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*Original article*

# Performance, pork quality and fatty acid composition of entire males, surgically castrated or immunocastrated males, and female pigs reared under organic system

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## Abstract

This study was carried out on the farm specializing in organic pig production on 80 fatteners of the Polish native Pulawska breed, allocated into 4 groups (20 pigs each): EM – entire (uncastrated) males, IM – immunocastrates – males vaccinated with Improvac®, CM – surgically castrated males and G – gilts. The highest average daily gains were achieved by the IM group, slightly lower by EM, whereas the lowest by CM and G groups. Content of polyunsaturated fatty acids (PUFA) in intramuscular fat and backfat (10.19% and 10.68%, respectively) of IM was lower ($P \leq 0.05$) than in fat of EM (11.4% and 13.20%, respectively), but higher ($P \leq 0.05$) in comparison to CM (8.43% and 8.71%, respectively). Vaccination of boars against GnRH has not decreased quality traits of organically produced pork. Furthermore, comparing to meat from surgically castrated males, it resulted in better qualities (lower fat content in carcass, higher PUFA level in fat, better physicochemical meat properties).

**Key words**: organic production, pigs, performance, carcass quality, castration method, gender

## Introduction

One of the crucial organic production standards is to reduce painful husbandry practices which cause animal suffering and stress such as surgical castration. Castration of male piglets without anesthesia induces stress and pain during the operation (Prunier et al. 2006). Moreover, animals suffer along with physiological and behavioral changes at post-surgical period. Nevertheless, pork production still relies on the actual fattening of barrows and gilts (Grela 2008, Grela and Kowalczuk-Vasilev 2010). While considering both, fast growth rate and good feed efficiency but primarily, animal welfare and organic approach to pig production, the usage of young boars in pork production is an important issue (Malmfors and Lundstrom 1983, Judge et al. 1990, Clarke et al. 2008). Compared to barrows, boars appear to utilize feed more efficiently and produce carcasses with lower fat deposit (Xue et al. 1997).

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Boar rearing could make an alternative for the physical castration practice, however, consumers from many countries decisively reject that pork meat due to an intensive off-odor. One of possible solutions in both, conventional and unconventional agriculture, proves to be the technique of immunocastration of young male pigs with vaccine against gonadotropin-releasing hormone (GnRH) (Improvac®, Pfizer Ltd.). It contains a modified form of GnRH-protein which has no hormonal activity (Dunshea et al. 2001), and does not stimulate hormone development and leaves no residues in pork that may be hazardous for human health (Brennan et al. 1986). GnRH-protein stimulates the immune system to produce specific antibodies that as a result of complex biochemical changes in the endocrine glands suppress androsterone formation in the testis, responsible for offensive taint of boar meat and fat. Development of the pig immunocastration technique, almost painless and easy to perform, proves to be a socially viable alternative to surgical castration (Lagerkvist et al. 2006). The recent studies have shown that consumption of pork from immunocastrated pigs is fully safe for human (Font i Furnols et al. 2008). Pig GnRH-immunization procedure may contribute to reduction of the risk of tainted boar carcasses and higher welfare standards of animals, so desirable in the organic pig production system.

Thus, an attempt of implementation of immunocastration in the organic swine production was undertaken. The aim of the study was to compare performance and some meat chemical properties (lipid oxidation – expressed as TBARS (2-thiobarbituric acid reactive substances) value and fatty acid profile of the intramuscular fat of the *longissimus dorsi* muscle and backfat) of entire males, surgically castrated or immunocastrated males, and female pigs, managed under organic production system.

## Materials and Methods

### Experimental design and dietary treatment

The experiment was conducted on a farm specializing in the organic pig production. Eighty pigs of the Polish native Pulawska breed, penned in groups of five, were used. The animals were randomly allocated into 4 groups (20 pigs each): EM – entire (uncastrated) males, IM – immunocastrates, Improvac® immunized boars, CM – surgically castrated males and group G – gilts. The barrows underwent the physical castration on 5$^{th}$ day of age, while the boars from IM group were administered 2 ml Improvac® Pfizer Ltd., containing 200 μg GnRH-protein, injected twice (on the 84$^{th}$ and 161$^{st}$ day of life) subcutaneously, immediately behind the right ear. Throughout the fattening period, all the pigs received the same feedstuffs and water *ad libitum.* The diets were cereal and legume seeds-based supplemented by fish meal (at growing period) and mineral-vitamin preparation "Dolfos" with additive of herbal extracts and lyophilized garlic. Formulation and nutritive value of diets are summarized in Table 1. Feeds for analyses were sampled four times – twice each fattening period (25-70 and 70-115 kg) and examined to determine basal nutrients content according to AOAC (2000) recommendations, i.e. crude protein (method 976.06), amino acids: lysine, methionine and cystine (method 994.12). Besides, there was established a phosphorus content, using the colorimetric procedure (method 965.17), and a calcium level by the atomic absorption spectrometry (method 968.08).

Table 1. Composition (%) and nutritive value of growing and finishing pigs' diets.

| Ingredients | Grower (25-70 kg) | Finisher (71 kg – slaughter) |
|---|---|---|
| Wheat | 24.0 | O.0) |
| Barley | 30.0 | 20.0 |
| Oat | 0.0 | 22.0 |
| Rye | 20.0 | 40.0 |
| Pea | 10.0 | 5.0 |
| Yellow lupine | 10.0 | 10.0 |
| Fish meal | 3.0 | 0.0 |
| Mineral-vitamin premix "Dolfos Sbio"* | 3.0 | 3.0 |
| *Content in 1 kg of mixture*: | | |
| Metabolic energy, MJ | 12.64 | 12.10 |
| Crude protein, g | 152.6 | 132.9 |
| Lysine, g | 6.54 | 5.46 |
| Methionine + cystine, g | 5.38 | 4.83 |
| Crude fibre, g | 46.51 | 79.27 |
| Phosphorus, g | 5.13 | 4.09 |
| Calcium, g | 6.52 | 6.11 |

* – 1 kg of mineral-vitamin premix "Dolfos Sbio" contained: vit. A 225000 IU, vit. D 22500 IU, vit. E 900 mg, vit. K 30 mg, vit. $B_1$ 30 mg, vit. $B_2$ 60 mg, vit. $B_6$ 60 mg, vit. $B_{12}$ 0.15 mg, nicotinic acid 300 mg, pantothenic acid 150 mg, folic acid 7.5 mg, biotin 0.75 mg, betaine 2660 mg, choline 1.2 g, L-lysine 4 g, DL-methionine + cystine 2.5g, threonine 1.8 g, tryptophan 0.7 g, calcium 298 g, phosphorus 60 g, magnesium 8 g, sodium 40 g, iron 3000 mg, zinc 3000 mg, manganese 2000 mg, copper 300 mg, cobalt 20 mg, iodine 25 mg, selenium 10 mg and phytase 16000 FTU + 100 g additive of herbal extracts (willow tree bark, thyme and basil) and 50 g lyophilized garlic.

During the whole experimental period daily feed intake was monitored. All the experimental animals were weighted as the experiment commenced (25 ± 1.0 kg body weight), at 65-70 kg body weight and

prior to slaughter. The study was completed when the pigs obtained the slaughter weight of 115 ± 2.0 kg.

All experimental procedures were approved by the Local Ethical Committee of the Faculty of Biology and Animal Breeding at the University of Life Sciences in Lublin, Poland.

### Sampling and meat quality parameters

At live weight of approximately 115 kg, the pigs were delivered to a commercial certified abattoir for slaughter. Transport and slaughter of the animals were performed using *ante-mortem* procedures to minimize animal stress. Carcass meatiness was determined with Ultra Fom 300 apparatus 45 min after slaughter.

A vernier caliper with accuracy of 0.1 mm was used to measure the backfat thickness at 5 points in compliance with the protocol of the Polish Pig Testing Station (SKURTCh) (over the shoulder, dorsal (between the last thoracic vertebrae and the first lumbar vertebrae) and at three points at the level of sacral vertebrae (over the cranial edge, in the midline and caudal edge of the *gluteus medius* muscle cross-section) (Różycki 1996).

Carcass weight was recorded for all carcasses and the weight of the liver and heart was also noted. Carcasses were conventionally chilled for 24 h in a chiller at 2-4°C and the loin eye area was measured at the level of the 10$^{th}$ rib. Samples of the backfat and the *m. longissimus* from the last thoracic vertebrae and two first lumbar vertebrae were collected from 8 animals of each group.

Total fat of the backfat and the *m. longissimus* for fatty acid analysis was extracted with a chloroform/methanol mixture according to the Folch et al. (1957) method. Further investigations concerning the fatty acid profile were conducted according to standards: PN-EN ISO 5509:2001 and PN-EN ISO 5508:1996. Percentage of fatty acid methyl esters was analyzed using gas chromatography procedure on a Varian CP-3800 chromatograph. The chromatograph operating conditions for fatty acid separation were as follows: the capillary column CP WAX 52CB DF 0.25 mm of 60 m length, gas carrier – helium, flow rate 1.4 ml/min, column temperature 120°C gradually increasing by 2°C/min up to 210°C, determination time 127 min, feeder temperature 160°C, detector temperature 160°C, other gases – hydrogen and oxygen.

Lipid oxidation was determined measuring 2-thiobarbituric acid reactive substances (TBARS) according to the method of Witte et al. (1970). All TBA values were determined on two different portions of each muscle and the resulting colour was measured at 530 nm in Varian Cary 300 Bio spectrophotometer. The TBA values were calculated by multiplying absorbance by 5.2 and the results were expressed as milligram of malondialdehyde (MDA) produced per kilogram of tissue.

### Statistical analysis

All the data were analyzed with the STATISTICA Software Ver. 6.1 (StatSoft 2003). The normality was assessed using the Kolmogorov-Smirnov test, and the Levene's homogeneity of variance test was applied to examine the equality of variances. The data obtained were analyzed statistically using a general linear model (GLM) of analysis of variance one-way ANOVA. Duncan's test was applied for the multiple comparisons among means, considering $P \leq 0.05$ as significant. The tables illustrate the means, the standard deviation and the levels of significance.

## Results

The obtained results of pigs performance revealed significant ($P \leq 0.05$) differences between experimental groups, both, in daily weight gains (ADG) and feed conversion ratio (FCR) (Table 2). In the first fattening period, the highest ADG were observed in the surgical castrates (CM) group. While in the second fattening period, as well as in the whole fattening period, the highest gains achieved immunocastrated boars (IM group). Significantly lower gains were reported for boars (EM), while the lowest for barrows (CM) and gilts (G). At the same time, significantly lower FCR was found for boars and immunocastrates as compared to the barrows and gilts. This tendency was observed during the whole research period.

Although carcass yield in EM, IM and G groups was slightly lower than in CM, the highest meatiness was determined in the entire males (56.1%), slightly lower in the IM and G (55.8 and 55.5%). The highest dressing percentage was obtained by the barrows (79.4%), but the carcasses had significantly ($P \leq 0.05$) lower meatiness (53.2%), in comparison to other experimental groups. Carcasses of CM had also significantly ($P \leq 0.05$) smaller loin eye area and higher backfat thickness in all 5 measurement points. The average thickness of the backfat in barrows was 23 mm and was substantially higher ($P \leq 0.05$) as compared to other animals with the mean value from 5 measurements 17.6 mm, 18.3 mm and 19.3 mm for CM, IM and G, respectively.

Table 2. Growth performance of growing and finishing pigs ($\bar{x}$ ± SD).

| Parameter | Experimental groups | | | |
|---|---|---|---|---|
| | EM | IM | CM | G |
| Initial body weight, kg | 25.3 ± 0.85 | 25.2 ± 0.89 | 25.3 ± 0.78 | 25.4 ± 0.59 |
| Final body weight, kg | 115.4 ± 2.12 | 115.1 ± 2.03 | 115.2 ± 1.91 | 115.1 ± 2.06 |
| Days of fattening | $102^{b}$ | $97^{a}$ | $107^{c}$ | $108^{c}$ |
| Average daily gains, g: | | | | |
| 25-70 kg | $735^{b}$ ± 32.1 | $734^{b}$ ± 31.7 | $789^{a}$ ± 36.9 | $725^{b}$ ± 39.2 |
| 71-115 kg | $1061^{b}$ ± 83.2 | $1167^{a}$ ± 78.4 | $902^{c}$ ± 73.7 | $956^{c}$ ± 81.2 |
| 25-115 kg | $882^{b}$ ± 63.5 | $927^{a}$ ± 61.3 | $840^{bc}$ ± 58.2 | $831^{c}$ ± 61.4 |
| Feed conversion ratio: | | | | |
| 25-70 kg | $2.78^{a}$ ± 0.09 | $2.73^{a}$ ± 0.11 | $3.13^{b}$ ± 0.08 | $3.22^{b}$ ± 0.10 |
| 71-115 kg | $3.54^{a}$ ± 0.12 | $3.51^{a}$ ± 0.12 | $3.92^{b}$ ± 0.11 | $3.89^{b}$ ± 0.11 |
| 25-115 kg | $3.16^{a}$ ± 0.10 | $3.12^{a}$ ± 0.11 | $3.53^{b}$ ± 0.09 | $3.56^{b}$ ± 0.09 |

$^{a, b, c}$ – values in the same rows with different letters differ significantly ($p \leq 0.05$).

Table 3. Carcass yield and carcass quality traits ($\bar{x}$ ± SD).

| Parameter | Experimental groups | | | |
|---|---|---|---|---|
| | EM | IM | CM | G |
| Carcass weight, kg | 90.4 ± 1.57 | 90.5 ± 1.46 | 91.5 ± 1.71 | 90.0 ± 1.62 |
| Carcass yield, % | 78.34 ± 1.25 | 78.63 ± 1.23 | 79.43 ± 1.29 | 78.19 ± 1.26 |
| Meatiness,% | $56.1^{a}$ ± 1.14 | $55.8^{a}$ ± 0.97 | $53.2^{b}$ ± 1.01 | $55.5^{a}$ ± 1.12 |
| Loin eye area, $cm^2$ | $45.6^{a}$ ± 0.89 | $45.9^{a}$ ± 0.82 | $43.1^{b}$ ± 0.93 | $45.4^{a}$ ± 0.78 |
| Backfat thickness: | | | | |
| Shoulder, mm | $24.4^{a}$ ± 0.06 | $25.3^{ab}$ ± 0.07 | $31.4^{c}$ ± 0.08 | $26.1^{b}$ ± 0.06 |
| Midback, mm | $17.8^{a}$ ± 0.05 | $17.6^{a}$ ± 0.04 | $21.2^{b}$ ± 0.06 | $18.3^{a}$ ± 0.05 |
| Rump, average of 3 measurements, mm | $15.3^{a}$ ± 0.04 | $16.2^{ab}$ ± 0.04 | $20.8^{c}$ ± 0.06 | $17.3^{b}$ ± 0.04 |
| Average of 5 measurements, mm | $17.6^{a}$ ± 0.05 | $18.3^{ab}$ ± 0.04 | $23.0^{c}$ ± 0.06 | $19.3^{b}$ ± 0.05 |
| Organ weights: | | | | |
| Liver, kg/100 kg BW | 1.48 ± 0.26 | 1.66 ± 0.29 | 1.52 ± 0.25 | 1.53 ± 0.26 |
| Heart, kg/100 kg BW | 0.41 ± 0.04 | 0.44 ± 0.05 | 0.45 ± 0.04 | 0.45 ± 0.03 |

$^{a, b, c}$ – values in the same rows with different letters differ significantly ($p \leq 0.05$).

The treatment did not have any clear influence ($p > 0.05$) on the weight of analyzed organs (Table 3). However, the liver weight of IM was higher than that of boars and barrows (1.66 kg vs. 1.48 and 1.52 kg, respectively). Heart weight in both, G and CM was similar, whereas the boars' heart appeared to be only slightly lighter.

Not only carcass fatness, but also the lipid composition of the subcutaneous fat differed among the experimental groups. Significant differences between groups in the content of most of fatty acids of backfat and in stearic, oleic, linoleic, eicosadienoic and arachidonoic acids content in *longissimus* muscle fat were noted (Table 4 and 5), as well as in the total content of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) in both tissues analyzed. The lowest share of saturated fatty acids (SFA) in the intramuscular fat as well as in the backfat was found in EM and G group (39.55 vs. 39.06% and 37.24 vs. 40.47%, respectively). Although in both, boars and gilts group, the content of unsaturated fatty acids (UFA) was similar, the highest PUFA percentage was found in EM tissues. The lowest content of PUFA was detected in fat of CM (8.63% in the muscle tissue and 8.69% in the backfat). EM group had the highest value of PUFA:SFA ratio, in both tissues analyzed. The proportion of PUFA n-6/n-3 ratio was significantly higher in EM and IM, as compared to CM and G groups.

The treatment did not affect the TBARS content, which maintained at the average level of 0.35 – 0.37 mg MDA per kg meat.

Table 4. TBARS* value and fatty acid composition (%) of the *longissimus* muscle fat.

| Parameter | | Experimental groups | | | |
|---|---|---|---|---|---|
| | | EM | IM | CM | G |
| Lauric | 12:0 | 0.08 | 0.09 | 0.07 | 0.11 |
| Myristic | 14:0 | 1.69 | 1.62 | 1.52 | 1.61 |
| Palmitic | 16:0 | 26.03 | 26.45 | 26.89 | 25.91 |
| Palmitoleic | 16:1,n-7 | 4.38 | 4.14 | 4.11 | 4.32 |
| Stearic | 18:0 | 11.61$^{ab}$ | 12.23$^{b}$ | 12.25$^{b}$ | 11.24$^{a}$ |
| Oleic | 18:1,n-9 | 43.34$^{b}$ | 43.83$^{b}$ | 45.29$^{a}$ | 45.22$^{a}$ |
| Linoleic | 18:2,n-6 | 10.02$^{a}$ | 9.03$^{b}$ | 7.46$^{c}$ | 8.91$^{b}$ |
| Linolenic | 18:3,n-3 | 0.59 | 0.55 | 0.39 | 0.48 |
| Arachidic | 20:0 | 0.14 | 0.14 | 0.12 | 0.19 |
| Gadoleic | 20:1,n-11 | 0.67 | 0.53 | 0.66 | 0.71 |
| Eicosadienoic | 20:2,n-6 | 0.19$^{a}$ | 0.17$^{a}$ | 0.08$^{b}$ | 0.15$^{a}$ |
| Arachidonoic | 20:4,n-6 | 0.64$^{a}$ | 0.45$^{b}$ | 0.45$^{b}$ | 0.61$^{a}$ |
| Docosadienoic | 22:2,n-6 | 0.27 | 0.29 | 0.25 | 0.27 |
| Other FA | | 0.35$^{b}$ | 0.48$^{a}$ | 0.46$^{a}$ | 0.27$^{a}$ |
| Total | | 100.00 | 100.00 | 100.00 | 100.00 |
| SFA | | 39.55$^{a}$ | 40.53$^{b}$ | 40.85$^{b}$ | 39.06$^{a}$ |
| MUFA | | 48.39$^{b}$ | 48.50$^{b}$ | 50.06$^{a}$ | 50.25$^{a}$ |
| PUFA | | 11.71$^{a}$ | 10.49$^{b}$ | 8.63$^{c}$ | 10.42$^{b}$ |
| PUFA:SFA | | 0.30$^{a}$ | 0.26$^{a}$ | 0.21$^{b}$ | 0.27$^{a}$ |
| n-6/n-3 | | 18.85$^{a}$ | 18.07$^{a}$ | 21.13$^{b}$ | 20.71$^{b}$ |
| TBARS, mg MDA$^{\#}$ kg$^{-1}$ meat | | 0.37 | 0.35 | 0.35 | 0.36 |

$^{a, b, c}$ – values in the same rows with different letters differ significantly ($p \leq 0.05$).

* – 2-thiobarbituric acid reactive substances

$^{\#}$ – *malonaldehyde*

Table 5. Fatty acid composition (%) of the backfat.

| Fatty acids | | Experimental groups | | | |
|---|---|---|---|---|---|
| | | EM | IM | CM | G |
| Lauric | 12:0 | 0.10 | 0.09 | 0.08 | 0.09 |
| Myristic | 14:0 | 1.63$^{b}$ | 1.56$^{a}$ | 1.55$^{a}$ | 1.57$^{a}$ |
| Palmitic | 16:0 | 24.38$^{a}$ | 26.81$^{b}$ | 26.77$^{b}$ | 26.28$^{b}$ |
| Palmitoleic | 16:1,n-7 | 3.17$^{a}$ | 2.94$^{b}$ | 2.88$^{b}$ | 3.03$^{ab}$ |
| Stearic | 18:0 | 10.99$^{a}$ | 13.06$^{c}$ | 13.42$^{c}$ | 12.38$^{b}$ |
| Oleic | 18:1,n-9 | 41.08$^{ab}$ | 39.55$^{b}$ | 41.69$^{a}$ | 41.50$^{a}$ |
| Linoleic | 18:2,n-6 | 11.72$^{a}$ | 9.40$^{b}$ | 7.66$^{d}$ | 9.20$^{c}$ |
| Linolenic | 18:3,n-3 | 0.80$^{a}$ | 0.63$^{b}$ | 0.49$^{c}$ | 0.55$^{c}$ |
| Arachidic | 20:0 | 0.14 | 0.14 | 0.17 | 0.15 |
| Gadoleic | 20:1,n-7 | 0.37$^{ab}$ | 0.49$^{a}$ | 0.43$^{ab}$ | 0.33$^{b}$ |
| Eicosadienoic | 20:2,n-6 | 0.43$^{a}$ | 0.38$^{b}$ | 0.32$^{c}$ | 0.36$^{b}$ |
| Arachidonoic | 20:4,n-6 | 0.22 | 0.24 | 0.20 | 0.23 |
| Docosahexaenoic | 22:6,n-3 | 0.03 | 0.03 | 0.02 | 0.02 |
| Other FA | | 4.94 | 4.68 | 4.32 | 4.31 |
| Total | | 100.00 | 100.00 | 100.00 | 100.00 |
| SFA | | 37.24$^{a}$ | 41.66$^{c}$ | 41.99$^{c}$ | 40.47$^{b}$ |
| MUFA | | 44.62$^{a}$ | 42.98$^{b}$ | 45.00$^{a}$ | 44.86$^{a}$ |
| PUFA | | 13.20$^{a}$ | 10.68$^{b}$ | 8.69$^{c}$ | 10.36$^{b}$ |
| PUFA:SFA | | 0.35$^{a}$ | 0.26$^{b}$ | 0.21$^{b}$ | 0.25$^{b}$ |
| n-6/n-3 | | 14.90$^{b}$ | 15.18$^{b}$ | 16.04$^{ab}$ | 17.18$^{a}$ |

$^{a, b, c, d}$ – values in the same rows with different letters differ significantly ($p \leq 0.05$).

## Discussion

The results show that the best productivity parameters (the highest daily gains, the lowest feed conversion ratio) achieved boars and boars vaccinated with Improvac. The highest ADG noted in the immunocastrated boars (IM), especially in the second fattening period, are in line with the study of Fàbrega et al. (2010). Moreover, the present study has indicated that throughout the whole fattening period, daily gains of organically produced EM, IM, CM and G did not differ substantially from the available in the literature daily gains values characterizing the pigs fed conventional feeds (Fàbrega et al. 2010). However, FCR in the conventional production system was markedly lower as compared to the organic system (average 2.59 vs. 3.34 kg feed/kg gain). Similar performance results tendencies were observed earlier by Skrlep et al. (2010b) but in this investigation fatteners were also managed under the conventional production system. In this study entire males and Improvac®-treated males were shown to obtain higher weight gains than those surgically castrated (725; 719 vs. 697 g/day, respectively). The barrows had also by 13% worse FCR as compared to the immunocastrates.

However, the results of other authors, illustrating the effect of Improvac® on productive performance, are quite variable. Jaros et al. (2005) and Schmoll et al. (2009) reported significantly lower feed conversion per kg gain by the immunocastrates as compared to that found in surgical castrates, however no differences were observed in animal growth. Other studies (Hennesy and Dunshea 2000, Dunshea et al. 2001, Cronin et al. 2003, Oliver et al. 2003) indicated a potential stimulating effect of Improvac® use on animal growth and feed intake as compared to boars or barrows after the second dose application. That is particularly important for the profitability of the organic pig production, especially taking into account a significantly shorter fattening period of EM and IM group compared to CM and G.

One of the main restrictions in the organic livestock production is the availability of protein feeds that do not ensure achieving that high dressing percentage, as it is obtained in the conventional production system. Many authors (Olsson et al. 2003, Millet et al. 2005, Hansen et al. 2006, Millet et al. 2006,) suggest that balanced organic diets allow to obtain high meatiness of pigs (55-60%) which is consistent with the present results. Although the carcass yield in EM, IM and G groups was slightly lower than that in CM, in all these groups higher meatiness, larger loin eye area and lower backfat thickness in all 5 measurement points was found. It is consistent with the results of experiments conducted by Pauly et al. (2009) and Škrlep et al. (2010a). These authors observed some higher dressing percentage in the case of barrows than in boars (however, the carcasses of entire boars or immunized ones had higher meatiness). Jaturasitha et al. (2006) and Gispert et al. (2010) found a higher content of lean meat in the carcasses of gilts and boars as compared to those in Improvac® immunized boars and castrates. However, the carcasses of surgically and immunologically castrated males were heavier by about 12% and 10% as compared to the gilts.

The highest liver weight in immunocastrates confirms previous studies (Pauly et al. 2009). Slightly lower weight of the liver was observed in barrows and gilts, while the lowest – in EM group. It may result from the fact that skatole in G and CM, which is a natural by-product of bacterial degradation in the intestine, is metabolized in the liver and excreted with faeces. As a consequence of the enhanced liver activity in the immunized animals and thus, high metabolic clearance rate, the liver in IM proves to be larger in size. While in EM, sex hormones slow down the skatole metabolism and thus, contribute to its accumulation in organism.

Similarly, the boars' heart appeared to be slightly lighter, in comparison to other groups. It is likely to be associated with markedly lower fatness of boars' carcasses that is caused by typical behavior of entire boars – more aggressive and more stress-susceptible than gilts or castrates (Cronin et al. 2003, Velarde et al. 2008). Group-penned boars tend to be more active and demonstrate propensity for fighting more frequently. Testosterone, however, is also a potent muscle growth stimulant, thus castrates, devoided of it, deposit more adipose tissue. That is in line with the backfat thickness results obtained in our study and other authors' findings (Latorre et al. 2004, Jaturasitha et al. 2006, Pauly et al. 2009, Gispert et al. 2010).

It is known that fatty acid composition of the porcine intramuscular fat is affected by feed composition as reviewed by Wood and Enser (1997). In organic pigs, a higher proportion of n-6 and n-3 PUFA, than in conventional ones, is noted (Hansen et al. 2006). Although the influence of sex hormones on fatty acids accretion in body is minor (Jaturasitha et al. 2006), in our study some significant differences among groups in fatty acid profile were observed. Both analyzed tissues of EM meat were characterized by the low share of saturated fatty acids (SFA) with the highest polyunsaturated fatty acids (PUFA) percentage. Consequently, beneficial from the human nutrition point of view, the highest values of PUFA:SFA ratio in both analyzed tissues were found in EM group, while the lowest in CM group. Similarly, lower values of PUFA

n-6:PUFAn-3 ratio ($p \leq 0.05$) was observed in EM and IM groups. The differences in the fatty acid profile agree with those reported by among others, Barton-Gade (1987), Jaturasitha et al. (2006) and Pauly et al. (2009).

Balance between antioxidants and pro-oxidants, such as PUFA concentration or free iron influence the oxidative stability of meat (Kanner 1992, Florek et al. 2012). Although there were significant differences between groups in the PUFA percentage, neither gender nor castration practice had significant effect on the lipid oxidative stability of the analyzed meat, expressed as TBARS value. A TBARS content in each group maintained at the level of 0.35 – 0.37 mg MDA per kg meat. Similarly, the studies conducted by Jaturasitha et al. (2006) did not show any correlations between the oxidative stability of the intramuscular fat and animal sex. The highest TBA values were observed in EM group which appears to correspond with the highest PUFA content. Both, animal gender (gilts, boars) and castration method (surgical or immunological) due to differentiated hormone metabolism may have serious influence on the fat content in meat and its quality, as well as on its deposition in organism.

## Conclusion

The implementation of immunocastration in the organic swine production did not decrease the quality traits of organic pork. The performance results obtained in immunocastrated males were similar to those obtained in uncastrated males and females, and much favorable as compared to surgical castrated boars (barrows). Application of this method can reduce negative effects of surgical intervention, improve productive performance (ADG, FCR), carcass meatiness and fatty acids composition.

Male pig immunocastration practice addresses the increasingly important animal welfare concerns. Nevertheless, the question of its impact on the nutritional value and stability of meat and its products, and its safety for human health is still open for discussion.

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