Influence of the Origin on Selected Determinants of the Quality of Pork Meat Products

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Abstract

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In recent years, great attention has been paid to the quality of eaten meat and its products. There have been launched a lot of promotional campaigns aimed at providing opportunities for the consumption of traditional products. Based on the experiment, a significantly higher protein content was found in sausages produced by large producers (24.73 ± 1.98%). The fat content was significantly higher in traditional ham (16.25 ± 14.47%), compared with local ham (4.38 ± 2.26%) and the mass (9.29 ± 5.25%). The samples of traditional and local ham had a significantly higher salt content (3.31 ± 0.72 and 2.90 ± 0.54%, respectively). No dye compounds were detected in any of the tested samples. There were no statistically significant differences in hydroxyproline and L-glutamic acid content between traditional and conventional samples of meat products. Analysis of nitrate (V and III) showed a statistically significant difference in the average contents of these compounds. Significantly higher levels of nitrates were revealed only in traditional ham samples (12.60 ± 8.08 mg NaNO(V)/kg and 17.53 ± 27.91 mg NaNO(III)/kg of the product, respectively), wherein there was a large variation in the content of these compounds in the samples.

Keywords: traditional ham; traditional sausage; pork; salt; fat; protein; nitrate; hydroxyproline;L-glutamic acid

Changes in consumer requirements for meat products as well as increased global competition are causing an unprecedented spur in processing and ingredient system developments within the meat manufacturing sector. Consumers demand healthier meat products which contain a lower amount of salt, fat, nitrites in general and contain in addition health-promoting bioactive components, for example carotenoids, unsaturated fatty acids, and fibre. On the other hand, consumers expect these products with altered formulations to taste, look and smell the same way as their traditionally formulated and processed counterparts.

In the European Union there is a growing interest in recreating favourable conditions for traditional extensive methods of plant and animal production to enable obtaining previously known raw materials. EU systems for the protection of traditional and regional products have been introduced which create the possibilities for certification of such products (Regulations 1982a,b). In Warmia and Mazury, producers may participate in the network of culinary heritage and thus label their products with the sign "Culinary Heritage Warmia Mazury Powiśle". These measures may stimulate consumer interest in purchasing regional food products of high quality and nutritional and health values.

The aim of this study was to compare: (1) health quality [nitrate(V) and nitrate(III) and presence of dye compounds: tartrazine (E102), quinoline yellow (E104), sunset yellow (E110), amaranth (E123), ponceau (E124), and indigo (E132)], (2) nu-

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tritional value (fat, protein, hydroxyproline, and L-glutamic acid) of pork meat and meat products in dependence on the product origin (produced by micro-companies and larger producers located in north-eastern Poland).

MATERIAL AND METHODS

Samples. The study was carried out on fresh raw (fresh) pork ham, boiled and smoked pork ham and boiled and smoked sausage produced by: (a) small-scale producers (meat-processing plants) that labelled their products with the sign "Culinary Heritage Warmia Mazury Powiśle" (CHWMP); (b) small-scale producers that declared the use of local raw materials and methods for producing traditional products (L); (c) large plants that manufactured products with names related to the following terms: rural, peasant, traditional, and for generations (C). The research material (CHWMP and L) was selected on the basis of previously conducted studies (Radzymińska *et al*. 2009; Staniewska *et al*. 2009) that focused on the identification of meat products which, in the opinion of the producers, demonstrated exceptional quality, resulting mainly from the traditional method of production and from raw materials (of local origin).

Nutritional value. Nutritional value of meat and its products was determined based on selected indicators: fat, protein, hydroxyproline, and L-glutamic acid. In addition, meat products were subjected to the evaluation of their physico-chemical parameters including salt content.

Protein content in samples was determined according to the Kjeldahl method (Horwitz 2000). This method consists in mineralising (burning) the examined organic substance in concentrated sulphuric acid, at a boiling temperature. About 0.5 g of the sample was mineralised and distilled. After distillation samples were titrated with 0.1M of hydrochloric acid. The Kjeldahl method using a FOSS Tecator Kjeltec system consisting of a 1001 digestion unit and 6002 distilling unit (Foss Analytical AB, Höganäs, Sweden) was performed to determine protein content, which was calculated by converting the nitrogen content (N%) obtained by digestion (6.25 × N%). To measure fat content, samples were dried in the oven at 100°C for 4 h, and then it was extracted using the method of Soxhlet solvent extraction (Horwitz 2000). Salt content was determined by titration with silver nitrate according to Horwitz (2000).

Hydroxyproline content was determined according to the method of Kolar (1990) and described in the AOAC (1998). Briefly, 4 g of the sample was mixed with 30 ml of sulphuric acid and hydrolysed in Erlenmeyer flasks in an air convection oven at 105°C for 16 hours. Hydrolysed samples were filtered and after that 2 ml of the hydrolysed diluted sample (5–200 times) was mixed with 1 ml of oxidative solution chloramine T (1.41%) prepared directly before use in an aqueous buffer solution containing 15 g of sodium hydroxide, 90 g of sodium acetate trihydrate, 30 g of citric acid monohydrate, and 290 ml of 1-propanol per litre. The reaction tubes were shaken and then incubated at room temperature for 20 minutes. After that 1 ml of reactive colour (10 g of dimethylamine benzaldehyde with 35 ml of 60% sulphuric acid and 65 ml of 2-propanol) was added and the mixture was incubated at 60°C for 15 minutes. After incubation absorbance was measured at 558 nm using a VIS 6000 spectrophotometer (Kruss Optronic GmbH, Hamburg, Germany). The stock solution of the standard to create a standard curve was 0.1, 0.5, 1.0, 1.5, and 2.0 mg/ml. All standard solutions were prepared directly before use.

The content of L-glutamamic acid was measured by a colorimetric method according to PN-ISO 4134 (2002). Briefly, approximately 50 g of the homogeneous sample was mixed with 100 ml of perchloric acid (at 0°C) and homogenised. Part of the homogenised sample was removed to a tube and centrifuged at 2000 *g*. Then the fat layer was removed and the sample was filtered. 50 ml of the filtrate was adjusted to pH 10.0 using potassium hydroxide. The mixture was filled up to a 100-ml volumetric flask. After cooling for 10 min in water bath the sample was filtered. 25 ml of the sample was filled up with 250 ml of distilled water using a volumetric flask. Add 2.5 ml of triethanolamine phosphorus buffer (solution A: 1.86 g triethanolamine hydrochloride in water adjusted to pH 8.6 using potassium hydroxide, 0.86 g Tritron X-100/100 ml; solution B: 0.86 g dipotassium hydrogen phosphate and 7 mg potassium dihydrogen phosphate/100 ml. Mix 20 ml of solution A and 5 ml of solution B into two cuvettes with 0.2 ml NAD (25 mg nicotinamide adenine dinucleotide/5 ml), 0.2 ml INT (30 mg iodonitrotetrazolium chloride per 50 ml) and 0.05 ml diaphorase (3 mg diaphorase/1 ml). Into one cuvette add 0.5 ml of the sam-

ple filtrate and to the other 0.5 ml of water. After that absorbance was measured at 492 nm against water. Then 0.05 ml GLDH (10 mg EDTA and glutaminase per ml) was added to each sample. After 10–15 min absorbance was measured at 492 nm, and the measurement was repeated every 2 min to reach a constant absorbance increase. Using the same procedure, absorbance of the stock solution of L-glutamic acid (50 mg diluted in 25 ml of water adjusted to pH 7.0 using potassium hydroxide and diluted with water to 50 ml) was measured.

Health quality. Health quality of raw meat and meat products was determined based on selected indicators: nitrate(V) and nitrate(III) and presence of dye compounds tartrazine (E102), quinoline yellow (E104), sunset yellow (E110), amaranth (E123), ponceau (E124), and indigo (E132). Contents of nitrate(III) and nitrate(V) were determined following PN-EN ISO 14673-1 (2004).

The presence of dye compounds was determined according to PN-ISO 13496 (2002). Dye compounds were extracted from the sample using distilled water and adsorbed on the polyamide powder. After extracted dye compounds were purified by column chromatography and eluted from the column. Thin-layer chromatography was used for identification. All samples of meat, ham, and sausage were tested for the presence of dyes such as tartrazine, quinoline yellow, sunset yellow, amaranth, ponceau, and indigo.

Statistical analysis. Differences in the tested elements between the examined categories of meat products (CHWMP, L, C) were determined by one-way analysis of variance (ANOVA). The significance of differences in the mean values of nitrate(V) and nitrate(III) between samples was determined by Duncan's t-test (analysis at the level of significance of $P = 0.05$).

RESULTS AND DISCUSSION

Nutritional value

Protein, fat, and salt content in the samples of investigated meat, ham, and sausages is shown in Table 1. The experimental results showed that in raw meat samples and ham samples (Table 1) the content of protein was similar, approx. 20%. A significantly higher protein content was found in sausages produced by large producers (24.73 ± 1.98%). Ham produced by producers labelling their products with the sign "Culinary Heritage Warmia Mazury Powiśle" contained a significantly higher amount of fat (16.25 ± 14.47%) compared with local ham (4.38 ± 2.26%) and the mass (9.29 ± 5.25%) (Table 1). Salt content was significantly different only in ham samples. Presented results (Table 1) showed that traditional and local hams contained a significantly higher amount of salt (3.31 ± 0.72% and 2.90 ± 0.54%, respectively). As published by Cheng and Sun (2007), in ham cooking in single netting the content of fat was 1.7%, protein 22.7%, and salt 2.1% on average. According to Ngapo *et al*. (2012) the concentration of protein in raw pork was 23.5% on average. In research conducted by Cheng *et al*. (2005) on different cooking methods of pork ham, 2.28% salt, 24.56% protein, and 2.07% fat were found in dry air cooking product. In wet air cooking ham the

Table 1. Content (in %) of protein, fat, and salt in pork meat, hams, and sausages produced by different producers

Product	Origin	Protein			Fat			Salt		
		$\bar{x}$	SD	ANOVA	$\bar{x}$	SD	ANOVA	$\bar{x}$	SD	ANOVA
Raw pork	L (n = 39)	21.62	2.57	F = 1.34 P = 0.29	6.58	4.27	F = 0.31 P = 0.73	0.64	0.74	F = 1.54 P = 0.24
	CHWMP (n = 12)	19.26	0.62		7.33	2.52		1.14	0.55	
	C (n = 18)	20.42	2.39		5.40	0.89		0.29	0.10	
Ham	L (n = 36)	20.06	2.56	F = 0.34 P = 0.71	4.38	2.26	F = 4.55 P = 0.02	3.31	0.72	F = 9.78 P = 0.00
	CHWMP (n = 15)	21.26	4.10		16.25	14.47		2.90	0.54	
	C (n = 36)	19.17	4.41		9.29	5.25		2.05	0.72	
Sausage	L (n = 9)	17.83	5.12	F = 5.07 P = 0.04	29.00	1.41	F = 1.02 P = 0.41	3.55	0.60	F = 1.07 P = 0.39
	CHWMP (n = 9)	21.31	1.61		22.00	2.16		3.17	0.22	
	C (n = 12)	24.73	1.98		24.25	8.30		2.88	0.71	

L, CHWMP, C see Material and Methods – Samples; SD – standard deviation

Table 2. Content of hydroxyproline and L-glutamic acid in samples of meat, ham and sausage

Product	Origin	Hydroxyproline (mg/100g)			L-glutamic acid (mg/100 g DW)		
		$\bar{x}$	SD	ANOVA	$\bar{x}$	SD	ANOVA
Raw pork	L (n = 39)	0.37	0.11	F = 0.65 P = 0.53	509	72	F = 2.10 P = 0.15
	CHWMP (n = 12)	0.31	0.12		576	182	
	C (n = 18)	0.31	0.04		448	82	
Ham	L (n = 36)	0.39	0.19	F = 0.36 P = 0.70	564	11	F = 0.26 P = 0.77
	CHWMP (n = 15)	0.35	0.05		517	91	
	C (n = 36)	0.33	0.09		537	93	
Sausage	L (n = 9)	0.32	0.15	F = 1.36 P = 0.33	498	81	F = 0.80 P = 0.49
	CHWMP (n = 9)	0.41	0.09		409	64	
	C (n = 12)	0.51	0.15		469	93	

L, CHWMP, C see Material and Methods – Samples; SD – standard deviation

authors found 1.97% salt, 23.40% protein and 1.64% fat. Jiménez-Colmenero et al. (2010) revealed that in Spanish sausage the level of protein was 15.57% and that of fat 37.33% on average.

Table 2 documents the content of hydroxyproline and L-glutamic acid in samples of raw meat and meat products. As some authors reported, there are no statistically significant differences in hydroxyproline and L-glutamic acid content between traditional and conventional meat products. Mean hydroxyproline content in meat, ham and sausage was 0.31 ± 0.12, 0.35 ± 0.05 and 0.41 ± 0.09 mg/100 g, respectively. The level of L-glutamic acid was 576 ± 182, 517 ± 91 and 409 ± 64 mg/100 g dry weight (DW) on average, respectively (Table 2).

According to Mazorra-Manzano *et al*. (2012) the mean content of hydroxyproline in Frankfurter sausage was 0.15 mg/100 g and in ham 0.09 mg/100 g of the product. As reported by Belloni et al. (2012), the content of this compound in analysed sausages ranged from 0.177 to 0.453 mg/100 g of the product, while in their research Messia *et al*. (2008) found in Mortadela the hydroxyproline mean level of 0.26 mg/100 g of the product. Aro Aro *et al*. (2010) conducted research on L-glutamic acid content in sausages. They found that the level of this amino acid ranged from 117.5 to 170.1 mg/100 g of the product. While Martuscelli *et al*. (2009) tested, among others, L-glutamic acid content in raw pork meat and ham produced by different methods. The authors found the mean content of this compound in raw material to be 243.3 mg/100 g on average and in ham after ripening the amount of L-glutamic acid ranged from 300.39 to 482.81 mg/100 g of the product. Similar research was conducted by Prevolnik *et al*. (2011). The authors investigated the occurrence of amino acids in dry-cured hams. They found the level of L-glutamic acid in this type of product to range from 742 to 1277 mg/100 g DW.

Health quality

Statistical analysis and mean content of nitrate(V) and nitrate(III) in ham are shown in Table 3. According to tests the results indicated statistically significant differences in the content of these compounds (Table 3). Statistically high contents of nitrates were determined in traditional samples

Table 3. Content (in mg/kg) of nitrate(V) and nitrate(III) in samples of ham

Product	Origin	Nitrate(V)		Nitrate(III)	
		$\bar{x}$	SD	$\bar{x}$	SD
Ham	L (n = 36)	17.02^{a}	7.15	8.89^{b}	9.30
	CHWMP (n = 15)	12.60^{a}	8.06	17.53^{a}	27.91
	C (n = 36)	6.25^{b}	2.41	0.52^{c}	0.90

L, CHWMP, C see Material and Methods – Samples; SD – standard deviation; $^{a–c}$statistically significant differences on the $P < 0.05$ level

of meat products (12.60 ± 8.08 mg NaNO(V)/kg and 17.53 ± 27.91 mg NaNO(III)/kg of the product, respectively), and high variability of these compounds in samples of tested products was found out (Table 3). Andrade et al. (2003) conducted research on nitrate(III) and nitrate(V) content in meat products. In pork sausage the authors found the level of tested compounds to be 59 mg/kg for nitrate(V) and 39 mg/kg nitrate(III) on average. As published by Honikel (2008), in German products the concentration of nitrates(V) in raw sausages was 59.2 and nitrates(III) 17.9 mg/kg, while in raw ham it was 16.9 and 19.2 mg/kg, respectively. Ferreira and Silva (2008) found in ham the level of nitrate(V) to range from 0.663–0.999 mg/kg and nitrate(III) 0.113–1.253 mg/kg.

In tested samples no dye compounds were revealed: E102, E104, E110, E123, E124, E132, which are not allowed as food additional compounds to meat products.

CONCLUSIONS

The study showed that traditional hams contained significantly higher levels of fat, salt and nitrate(III) and nitrate(V). Nitrates and salt are used as a factor extending durability of meat products. Traditional production includes the addition of those two compounds only and probably because of that the level of nitrates and salt is higher in traditional products. Generally, the nutritional value of local, traditional, and conventional meat products did not differ. Only the protein concentration in conventional sausages was significantly higher in comparison with local and traditional products. No colour compounds (E102, E104, E110, E123, E124, E132) were found out in any sample.

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