CHEMICAL COMPOSITION, AMINO AND FATTY ACID PROFILES OF MUSCLE AND FAT TISSUE IN IMMUNOLOGICALLY CASTRATED, SURGICALLY CASTRATED MALE AND FEMALE PIGS

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Abstract

The aim of study was to evaluate chemical composition, amino acid profile of muscle and fatty acid profile of both muscle and back fat in immunological castrated males and compare it with surgically castrated males and female pigs. Forty pigs, immunocastrates (IC), surgical castrates (SC) and gilts (G), progeny of Landrace sows and hybrid (Yorkshire x Landrace) boars, was randomly selected for the experiment. Pigs were housed by pairs in pens according to sex. They were fed commercial feed mixture. Immunocastration of entire males was performed by double vaccination (Improvac®), the first at 50 kg, the second at 80 kg of live weight. Experiment was realized from 30 to 125 kg of live weight. After reaching the slaughter weight, pigs were slaughtered at the experimental slaughter house of the Research Institute for Animal Production according to standard procedure. The second day after slaughter, the dissection of the right half of carcass was done. Samples of muscle (from the neck) and backfat (over the neck) from each pig were taken for analyses of chemical composition, cholesterol content, amino and fatty acid profiles using FTIR spectroscopy. Immunocastrates had significantly higher content of crude protein than surgical castrates (21.09 vs. 20.34 %, $P<0.05$). On the other hand, they had lower content of cholesterol as well as crude fat compared with barrows (0.44 vs. 0.54 %, $P<0.05$; 3.23 vs. 4.83 %, $P<0.01$). Amino acid profile of pig muscle was very similar in all three sexes and differences were not significant. However, fatty acid profile of pig muscle showed differences between sexes. Immunocastrates had significantly lower content of oleic and eicosanoic fatty acid compared to barrows (42.42 vs. 46.60 %, $P<0.01$ and 0.62 vs. 0.74 %, $P<0.01$). They also had better PUFA/SFA ratio that could be profitable from the human health point of view. Content of polyunsaturated fatty acids in barrows (6.94 %) was lower than in gilts (8.77 %, $P<0.05$) and immunocastrates (8.54 %, $P=0.05$). Fatty acid profile of back fat did not show any significant differences between immunocastrates, surgical castrates and females.

Key words: Immunocastration, amino acid, fatty acid, chemical composition

Conventional castration, which is performed a few days after birth of piglets, has been used for many decades in pig industry to prevent aggressive behaviour and eliminate the occurrence of boar taint – unpleasant odour damaging the sensory attributes of pig meat. Nowadays, this practise is regarded as a stressful intervention with negative impact on animal health and welfare. Alternative way to conventional castration is active immunization against gonadotropin – releasing hormone (GnRH) – so called immunocastration. The use of this method is increasing, with approximately 1.3 mil. pigs vaccinated worldwide every month (ZAMARATSKAIA and KRØYER RASMUSSEN, 2015). Immunocastration uses natural immune system of pigs to produce specific antibodies that bind and neutralize GnRH, and by that block hypothalamic – pituitary – gonadal axis. It effectively inhibits growth of testes and production of sexual steroids, including androstenone (HILBE et al., 2006; FANG et al., 2010; EINARSSON et al., 2011). Immunocastration consists of double vaccination of pigs with dosage 2 ml of the vaccine in the muscle behind ear, the first 8 and the second 4 weeks towards slaughter. This method prevents incidence of boar taint while preserves positive effect of testicular steroids and anabolis hormones of entire males (until second vaccination). Several studies have been investigated effect of immunocastration on

growth (MILLET et al., 2011; BATOREK et al., 2012; DUNSHEA et al., 2013), carcass composition (PAULY et al, 2009; GISPERT et al., 2010; ŠKRLEP et al., 2010; BATOREK et al., 2012; BOLER et al., 2014) or meat quality (BATOREK et al, 2012; PAULY et al, 2012; TREFAN et al., 2013). However, there is a very little research related to amino and fatty acid composition of meat and fat tissue of immunologically vaccinated entire males. Therefore, the aim of study was to evaluate chemical composition, amino and fatty acid profiles of immunocastrates and compare it with surgical castrates and female pigs.

Material and Methods

Animals and diet

Forty pigs, immunocastrates (IC, n = 14), surgical castrates (SC, n = 13) and gilts (G, n = 13), progeny of Landrace sows and hybrid (Yorkshire x Landrace) boars, was randomly selected for the experiment. Pigs were housed by pairs in pens according to sex. They were fed commercial diet (Tab. 1) according to nutrient requirements for growing-finishing pigs, (ŠIMEČEK et al., 1995). Immunocastration of entire males was performed by double vaccination (Improvac®), the first at 50 kg, the second at 80 kg of live weight. Experiment started at 30 kg live weight.

Slaughtering and sampling

After reaching the average slaughter weight of 125 kg ± 5 kg, pigs were slaughtered at the experimental slaughter house of the Research Institute for Animal Production situated approximately 200 m from the test stable. A slaughter was done according to standard procedure e.g. electrical stunning, vertical exsanguination, vapour scalding and evisceration. After that, carcasses were chilled 24 h at air temperature of 2 to 4 °C, air velocity 0.5 to 1.0 m/ s started approximately 60 min post mortem. The second day after slaughter, the dissection of the right half of carcass was done. Samples of muscle (from the neck) and backfat (over the neck) from each pig were taken for analyses of chemical composition, cholesterol content, amino and fatty acid profiles. All analyses were done in the laboratory of the Slovak Agricultural University using FTIR spectroscopy (Nicolet 6700).

Statistical methods

Statistical package (SAS Institute Inc., Cary, N.C., USA, 2009, version 9.2) was employed in the analyses. Basic statistics was done using MEANS procedure. The differences between sexes were analysed using ANOVA:

$$y_i = \mu + B_i + e_i$$

where y_i – characteristic of trait selected
μ - intercept
B_i – effect of sex (i = IC, SC, G)
e_i – random error

The values in tables are presented as means and standard error.

Table 1. Nutritive value of the pig diet

Item	g.kg^{-1}
Dry mater	902.8
Crude protein	152.3
Crude fiber	46.4
Crude fat	25.4
Ash	47.8
Lysine (in DM)	71.4
ME (MJ/kg)	12.78

DM – dry mater, ME – metabolizable energy

Results and Discussion

Chemical composition and cholesterol content in pork are shown in Tab. 2. Immunocastrates had significantly higher content of crude protein than surgical castrates (21.09 vs. 20.34 %, P<0.05). On the other hand, immunocastrates had lower content of cholesterol as well as crude fat compared with barrows (0.44 vs. 0.54 %, P<0.05; 3.23 vs. 4.83 %, P<0.01). The values of gilts were between immuno- and surgical castrates.

Amino acid profile of pig muscles is presented in Tab. 3. The values of all the three sexes were almost identical and no significant differences were found.

Fatty acid composition of muscle is shown in Tab. 4. Insignificant differences between sexes in single and/or total saturated fatty acids were found. However, immunological castrates had significantly lower content of two monounsaturated fatty acids – oleic and eicosanoic – than surgically castrated males (42.42 vs. 46.60 % and 0.62 vs. 0.74 %, P<0.01). GRELA et al. (2013) also found lower content of oleic fatty acids in immunocastrates than barrows.

Whilst contents of single polyunsaturated fatty acids were very similar in all three groups, total contents were significantly different in favour of gilts and immunocastrates compared to barrows (8.77 and 8.54 vs. 6.94 %, P<0.05, P=0.05). Higher content of polyunsaturated fatty acids in immunocastrates than in surgical castrates was found again in the study of GRELA et al. (2013). Content of n-6 fatty acids in immunocastrates and gilts in our study was significantly higher than that of surgical castrates (8.34 and 8.42 vs. 6.74 %, P<0.05). More beneficial ratio between poly-unsaturated and saturated fatty acids was found in immunocastrates and gilts compared to barrows (0.22 and 0.23 vs. 0.18, P<0.05). This is also in agreement with GRELA et al. (2013).

Fatty acid profile in fat tissue of the three groups of pigs is shown in Tab. 5. Almost all values were the highest for immunocastrates and the lowest for surgical castrates but the differences were very small and insignificant. Tendency to lower monounsaturated and higher saturated and polyunsaturated fatty acids in immunocastrates compared to barrows was found, which is in agreement with ANONYMOUS (2012) and GRELA et al. (2013).

Table 2. Chemical composition and cholesterol content in muscle

Item	IC	SC	G
Crude protein, %	21.09 ± 0.10[a]	20.34 ± 0.25[b]	20.88 ± 0.19
Crude fat, %	3.23 ± 0.16[A]	4.83 ± 0.45[B]	3.73 ± 0.30
Cholesterol, %	0.44 ± 0.01[a]	0.54 ± 0.04[b]	0.51 ± 0.02
Water, %	74.24 ± 0.11	73.67 ± 0.35	73.98 ± 0.21

[a,b] Values with different letters within rows are significantly different (P< 0.05)
[A,B] Values with different letters within rows are significantly different (P<0.01)

Table 3. Amino acid composition of muscle (%)

Item	IC	SC	G
Arginine	1.68 ± 0.02	1.66 ± 0.04	1.68 ± 0.02
Cysteine	0.37 ± 0.00	0.39 ± 0.01	0.38 ± 0.00
Phenylalanine	1.09 ± 0.01	1.07 ± 0.02	1.08 ± 0.01
Histidine	1.29 ± 0.02	1.26 ± 0.02	1.29 ± 0.02
Isoleucine	1.03 ± 0.02	1.01 ± 0.07	1.04 ± 0.01
Leucine	2.13 ± 0.03	2.10 ± 0.04	2.12 ± 0.03
Lysine	2.26 ± 0.03	2.23 ± 0.05	2.30 ± 0.03
Methionine	0.83 ± 0.01	0.82 ± 0.02	0.84 ± 0.01
Threonine	1.22 ± 0.02	1.23 ± 0.03	1.21 ± 0.02
Valine	1.12 ± 0.01	1.12 ± 0.02	1.12 ± 0.01

Table 4. Fatty acid composition of muscle (% of FAME)

Item	IC	SC	G
Myristic C14:0	1.25 ± 0.01	1.26 ± 0.01	1.25 ± 0.01
Palmitic C16:0	24.43 ± 0.04	24.38 ± 0.06	24.34 ± 0.04
Stearic C18:0	11.30 ± 0.06	11.23 ± 0.04	11.70 ± 0.08
Total SFA	**38.47 ± 0.32**	**37.71 ± 0.23**	**38.08 ± 0.38**
Oleic C18:1 n-9	42.42 ± 0.67^{A}	46.60 ± 0.64^{B}	43.31 ± 0.66
Eicosanoic C20:1	0.62 ± 0.02^{A}	0.74 ± 0.03^{B}	0.66 ± 0.02
Vaccenic C18:1 11c	4.43 ± 0.02	4.46 ± 0.02	4.44 ± 0.02
Total MUFA	**53.45 ± 0.54**	**54.78 ± 0.41**	**53.04 ± 0.34**
Linolenic C18:3 n-3	0.30 ± 0.01	0.31 ± 0.01	0.29 ± 0.01
Linoleic C18:2 n-6	0.05 ± 0.00	0.05 ± 0.00	0.05 ± 0.00
Arachidonoic C20:4	1.42 ± 0.05	1.38 ± 0.04	1.55 ± 0.06
Eicosapentaenoic C20:5	0.09 ± 0.00	0.14 ± 0.00	0.09 ± 0.00
Docosapentaenoic C22:5	0.14 ± 0.00	0.14 ± 0.00	0.14 ± 0.00
Docosahexaenoic C22:6	0.04 ± 0.00	0.04 ± 0.00	0.05 ± 0.00
Total PUFA	**8.54 ± 0.43***	**6.94 ± 0.64**^{a*}	**8.77 ± 0.24**^{b}
n3 FA	0.54 ± 0.01	0.58 ± 0.02	0.59 ± 0.01
n6 FA	8.34 ± 0.45	6.74 ± 0.61	8.42 ± 0.26
PUFA/SFA	0.22 ± 0.03^{a}	0.18 ± 0.03^{b}	0.23 ± 0.04^{a}

FAME, fatty acid methylesther; FA, fatty acids; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids

^{a,b} Values with different letters within rows are significantly different (P< 0.05)

^{A,B}Values with different letters within rows are significantly different (P<0.01)

*P=0.05

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

Item	IC	SC	G
Myristic C14:0	1.38 ± 0.01	1.33 ± 0.03	1.36 ± 0.02
Palmitic C16:0	26.06 ± 0.13	25.58 ± 0.31	26.04 ± 0.26
Stearic C18:0	15.78 ± 0.25	14.78 ± 0.59	15.42 ± 0.41
Total SFA	**44.89 ± 0.36**	**43.46 ± 0.89**	**44.55 ± 0.61**
Oleic C18:1 n-9	36.38 ± 0.30	37.91 ± 0.77	37.02 ± 0.50
Total MUFA	**42.97 ± 0.35**	**44.90 ± 0.94**	**43.57 ± 0.61**
Linoleic C18:2 n-6	9.50 ± 0.12	9.26 ± 0.10	9.44 ± 0.11
Linolenic C18:3 n-3	0.60 ± 0.01	0.58 ± 0.01	0.59 ± 0.01
SUM PUFA	**11.18 ± 0.14**	**10.86 ± 0.10**	**11.10 ± 0.12**
n6 FA	9.89 ± 0.13	9.59 ± 0.11	9.88 ± 0.11
n3 FA	0.72 ± 0.01	0.70 ± 0.01	0.71 ± 0.01
PUFA/SFA	0.25 ± 0.03	0.25 ± 0.05	0.25 ± 0.04

FAME, fatty acid methylesther; FA, fatty acids; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids

Conclusion

Immunologically castrated males had significantly less cholesterol and intramuscular fat as well as higher crude protein content compared to surgical castrates. Vaccination of males had no significant impact on amino acid profile of muscle and fatty acid profile of backfat. However, immunocastrates had less monounsaturated and more polyunsaturated and n -6 fatty acids in muscle than barrows. They also had better PUFA/SFA ratio that could be profitable from the human health point of view.

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