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PRODUCTION

PROCEEDINGS

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MODERN TRENDS IN LIVESTOCK PRODUCTION

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QUALITY OF MEAT FROM NATIVE PIGS

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Abstract: Production of traditional meat products, characterized by very good organoleptic properties demands specific raw material which is meat from pigs with slaughter weight 120 kg, intramuscular fat content higher then 3% and bred by extensive system. Some of breeds which can fulfil this requirements are native breeds like Mangalitza, Moravka, Złotnicka Spotted, Złotnicka White and Pulawska pigs. Aim of this study was analysis of raw meat from Mangalitza, Moravka, Złotnicka Spotted, Złotnicka White and Pulawska pigs – quality of meat and its technological values were evaluated. Meat from analysed pigs had proper chemical composition, favourable n3/n6 fatty acids profile, low drip loss, proper pH. The composition of loin of: Puławska, Złotnicka, Mangalica and Moravka races was similar in protein, ash and carbohydrates contents. The content of intramusular fat in loins of examined races ranged from 3.0% (Złotnicka White) to 5,1% (Moravka). In this study there was confirmed good meat quality and its usefulness for production of traditional products.

Key words: pigs, Złotnicka Spotted, Złotnicka White, Puławska, Mangalitza, Moravka, meat, quality

Introduction

The market of meat products is differentiated, beside the high yield efficiency goods there are also produced the low yield usually considered as luxury articles. The last group also includes raw, ripening products, characterised by specific, very good organoleptic properties, namely Parma hams, Iberico hams or Polish raw smoked meat products, e.g. Lublin loin or Podlaski kumpiak. The

production of raw-ripening meat products requires a specific raw material - meat of heavy pigs with slaughter body weight of over 120 kg, with intramuscular fat content exceeding 3%, and which should be fed traditionally using extensive methods. Breeds which meat has long been used to manufacture such products include: Iberico, Casertana, Alentejana and Mangalica *(Pugliese and Sirtori, 2012)*. Polish national husbandry is still posses swine breeds which were used in the past and can still be used for production of high quality raw ripening products, although populations of these breeds are small *(Szulc et al., 2011)*. These pigs include the following native breeds: Złotnicka Spotted, Złotnicka White and Puławska *(Babicz et al., 2009; Buczyński et al., 2005)*. In Republic of Serbia there are three native pig breeds: Mangalitza, Moravka and Resavka. Mangalitsa is typical fat breed which is farmed mainly in Hungary and also in Serbia and Croatia. There is 65-70% of fat in carcass halves and approx. 30-35% of meat *(Egerszegi et al., 2003)*. Results of recent studies *(Egerszegi et al., 2003)* show this amount of meat is sufficient for production of high quality ham. Moravka is breed of combined production with more meat in carcass halves and significantly less fat *(Petrović et al., 2010)*.

The Złotnicka Spotted, Złotnicka White and Puławska breeds has not been improved by crossing with other breeds. Due to its small size, the conservation breeding aims to maintain biodiversity and is not focused on selection towards increasing production. That is why Złotnicka Spotted, Złotnicka White and Puławska pigs maintained good meat quality suitable for the manufacture of traditional products. This was confirmed by experiments carried out by *Buczyński et al., (1997)*; *Kapelański et al., (2006); Grześkowiak et al., (2009)* and *Szulc et al., (2012)* which revealed that meat of the Złotnicka Spotted breed was characterised by lack of quality changes, small free drip loss and proper pH. Meat used for manufacturing raw and raw-ripening products must be characterised by pH 5.6-5.8, approximately 3.5% intramuscular fat as well as good profile of muscle fibres. It is evident from experiments carried out so far that the size and quantity of individual muscle types exert a decisive impact on muscle "functional character" and, hence, on its quality as well as technological and culinary value *(Cameron et al., 1998)*.
Aim of this study was analysis of raw meat products from Mangalitza, Moravka, Złotnicka Spotted, Złotnicka White and Puławska pigs.

Materials and Methods

Animals

The performed investigations used 30 carcasses of fatteners from the following five genetic groups (purebreed fatteners):

- Złotnicka Spotted (ZS) - (n= 6),
- Złotnicka White (ZW) - (n=6),

- Puławska (Pul) (n=6),
- Mangalitza (Ma) (n=6)
- Moravka (Mo) (n=6).

Animals were divided into five experimental groups keeping the sex ratio at 1: 1. Złotnicka Spotted (ZS), Złotnicka White (ZW) and Pulawska (Pul) pigs were bred in Poland and Mangalitza (Ma) and Moravka (Mo) were bred in Serbia. All the analyses on pigs' meat were performed in Poland.

Experimental animals with the average weight of 20 kg were selected and the experiment was terminated when the animals attained the slaughter weight of about 120 kg (113.0 – 123.6 kg). They were fed *ad libitum* with complete mixed rations and had constant access to water. At the final of fattening, the animals were slaughtered. The half-carcasses were cooled down using the mono-gradual system at the temperature of about 4^{o} C. After 24 h of meat ageing, samples of *m. longissimus dorsi* (LD) were collected from half-carcasses.

Meat quality

24 hours (pH_{24}) after the slaughter, pH was measured in the *longissimus dorsi* (LD) muscle at the last rib by means of an integrated electrode pH meter Radiometr PHM 80 Portable. Samples from the lumbar section of the LD muscle were collected for laboratory investigations. The following items were estimated in the raw meat samples:

- water content according to the standard *PN-ISO 1442:2000*,
- fat content according to the standard *PN-ISO 1444:2000*,
- protein content by Kjeldahl method *(PN-75/A-04018)* with TECATOR apparatus
- total ash content according to the standard *PN-ISO 936:2000*,
- total carbohydrates content was calculated assuming that the all total solids and water stand for 100%
- fatty acid profile – was obtained by gas chromatography method. The fat samples were extracted with chloroform-methanol (2:1, v/v) according to the method of *Folch et al. (1957)*. Then 1 g of meat samples was mixed with 15 mL chloroform–methanol mixture and homogenized for 10 min at 5000 rpm, and after 5 min pause – 5 min at 1000 rpm using homogeniser MPW-120. The mixture was then filtered through filter paper tothe regular cylinder and completed with extraction mixture up to 15 mL. Next, 3 mL of 0.74% KCl solution was added to 15 mL of filtrate. The alcohol–water phase was removed, and the chloroform phase was washed 3 times using 2 mL solution of chloroform:methanol: 0.74% KCl (3:48:47, v/v/v). Subsequently the chloroform phase was recovered, dehydrated with anhydrous sodium sulphate (Na2SO4) and dried using nitrogen at 45ºC. To

the sample (about 10 mg) were added 0.5 ml 0.5 N KOH in methanol and heated at 85ºC. Next 1 ml 12% BF3 in methanol were added and the sample was again heated at 85ºC. After cooling in room temperature 1 ml hexane and 5 ml saturated solution of NaCl were added. Fatty acid methyl esters profile in one µl samples at the split ratio of 10:1 were separated by gas chromatography on a TRACE GC ULTRA gas chromatograph, equipped with 30 m capillary column SUPELCOWAX 10 of 0.25mm inner diameter and coating thickness of 0.25 µm (30 m × 0.25 mm × 0.25 um). Operating conditions were as follows: helium was used as a carrier gas, flow 1 ml/min, split flow 10 ml/min, injector temperature 220ºC, detector temperature 250ºC, initial column temperature 160ºC.

- meat weight cooking loss. Samples were heated to reach the internal temperature of 75ºC in the geometric centre of the sample. The results were computed from the difference between the weight before and after cooking *(Baryłko–Pikielna, 1975),*
- the measurements of colour of meat samples were obtained in CIELab system. Lightness [L*], redness [a*] and yellowness [b*] of meat were determined using a Konica Minolta CM – 600d spectrophotometer. Values of [a*] and [b*] were used to calculate the saturation value - chroma [C*].

Statistical analysis

All samples were obtained at least in duplicates. All results were analysed with ANOVA and present as means with standard deviation. The calculations were performed with Statistica 6.0 *(StatSoft, 2003)*.

Results and Discussion

In table 1 is presented the basic chemical composition of examined loins of different pigs' breeds, whereasin table 2 the fatty acid profile of intramuscular fat of analysed pigs.

Table 1. The chemical composition of loin of analysed pigs' breeds

Chemical componet [%]	Breed of fatteners					SEM
	Złotnicka Spotted (ZS)	Złotnicka White (ZW)	Puławska (Pul)	Mangalitza (Ma)	Moravka (Mo)	
Water	72.7	73.7	73.6	73.3	72.9	0.36
Total solids	27.3	26.3	26.4	26.7	27.1	0.36
Protein	22,1^{a}	21.7^{a}	21.4^{ab}	20.7^{b}	20.2^{b}	0.68
Fat	3,4^{ab}	3.0^{a}	3.2^{a}	4.0^{b}	5.1^{c}	0.95
Ash	1.2	1.1	1.2	1.3	1.2	0.08
Carbohydrates	0.6	0.5	0.6	0.7	0.6	0.08

a,b,c – Mean values in the same columns designated by the different letters differ significantly at $P \leq 0.05$
SEM- standard deviation

The loins of sustainable breeds were characterised by a proper chemical composition. The level of total solids ranged from 26.3% (Złotnicka White breed) to 27.3% (Złotnicka Spotted), and the level of protein from 20.2% (Moravka) to 22,1%(Złotnicka Spotted), respectively. The contents of protein in longissimus dorsi of Pulawska and Zlotnicka White were lower that those obtained by *Babicz et al., (2013 and 2013a)* and *Grześkowiak et al., (2009)* in the meat of two, above mentioned breeds. The contents of ash and carbohydrates in analysed pigs' muscles were similar and did not differed statistically, whereas the meats statistically significantly differed in fat content.The fat level in Zlotnicka white pig meat was 3,0%, in loin of Pulawska pig 3,2% whereas in loin from Mangalitza 4,0% and as much as 5,1% in loin of Moravka pig. The levels of intramuscular fat content of assessed loins of different pig breeds can be recognised as optimal. According to *Wood et al., (1999)*, *Daszkiewicz et al., (2005)* oraz *Tyra & Mitka (2015)* to obtain the optimal taste, juiciness and tenderness of meat the amount of fat should be at least 2,5-3,0% Intramuscular fat (IMF) is an important marker of meat quality, because higher contents of intramuscular fat exert a positive influence on sensory characteristics, technological and culinary usefulness of meat *(Wood et al., 1999; Buczyński et al., 2005; Świtoński et al., 2010)*. *Schwörer et al., (2000)* reported that the intramuscular fat content below 1% influences on lowering of meat flavour. After the thermal treatment of such (above) meat it becomes dry and fibrous. The smaller amounts of intramuscular fat (1.19 ÷ 2.20 %) and at the same time lower caloric value of *l.dorsi* of Pulawska pig was described by *Piórkowska et al. (2010) and Kasprzyk et al. (2013)*. Meat of Mangalica and Moravka pigs contained higher amounts of fat from 4.0 to 5.1%, respectively. Similar results for above two breeds were obtained by *Petrović i in. (2010)*. Their research revealed that tere was less total fat and cholesterol contents in musculus longissimus dorsi of Moravka than in Mangalitsa.

It is generally accepted that traditional, local breeds produce a higher IMF content *(Serra et al., 1998; Rosenvold and Andersen 2003; Florowski et al., 2006; Park et al., 2007; Pugliese and Sirtori, 2012)*. As *Serrano et al. (2008)* indicated, muscles of the Spanish breed Iberico are characterised by a particularly high content of fat (8.8%). Intramuscular fat considerable ranging from 3.32 to 4.27% in the *m. longissimus dorsi* was reported for the native Italian breed of Nero Siciliano *(Pugliese et al., 2004)*. On the other hand, *Čandek-Potokar et al. (2003)* determined the content of IMF in the Slovenian breed of Krškopolje at 3%. The fat content above 2.5% can influence on lower consumers' score because of meat high marbling *(Czarniecka-Skubina et al., 2007)*.

The fat content in loin was assessed as high but desirable because of meat flavor and consumers' demands concerning traditional products obtained from that kind of meat in Hungary, Serbia, Croatia and Romania. It is considered that high intramuscular greasing is essential to obtain optimum of flavor, juiciness and tenderness of meat and is decisive for food acceptability *(Florowski et al., 2005)*. The desirability level of such product is formed by the shares of basic chemical components present in the IMF fat. The levels of IMF fat are different and influenced by many factors i.e. species, breed, age, muscle kind and muscle's physical activity. The problem of too low levels of IMF concerns mainly pork obtained from breeds and lines of high productivity *(Tyra & Mitka, 2015)*.

The content of IMF of Polish bred pig's breeds (Polish Landrace and Polish Large White) is much lower than 2% *(Tyra i Żak, 2010)*. As far as the primitive pigs' breeds (for this group belong pigs analysed in this experiment) the problem with IMF fat level is not observed *(Tyra & Mitka, 2015)*. Beside the level of IMF the composition of the individual fatty acids –the fatty acids profile – is important. The fatty acids profile depends mainly on feeding mixtures and way of feeding. In table 2 there is presented the fatty acids profile of IMF of loins for analysed native breeds. The differences in IMF's fatty acids profiles were caused by different ways of breeding. Polish fatteners were bred with full portion mixtures with barley, triticale, corn middlings, post-extraction soya and post-extraction rapeseed meals, whereas the fatteners of Mangalitsa and Moravka were fed with corn silage, wheat, soya and corn middlings. It should be pointed out the high levels of C16:0 and C18:0 in IMF of Mangalitsa and Moravka. Also in IMF of above breeds there was observed wide, adverse from nutritional point of view, ratio of PUFA n6/n3. Therefore, the *n*-6/*n*-3 ratio was higher than dietary recommendations in all cases *(British Nutrition Foundation, 1994)*. *Ruiz et al. (1998)* and *Andrés et al. (2001)* concluded that free-reared pigs fed on pasture and acorns showed higher levels of MUFA than those fed on concentrates. *Parunović et al. (2012b)* found that free-range Mangalitsa pigs showed a higher PUFA content in the *musculus longissimus* than pigs reared indoors and fed

conventionally. The varying fatty acid compositions of adipose tissue and muscle have profound effects on meat quality *(Wood et al., 2008; Parunović et al.2013).*

Table 2. The fatty acids profile of *m. longissimus dorsi* (LD) of analysed pigs' breeds

Fatty acid	Breed of fatteners					SEM
	Złotnicka Spotted (ZS)	Złotnicka White (ZW)	Pulawska (Pul)	Mangalitza (Ma)	Moravka (Mo)	
C-10:0	0.07	0.10	0.07	0.12	0.12	0.02
C-12:0	0.06	0.07	0.08	0.09	0.09	0.01
C-14:0	0.99	1.34	1.06	1.43	1.57	0.25
C-14:1	0,02	0.03	0.02	0.03	0.04	0.008
C-15:0	0.05	0.02	0.04	0.03	0.03	0.01
C-16:0	24.28^{ab}	27.51^{a}	20.51^{b}	27.78^{a}	28.48^{a}	3.33
C-16:1*n9*	0.39	0.27	0.23	0.26	0.29	0.061
C-16:1*n7*	3.80	4.42	3.41	3.81	4.68	0.51
C-17:0	0.13^{a}	0.07^{b}	0.14^{a}	0.12^{a}	0.15^{a}	0.031
C-17:1	0.16	0.11	0.19	0.15	0.21	0.038
C-18:0	10.70	11.61	10.60	12.24	11.55	0.68
C-18:1 *n-9*	40.86^{a}	45.34^{b}	46.89^{b}	41.18^{a}	41.66^{a}	2.74
C-18:1*n-7*	5.56	4.58	4.79	4.53	4.95	0.41
C-18:2 *n-6*	8.66^{a}	2.94^{b}	7.79^{a}	5.91^{a}	4.14^{ab}	2.40
C-18:3*n-6*	0.06	0.03	0.08	0.04	0.03	0.02
C-18:3*n-3*	0.32^{a}	0.17^{b}	0.43^{a}	0.22^{b}	0.12^{b}	0.12
CLA	0.05	0.06	0.09	0.07	0.06	0.015
C-20:0	0.14	0.17	0.14	0.15	0.18	0.018
C-20:1	0.50	0.43	0,73	0.57	0.66	0.12
C-20:2	0.13^{a}	0.06^{a}	0.30^{b}	0.17^{a}	0.12^{a}	0.09
C-20:3 *n-6*	0.23^{a}	0.06^{b}	0.21^{a}	0.09^{b}	0.08^{b}	0.08
C-20:4*n-6*	1.97^{a}	0.38^{b}	1.24^{a}	0.69^{b}	0.59^{b}	0.64
C-20:5 *n-3*	0.09	0.03	0.05	0.03	0.02	0.028
C-22:4 *n-6*	0.21^{a}	0.06^{b}	0.26^{a}	0.12^{ab}	0.07^{b}	0.087
C-22:5 *n-3*	0.29^{a}	0.06^{b}	0.26^{a}	0.10^{b}	0.07^{b}	0.11
C-22:6 *n-3*	0.09^{a}	0.01^{b}	0.01^{b}	0.04^{b}	0.03^{b}	0.03
PUFA *n-3*	0.79^{a}	0.27^{b}	0.75^{a}	0.39^{b}	0.24^{b}	0.26
PUFA *n-6*	10.92^{a}	3.47^{b}	9.58^{a}	6.85^{ab}	4.91^{b}	3.11
PUFA *n6/n3*	13.82^{a}	12.85^{a}	12.77^{a}	17.56^{ab}	20.46^{b}	3.39

a,b,c – Mean values in the same columns designated by the different letters differ significantly at: a, b - $P \leq 0.05$
SEM- standard deviation

In table 3 there are presented meat pH, cooking loss and CIELab colour parameters.

Table 3. The quality characteristics of loin of analysed fatteners breeds

Meat quality parameters	Breed of fatteners					SEM
	Złotnicka Spotted (ZS)	Złotnicka White (ZW)	Pulawska (Pul)	Mangalitza (Ma)	Moravka (Mo)	
pH_{24}	5.80	5.72	5.54	5.55	5,64	0.32
cooking loss %	29,32^{a}	22.76^{b}	26.95^{ab}	25.76^{ab}	24.68^{ab}	2,82
colour parameters	46.43^{a}	49.54^{ab}	55,45^{a}	51,35^{ab}	52.94^{ab}	4.32
L*	8.20^{a}	14.23^{b}	13.82^{b}	13,27^{b}	2.74^{c}	0.84
a*	2.95^{a}	3.34^{a}	6.32^{b}	7.12^{b}	10.15^{c}	1.74
b*						

a,b,c – Mean values in the same columns designated by the different letters differ significantly at: a, b, c - $P \leq 0.05$
SEM- standard deviation

The pH of pork loin of Złotnicka Spotted was higher than pH of other analysed breeds but the difference was not statistically significant. Also the loin meat of Złotnicka Spotted was characterised by the highest cooking losses.

The meat of pigs of the Złotnicka Spotted breed was darker (statistically non-significantly lower value of the lightness parameter L*) in comparison with the Złotnicka White, Pulawska Mangalitza and Moravka pigs. Variations in the fibre type composition may affect meat colour. The right colour of meat can be conditioned by the ferrous oxymioglobin (oxyMb) - *Philips et al. (2001)*, which is directly connected with the percentage and size of muscle fibre types *(Warriss et al., 1990)*. Colour parameters (L*, and a* values) of the *m. longissimus dorsi* of ZS pigs corresponded to the red meat parameters of other native pig breeds *(Serra et al., 1998; Fortina et al., 2005)*. The colour of meat and the fat content may also be a significant determinant in the evaluation of pork quality *(Faustman and Cassens, 1990)*. The meats of Mangalitsa and Moravka had statistically higher value of b* parameter. that was caused by a high share of corn in feeding mixture of those pigs' breeds.

Both native autochthonous breeds, beside gene preservation and expanding of the population (especially Moravka and Resavka), are very suitable for outdoor rearing, for organic livestock production and manufacturing of traditional pork meat products *(Petrović et al., 2010)*. The same can be stated for Polish native breeds - Złotnicka White, Złotnicka Spotted, Pulawska

Because the meat of those Polish breeds is used for manufacturing of traditional products, demanded by the consumer, the breeds need to be preserved and protected. The practical protection of native breeds depends on their market position, i.e. the quality of after slaughter raw material, the quality of traditional and regional products possible to obtain and on proper promotion and marketing.

To integrate the breeding of Pulawska pig with home livestock production Policy the Regional Union of Breeders and Users of Pulawska pig breed - „PUŁAWIAK", was established at 14th July 2005. Whereas the culmination of marketing activities was, at 27th of May 2009, placement of „Pulawska breed pig" on the governmental list leaded by minister of The Ministry of Agriculture and Rural Development *(Szulc & Skrzypczak, 2015)*.

The meat of Pulawska breed pigs was appreciated by homeland consumers and at foreign markets – the lots of heavy fatteners of that breed were bought by Spanish swine producers for long ripened hams production. In 2010 there was established cooperation with the Auchan markets network which placed as delicatessen product the meat of Pulawska breed. Also meat and the products obtained of Zlotnicka pigs were placed on home governmental Traditional Products List. The products are among others: Great Poland Voivodship pig meat of Złotnicka breed, Nowy Tomyśl sausage, roasted haunch of Zlotnicka White pig and White sausage in the glass pot. The staff of Department of Breeding and Production of Swine of Poznan University of Life Sciences in cooperation with Great Poland Voivodship regional government are the organizers of "Złotnicka Premium" competitions which aim to enhance meat sector firms and producers to produce high quality meat products. Also there is a campaign "Regional swine meat – appreciate taste of tradition" to enlarge the knowledge concerning the native traditional pig breeds among restaurants' owners and also enlargement of knowledge concerning valuable sensory characteristics and possibilities of usage of culinary meat of Puławska, Złotnicka White and Spotted breeds. Similar breeding and marketing policies in Hungary, Croatia, Romania and Serbia caused that Mangalitsa pigs and the meat products produced of that species meat have become the most recognizable trademark. The specific example is the Hungarian market which offers the wide game of products made of Mangalitsa.

Conclusion

Meat from analysed pigs had proper chemical composition, favourable n3/n6 fatty acids profile, low drip loss, proper pH. This study confirmed good meat quality and its usefulness for production of traditional products.

Kvalitet mesa autohtonih rasa svinja

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Rezime

Proizvodnja tradicionalnih proizvoda od mesa, koje karakterišu vrlo dobre organoleptičke osobine, zahteva specifičnu sirovinu tj. meso od svinja težine na klanju od 120 kg, intramuskularnim sadržajem masti većim od 3% i uzgajanih u ekstenzivnom sistemu. Neke od rasa koje mogu ispuniti ove zahteve su domaće rase kao što su mangulica, moravka, zlotnička šarena, zlotnička bela i pulavska svinja. Cilj ove studije bila je analiza sirovog mesa svinja rase mangulica, moravka, zlotnička šarena, zlotnička bela i pulavska - kvalitet mesa i njegove tehnološke vrednosti. Meso od analiziranih svinja imalo je adekvatan hemijski sastav, povoljan profil n3/n6 masnih kiselina, nizak kalo, odgovarajući pH. Sastav slabine puławske svinje, złotničke svinje, mangulice i moravke je sličan u sadržaju proteina, pepela i ugljenih hidrata. Sadržaj intramuslularne masti u slabinama ispitanih rasa varira od 3,0% (zlotnička bela) do 5,1% (moravka). U ovoj studiji potvrdjen je dobar kvalitet mesa i njegova korisnost za proizvodnju tradicionalnih proizvoda.

Ključne reči: svinje, zlotnička šarena, zlotnička bela, puławska, mangulica, moravka, meso, kvalitet

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