AMINO AND FATTY ACIDS PROFILE, AND CHEMICAL COMPOSITION OF MUSCLE AND BACKFAT IN ENTIRE MALE, SURGICALLY CASTRATED AND FEMALE PIGS

Bahelka I.[1], Bučko O.[2], Hanusová E.[1], Gondeková M.[1]

[1]National Agricultural and Food Centre – Research Institute for Animal Production, Lužianky, Slovakia
[2]Slovak Agricultural University, Nitra, Slovakia

Abstract

The aim of the study was to compare chemical and amino acid composition of muscle as well as fatty acid content of both muscle and backfat in entire males, surgical castrates and gilts. Total of 42 hybrid fatteners was included into the experiment. Pigs were divided into three groups (each of 14) according to sex. They were housed by pairs in the pens and fed commercial feed mixture. The fattening was realized from 30 to 105 kg of live weight. After that, pigs were slaughtered at experimental abattoir according to standard slaughter procedure. Twenty-four hours after slaughter, the dissection of the right half of carcasses was done. Subsequently, samples of muscle from the neck and backfat over the neck were taken. The analyses of chemical composition, amino and fatty acid content were realized by the FTIR method. Entire males reached the lowest crude fat and cholesterol contents which were significantly different from those of castrates (2.52 vs 3.14 %, 0.31 vs 0.41 %, $P<0.05$). Amino acid profile of muscle in boars differed substantially from that of barrows. All the values of amino acids except cysteine were significantly higher in entire males. Smaller differences between sexes were found in fatty acid composition of muscle since only three parameters were significantly different between entire males and castrates – the first ones had lower oleic (41.71 vs 47.42 %) and eicosanoic (0.60 vs 0.67) as well as higher linolenic (2.06 vs 1.92 %) fatty acid than castrates. In the backfat, entire males had lower content of saturated fatty acids and higher content of mono- and polyunsaturated, n6 and n3 fatty acids than barrows (and some cases also gilts). Therefore, pork and fat from entire males could be more beneficial from the human health point of view.

Key words: pigs, entire males, pork, amino acid, fatty acid

Surgical castration of piglets is commonly used to reduce aggressive behaviour and produce meat without unpleasant off-flavour, so called boar taint,which is developed in sexually mature entire males. At present, this practice is regarded as a stressful procedure with negative impact on animal welfare and health. Therefore, European Commission (EC) and the representatives of European farmers, meat industry, veterinarians, scientists, retailers and NGO´s committed to end surgical castration of pigs by January 1st, 2018 (EC Declaration, 2010). If a ban on surgical castration is introduced, the consequences for the whole pork production sector will be huge. One possible alternative to pork production from surgical castrates is being considered entire males raising. The advantages of boars over barrows in growth intensity, feed conversion ratio and carcass quality are well-known (PAULY et al., 2008; ŠKRLEP et al., 2012; ZAMARATSKAIA and RASMUSSEN, 2015). However, little research has been conducted on the quality of amino and fatty acid composition of meat from entire males. As known, amino acids play an important role in nutrition not only of animals but also in humans (HIGGS, 2000; OKROUHLÁ et al., 2006). Moreover, intramuscular fat and fatty acid composition affect the eating quality of meat (SIRET et al., 1997; FONT I FURNOLS et al., 2008). In the past, several studies have been focused on fatty acid composition in adipose tissue, but recently, there is more emphasis on fatty acid composition in pig muscles.

The aim of the study was to evaluate the chemical composition as well as amino and fatty acid profiles in muscle and fat tissue of entire males, surgical castrates and gilts.

Material and Methods

Animals and diet

The trial was performed in the experimental facility of the Research Institute for Animal Production (RIAP) in Nitra. Forty-two pigs, progeny of Landrace sows and hybrid (Yorkshire x Landrace) boars, was randomly selected for the experiment. They were divided into three groups: entire males (EM), surgical castrates (SC) and gilts (G), each of 14. Pigs were housed by pairs (the same sex) in pens. Test started at 30 kg of live weight. The whole testing period pigs were fed commercial diet (Tab. 1) according to nutritive requirements for growing-finishing pigs (ŠIMEČEK et al., 1995).

Slaughtering and sampling

When pigs reached average slaughter weight of 105 kg, they were slaughtered at the experimental slaughter house of the RIAP. A slaughter was done according to standard procedure e.g. electrical stunning, vertical exsanguination, vapour scalding and evisceration. Subsequently, carcasses were chilled 24 h at temperature of 2-4 °C. The second day after slaughter, dissection of right half of carcasses was done. The samples of muscle from the neck (400 g) and backfat (200 g) were taken for analyses of chemical composition, amino acid and fatty acid content. They were frozen at -20 °C until analysis, then thawed, homogenized and analysed in the laboratory of the Slovak Agricultural University by the FTIR method using device 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 = EM, SC, G)
e_i – random error

The values in the tables are presented as means ± standard error.

Table 1. Nutritive value of the pig diet

Item	g.kg^{-1}
Dry mater	899.2
Crude protein	149.8
Crude fiber	47.7
Crude fat	23.5
Ash	41.7
Lysine (in DM)	70.3
Metionine + Cysteine (in DM)	53.4

DM – dry mater

Results and Discussion

Chemical composition of pork is shown in Tab. 2. Entire males had significantly lower content of crude fat and cholesterol compared to surgical castrates (2.52 vs 3.14 %, 0.31 vs 0.41 %, P<0.05). The same findings related to crude fat content were reported in several studies (NADĚJE et al., 2000; LATORRE et al., 2003; JATURASITHA et al., 2006; CAI et al., 2010; BATOREK et al., 2012). On the other hand, entire males had the highest water content in meat with comparison to barrows and gilts (74.44 vs 73.93, P<0.05 and 74.09 %). Similar observations were found in other studies (XUE et al, 1997; NOLD et al., 1999; CAI et al., 2010).

Amino acid composition of pork from entire males, surgical castrates and gilts is presented in Tab. 3. The highest values of all essential amino acids were found in entire males (in two cases together with gilts) and were significant compared to castrates with exception of cysteine. Contrary, CAI et al. (2010) reported opposite results when compared entire males and castrates. All the amino acid values were higher in barrows than boars with eception of histidine.

Table 2. Chemical composition of pork (%)

Item	Entire males	Surgical castrates	Gilts
Crude protein, %	21.74 ± 0.15	21.98 ± 0.20	21.97 ± 0.23
Crude fat, %	2.52 ± 0.12^{a}	3.14 ± 0.10^{b}	2.87 ± 0.23
Cholesterol	0.31 ± 0.02^{a}	0.41 ± 0.01^{b}	0.33 ± 0.03^{a}
Water, %	74.44 ± 0.13^{a}	73.93 ± 0.12^{b}	74.09 ± 0.18

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

Insignificant differences between the sexes in single and/or total saturated fatty acids of pork were found (Tab. 4). However, castrates had significantly higher content of two monounsaturated fatty acids – oleic and eicosanoic than entire males (47.42 vs 44.71 %, 0.67 vs 0.60 %, P<0.05). The same results related to oleic and linolenic fatty acids were reported by GRELA et al. (2013).

Whilst composition of fatty acids in muscle was not too different between sexes, composition of them in backfat showed considerable differences (Tab. 5). Values of myristic, palmitic, stearic and total saturated fatty acids in castrates were significantly higher than that of entire males (1.45 vs 1.39 %, 26.83 vs 25.41 %, 16.90 vs 14.88 %, 46.70 vs 43.40 %, P<0.05). In contrast, boars had significantly higher content of oleic, linoleic, linolenic as well as total monounsaturated and polyunsaturated, n-3 and n-6 fatty acids than barrows and/or both barrows and gilts. Similar results were observed by JATURASITHA et al. (2006), RAZMAITÉ et al. (2008), PAULY et al. (2009), SERRANO et al. (2009), GISPERT et al. (2010) and GRELA et al. (2013).

A strong correlation was observed between concentrations of polyunsaturated linoleic and saturated stearic fatty acid to firmness/hardness of fat (WOOD and ENSER, 2008; WOOD et al., 2008). High linoleic and low stearic indicated softer fat, especially in leaner carcasses (such as entire males). This fact is undesirable for meat industry because of harmful effect on consistency, storage stability and texture of processed meat products. On the other hand, higher content of polyunsaturated, n-6 and n-3 fatty acids and lower saturated fatty acids (as observed in entire males) is beneficial from the human health point of view.

Table 3. Amino acid composition of muscle (%)

Item	Entire males	Surgical castrates	Gilts
Arginine	1.61 ± 0.03[a]	1.49 ± 0.02[b]	1.59 ± 0.02[a]
Cysteine	0.37 ± 0.00	0.36 ± 0.00	0.37 ± 0.00
Phenylalanine	1.06 ± 0.02[a]	0.98 ± 0.01[b]	1.05 ± 0.01[a]
Histidine	1.21 ± 0.02[a]	1.11 ± 0.02[b]	1.18 ± 0.02
Isoleucine	0.97 ± 0.02[a]	0.89 ± 0.02[b]	0.95 ± 0.01[a]
Leucine	2.06 ± 0.04[a]	1.92 ± 0.03[b]	2.04 ± 0.03[a]
Lysine	2.15 ± 0.04[a]	2.00 ± 0.03[b]	2.14 ± 0.03[a]
Methionine	0.75 ± 0.01[a]	0.71 ± 0.01[b]	0.75 ± 0.01[a]
Threonine	1.19 ± 0.02[a]	1.12 ± 0.01[b]	1.18 ± 0.02[a]
Valine	1.09 ± 0.02[a]	1.02 ± 0.01[b]	1.08 ± 0.01[a]

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

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

Item	Entire males	Surgical castrates	Gilts
Myristic C14:0	1.24 ± 0.00	1.25 ± 0.01	1.24 ± 0.01
Palmitic C16:0	24.40 ± 0.04	24.35 ± 0.05	24.46 ± 0.04
Stearic C18:0	11.29 ± 0.08	11.26 ± 0.04	11.31 ± 0.06
Total SFA	**39.54 ± 0.40**	**38.57 ± 0.34**	**39.37 ± 0.39**
Oleic C18:1 n-9	44.71 ± 0.71[a]	47.42 ± 0.42[b]	45.82 ± 0.58
Eicosanoic C20:1	0.60 ± 0.02[a]	0.67 ± 0.01[b]	0.62 ± 0.02
Total MUFA	**55.48 ± 0.56**	**55.51 ± 0.34**	**55.15 ± 0.31**
Linolenic C18:3 n-3	2.06 ± 0.04[a]	1.92 ± 0.03[b]	2.04 ± 0.03[a]
Linoleic C18:2 n-6	0.05 ± 0.00	0.05 ± 0.00	0.05 ± 0.00
Total PUFA	**5.64 ± 0.43**	**5.02 ± 0.29**	**5.73 ± 0.22**
n3 FA	0.50 ± 0.01	0.49 ± 0.02	0.49 ± 0.01
n6 FA	5.30 ± 0.45	4.49 ± 0.29	5.21 ± 0.30
PUFA/SFA	0.14 ± 0.04	0.13 ± 0.03	0.15 ± 0.02

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)

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

Item	Entire males	Surgical castrates	Gilts
Myristic C14:0	1.39 ± 0.04[a]	1.45 ± 0.03[b]	1.40 ± 0.07
Palmitic C16:0	25.41 ± 1.14[a]	26.83 ± 0.45[b]	26.27 ± 0.83[b]
Stearic C18:0	14.88 ± 1.44[a]	16.90 ± 1.00[b]	15.98 ± 1.16
Total SFA	**43.40 ± 2.40[a]**	**46.70 ± 1.28[b]**	**45.53 ± 1.93[b]**
Oleic C18:1 n-9	36.71 ± 1.22[a]	34.95 ± 0.99[b]	36.05 ± 1.55
Total MUFA	**43.58 ± 1.58[a]**	**41.35 ± 1.33[b]**	**42.61 ± 1.81**
Linoleic C18:2 n-6	10.29 ± 0.95[a]	9.45 ± 0.43[b]	9.56 ± 0.75[b]
Linolenic C18:3 n-3	0.65 ± 0.08[a]	0.59 ± 0.03[b]	0.60 ± 0.06
SUM PUFA	**12.06 ± 1.17[a]**	**11.06 ± 0.54[b]**	**11.22 ± 0.94**
n6 FA	10.69 ± 1.05[a]	9.83 ± 0.52[b]	9.98 ± 0.88
n3 FA	0.78 ± 0.08[a]	0.71 ± 0.03[b]	0.72 ± 0.05[b]
PUFA/SFA	0.28 ± 0.04[a]	0.24 ± 0.01[b]	0.25 ± 0.03[b]

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)

Conclusion

Entire males had significantly lower content of crude fat and cholesterol than surgically castrated males. Amino acid profile of muscle showed significantly higher values in all the acids except cysteine in boars than barrows. Fatty acid concentrations in muscle showed little differences between sexes. However, considerable differences between sexes were found in fatty acid composition of backfat. Boars had less saturated, and more unsaturated, n-6 and n-3 fatty acids as well as better PUFA/SFA ratio than barrows and/or barrows and gilts. Therefore, pork from entire males seems to be more beneficial from the human nutrition point of view.

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Corresponding Address:
Ing. Ivan Bahelka, PhD.
National Agricultural and Food Centre – Research Institute for Animal Production
Departement of Animal Husbandry Systems, Breeding and Product Quality
Hlohovecká 2
951 41 Lužianky
Slovakia
e-mail: bahelka@vuzv.sk