in the UK as the country with high bacon intake was 5.9-8.8 g/day. Fermented dry sausages' manufacturing is perceived by consumers as closely related to tradition. A survey conducted in Italy showed that traditional sausages are an important part of diet of the interviewed meat products' consumers. In that survey, handling and consumption habits were linked to the type of sausages consumed and the geographical territory on which they are manufactured and consumed (Conter *et al.* 2008).

Most of the meat products' consumers interviewed within this research were from Eastern part of Continental Croatia (31.39%), where the highest average consumption was proven (58.6 g/day) (Table 4). In Eastern Croatia meat products' production and consumption is deeply rooted into tradition.



Table 4. Average consumption (g/day) of traditional meat products established among consumers (per consumer) in different Croatian regions

Regions	Parts	Meat products' consumers n (%)	Consumption (g/day)	Range
Mediterranean	Dalmatia	54 (16.62)	38.84±36.40	0.09-150.00
	Istria	17 (5.23)	44.75±43.90	0.18-150.00
Continental	North-Western	41 (12.62)	77.80±116.32	3.00-726.00
	North	43 (13.23)	31.31±26.87	0.60-100.00
	City of Zagreb	68 (20.92)	50.16±56.30	1.40-280.007
	Eastern	102 (31.39)	58.60±66.29	1.08-400.00

Generally, the frequency and the amount of consumption of traditional meat products were lower in Mediterranean region in comparison with Continental part ($p < 0.05$). In the Continental parts of the Country, traditional diet mostly resembles the Mid-European diet characterized by high intakes of sausages and ham. However, in the Mediterranean region, the local diet is rich in fruit, vegetables and fish, similar to the Mediterranean diet, with less pork and processed meat products (ham, bacon and sausages) consumed (Doko Jelinić *et al.* 2009). In our survey, it was confirmed that the most preferable meat products in this region was Prosciutto. Most of the meat products' consumers interviewed within this research were from Eastern Croatia (31.39%) and the Croatian capital (the City of Zagreb) (20.92%), while the lowest number came from Istria (5.23%). In North- Western part of Continental Croatia, the average daily consumption of meat products was the highest (77.80 g/day) while in the Northern Croatia the consumption of these products was proven to be the lowest (31.31 g/day).

Other studies have also reported regional influences on dietary habits, for example, in France, Spain and Italy (Perrin *et al.* 2005; Corrêa Leite *et al.* 2003; Linseisen *et al.* 2002). Perrin *et al.* (2005) reported regional influences to be most profound among people of low and medium social and economic standing, while in subjects having a university degree these influences were less significant. The Croatian Adult Health Survey showed the highest prevalence of the main diet-related cardiovascular risk factors, unhealthy dietary habits included, in Continental part of Croatia. Regional differences were explained by a more frequent consumption of red meat and meat products, lard and bacon in the Continental as compared to the Mediterranean region (Doko Jelinić *et al.* 2009).

In industrialized countries, about 36–40% of the total food-supplied calories come from fat, nearly half of it thereby from the intake of meat (10-20%), although recommendations are set to 15-30% of the daily energy intake (WHO 2003; Aranceta & Perez-Rodrigo, 2012). The research by Linseisen *et al.* (2002) showed that, in European countries, processed meat consumption (mainly that of sausages, ham and bacon) provides for 1.2-10.1 % of the total energy intake in men and 1.0-6.5% in women.

The average fat intake by traditional meat products among our samples is 12.45 g/day, which is slightly higher

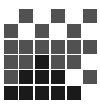
than 5% of the recommended daily energy intake (Table 3). The highest daily fat intake was that through the consumption of pancetta (18.55 g) and bacon (18.77 g), which is a bit lower than 10% of the recommended energy intake or about one third of the recommended daily fat intake. Assuming that the recommended daily energy intake should not exceed 2,000 kcal, the recommended fat intake should be limited to 70 g. The intake of fat was proven to be the lowest (2.84 – 6.37 g/day) in dry-cured meat consumers. It is evident that the consumption of traditional meat products in terms of sausages, bacon and cracklings provides for roughly 5-10% of the recommended daily energy intake, while the consumption of traditional dry-cured meat products ensures less than 5% of the recommended daily energy intake.

The average fat content found in meat products produced and sampled in different Croatian regions reads as follows: 25.89% in products produced in Mediterranean region, 31.02% in products produced in the Eastern part of Continental Croatia and 31.64% in products produced in the North-Western part of Continental region. Based on these average fat content and the average daily intake of traditional meat products in different Croatian regions, it can be concluded that the highest fat intake that occurs through the consumption of these traditional meat products was determined in the Eastern (18.17 g/day) and North-Western (16.79 g/day) Continental Croatia, while the lowest intake can be found in the Mediterranean region (10.82 g/day) (*data not shown*). This is in agreement with previous reports on dietary habits in continental and coastal Croatia (Doko Jelinić *et al.* 2009). In the Mediterranean region, meat products' consumers meet roughly 5% of the recommended daily energy intake, while in the Continental regions a bit less than 10% of the recommended daily energy intake or about one third of the recommended daily fat intake (30% of E) is ensured by the consumption discussed above.

Health-related issues associated with meat and meat products consumption are given an ever increasing importance due to the rising health concerns. As a result, meat and meat products reduced in fat and having a modified fatty acid profile are being developed (Valencia *et al.* 2006). Nevertheless, such improvements in the traditional food sector are also somewhat risky, because consumers tend to reject innovations such as fat reduction that affect the traditional profile of the product. On the other hand, the production of protected meat products is strictly defined and should come up with products having the exact same properties as those defined under old and unique traditional recipes on which the production of these products has leaned for ages.

Conclusion

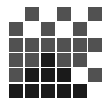
Judging by the average consumption of traditional meat products analysed in this study, the daily fat intake was below the recommended, but some products provide for almost one third of the recommended daily fat amount. Traditional meat products cannot be substantially modified, but some opportunities capable of yielding healthier products, such as fat reduction and fatty acid profile modification, should be explored in future. Future research should focus on fatty acid composition of meat products so as to determine their nutritional



properties and estimate the fatty acid intake among Croatian adult population. Furthermore, it would be recommendable to widen the range of meat and meat products under study rather than limit it to traditional products only, so as to obtain more informative data on fat and fatty acids' intake via meat and meat products descriptive of Croatian population.

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