THE EFFECT OF THE SEX ON CHEMICAL COMPOSITION IN PORK MEAT

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Abstract

The aim of this study was to evaluate the effect of sex on chemical composition and amino acid content in pig meat of the main meat parts (MMP) in pigs carcasses.

The total of 120 finishing hybrid pigs commonly used in the Czech Republic were fattened in the test station according to test station method.

After finishing the test all right half-carcasses were dissected onto individual carcass parts. Lean meat samples were taken from the carcass parts as neck *(musculus serratus ventralis)*, ham *(musculus semimembranosus)*, loin *(musculus longissimus lumborum et thoracis)* and shoulder *(musculus cleidocephalicus)*. The representative ones were homogenized for chemical analyses to determine water, intramuscular fat (IMF), crude protein (CP), ash and selected amino acids (AA) content.

From the obtained results of measuring it stands to reson that barrows achieved lower water content values in the neck, ham and shoulder than gilts. Different values were assessed in the IMF content of MMP, when the highest content was find out for neck (barrows, 9.25%), contrary the lowest one for loin (gilts, 1.65%). Statistically highly significant ($P<0.0001$) difference was observed in shoulder (4.14% *versus* 3.38%). There were no statistically significant differences between sexes in the content of CP in all evaluated MMP. The values ranged in barrows, resp. gilts in the interval 19.71 – 23.30%, resp. 19.81 – 23.21%. The highest (1.53%)/lowest (1.12 %) value of the ash matters was monitored in barrows in ham/shoulder. Barrows had significantly ($P<0.0494$) higher share of ash in ham than gilts (1.53 versus 1.44%). No influence of sex was observed for aminoacid contents in the MMP. Further, the absolutely highest/lowest values were obtained for essential and semi-essential AA 10.40/0.97% lysine (ham, barrows)/phenylalanine (neck, barrows). In regard to nonessential AA the highest value was obtained for glutamic acid in the loin (barrows, 12.98%) and the lowest content was assessed for proline in shoulder (gilts, 4.66%).

Key Words: *Pig; sex; chemical composition; amino acid*

The quality and chemical composition of pig meat is influenced by various factors, such as: genetic, sex, slaughter weight and nutrition.

Numerous studies were engaged in intramuscular fat. Mullan and D´Souza (2000) reported a strong correlation ($R^2 > 0.5$) between intramuscular fat levels and eating quality. The optimal range of intramuscular fat content for optimum eating quality was suggested to be 2 to 3% (Bejerholm and Barton-Gade 1986; DeVol et al. 1988).

Many investigators ascertained a significant effect of sex on intramuscular fat content (Barton-Gade, 1987; Leach et al., 1996; Latorre et al., 2003a; Latorre et al., 2003b; Channon et al., 2004; Okrouhlá et al., 2006; Bahelka et al., 2007). Barrows had higher intramuscular fat proportion than gilts. Stupka et al. (2008) found that gilts attained a statistically significant lean meat proportion. Poltársky and Palanská (1991) accordingly stated that boars had about 0.40% higher content of intramuscular fat (3.67% and 3.27%, resp.) in comparison with gilts, which gives to pork its specific taste and tenderness. The fat content is also very important in modern types of pigs. The content of intramuscular fat is in close relationship to the energy value of meat (in KJ/100 g): boars had 526.5 KJ and gilts 516.48 KJ. These findings are not consistent with those of Channon et al. (2004), who showed that pork from entire male pigs had a lower intramuscular fat content. Low percentage of intramuscular fat reduces tenderness and juiciness of the meat (DeVol et al., 1988). Opposite results were reported by Beattie et al. (1999) who determined significantly ($P < 0.05$) higher intramuscular fat content in meat from gilts.

On the other hand, Cisneros et al. (1996), Hamilton et al. (2000), D´Souza and Mullan (2002) and Latorre et al. (2004) did not find out any significant effect of sex on level of intramuscular fat. Blanchard et al. (1999) and D´Souza and Mullan (2003) evaluated the effect of castration method on intramuscular fat content. They observed no significant differences in intramuscular fat content between the castration methods, too.

Opposite trends were observed for the subcutaneous fat proportion (Stupka et al., 2008). This results are in agreement with Beattie et al. (1999) who reported significantly ($P < 0.001$) more subcutaneous fat in gilts in contrast to boars.

Poltársky and Palanská (1991) recorded significant differences in free water content. Furthermore, boars had about 0.25% less water than gilts. The effect of sex on water content is evident in study which carried out

Okrouhlá et al. (2006), too. Gilts had higher water content in comparison with barrows. By contrast, Cisneros et al. (1996), Hamilton et al. (2000) and Latorre et al. (2004) ascertained no effect of sex on moisture content.

Okrouhlá et al. (2006) and Stupka et al. (2008) detected no effect of sex on crude protein content. Conversely, Poltársky and Palanská (1991) revealed that boars had about 0.20% less protein in comparison with gilts. Latorre et al. (2004) showed that *musculus longissimus* of gilts had more ($P < 0.05$) protein than *musculus longissimus* from barrows, too. This is in accordance with Beattie et al. (1999) who found out higher ($P < 0.001$) values of crude protein and dry matter content in gilts in contrast to boars.

In general, meat is the most important source of protein for humans. The nutrition value of protein is determined by the composition and content of its amino acid, especially the essential amino acid. Statistically significant difference between sexes was recorded only in lysine (Okrouhlá et al., 2006). Differences ($P < 0.05$) between males and females were detected in aspartic acid, glycine, proline and phenylalanine contents, being higher in males (Armero et al., 1999).

Material and Methods

The objective of the work was to determine the effect of the sex influence on the chemical composition and amino acid content of the main meat parts (MMP) in pigs carcasses.

The total of 120 finishing hybrid pigs commonly used in the Czech Republic were fattened in the test station according to test station method.

The tests were realized at the test-station Ploskov, Lány. All pigs were penned pairly and divided according to sex (gilts, barrows). The pigs were placed into tests at the average live weight of 23.6 kg (the same age and well-balanced sex ratio - barrows /gilts) and age of 65 – 70 days after birth. The feeding was carried out by means of full feeding mixture (FFM), which contained three components (wheat, barley, soybean extracted meal) and feeding premix. The pigs was after attainment average live weight 111.6 kg (at the age of 168 – 171 days from the birth) killed and subjected to the carcass analysis.

The right half-carcasses was dissected into individual parts. Meat samples were taken from the carcass parts like neck *(musculus serratus ventralis)*, ham *(musculus semimembranosus)*, loin *(musculus longissimus lumborum et thoracis)* and shoulder *(musculus cleidocephalicus)* and were homogenized and subjected to chemical analyses to determine the content of water (from the difference of the sample weight before and after drying with sea sand), IMF (by gravimetric determination after extraction with petrolether), crude protein (determination of amino nitrogen according to Kjeldahl), ash (by burning the sample at 550 °C until the burning of organic substances), was complete and selected amino acids (analysis of the hydrolysed product with an automatic analyzer AAA 400 and evaluation by the ChromuLan programme).

The obtained results were evaluated by the statistical programme SAS® Propriety Software Release 6.04 (2001), formulated in tables. Whereas the differences between the individual traits were tested by the GLM procedure on the basis of mutual interactions between lean muscles. The following parameters were used to evaluated the appropriateness of the allometric models:

$Y_i = \mu + (S)_i + e_i$ - analysis of a single class (sex).

Results and discussion

The carcass pigs were divided in barrows and gilts according to sex. As it is evident from Table 1, higher average values of water content were found out in gilts in all assessed carcass parts, except loin. The highest water content was recorded in shoulder (74.07%). Further, loin, ham and neck contained 72.46%, 71.22% and 70.43% of water in gilts. The similar tendency was in barrows, where the values of water content were following: 73.59%, 72.48%, 71.21% and 69.42%. Statistically significant ($P<0.012$) influence of sex was ascertain in neck.

The effect of sex was evident in our previous stud Okrouhlá et al. (2006). The gilts had higher water content than barrows. Whereas, Cisneros et al. (1996), Hamilton et al. (2000) and Latorre et al. (2004) detected no significant differences in water content in relation to sex. But also value of water content in gilts was higher (73.14%) contrary to barrows (72.85%) (Cisneros et al., 1996).

Most of authors showed significant effect of sex on content of intramuscular fat in pigs. Gilts had lower values of intramuscular fat content than barrows. These findings are in agreement with the results showed in Table 1. It is possible to state that the values of intramuscular fat content were higher for barrows in all evaluated carcass parts in comparison with gilts. Statistically highly significant ($P<0.0001$) difference was observed in shoulder (4.14% *versus* 3.38%). Significant differences between castrates and gilts were found by Bahelka et al. (2007) in intramuscular fat content (2.49 versus 2.00%) of the *musculus longissimus dorsi*. Accordingly, higher content of intramuscular fat in barrows was record also in *musculus longissimus lumborum et thoracis*. The intramuscular fat proportion in barrows ranged from 1.65 to 2.00%, in gilts it was in the range of 1.31–1.53% (Okrouhlá et al., 2006). Significantly ($P<0.01$) higher intramuscular fat levels had barrows (2.5%) compared to gilts (1,8%) (Leach et al., 1996). Latorre et al. (2003a) found out that meat from barrows had more ($P<0.05$) intramuscular fat than meat from gilts (27.6 versus 25.1 g/ kg), too. By contrast, Cisneros et al. (1996) reported no effect of sex on intramuscular fat content in *musculus longissimus lumborum et thoracis*. Nevertheless, barrows had 3.70% and gilts 3.26% of intramuscular fat. Barrows (2.74%) had nosignificant higher intramuscular fat in *musculus longissimus* than gilts (2.44%) (Hamilton et al., 2000).

Blanchard et al. (1999) observed no differences in intramuscular fat between the castration methods. Entire males had proportionately about 0.18% and 0.12% lower intramuscular fat levels compared with surgically and immunologically castrated pigs, respectively.

The content of intramuscular fat is influenced by genotype, too. D´Souza and Mullan (2002) compared genotype (50% and < 25% Duroc bloodline) and sex (females, surgical barrows and immunological barrows). They reported corresponding increases in intramuscular fat levels in pigs with increasing Duroc bloodline. The genotype with higher Duroc bloodline had significantly ($P < 0.001$) higher (2.8%) intramuscular fat levels in *musculus longissimus thoracis* muscle than the genotype with 25% Duroc bloodline (2.2%). The effect of sex was not proved. But in genotype with 50% Duroc bloodline was found out 2.5% in female, 2.7% in surgical barrows and 3.5% in immunological barrows.

Intramuscular fat share obtained by us was different for every carcass meat part. It stands to reason that the highest proportion of intramuscular fat was in neck, 9.25% in barrows and 8.18% in gilts. On the contrary, the lowest content of intramuscular fat was attained in loin where values in barrows, resp. gilts were 1.18%, resp. 1.65%.

Opposite tendency was observed for the subcutaneous fat share. Significantly ($P < 0.001$) more subcutaneous fat had gilts in contrast to boars (Beattie et al.,1999). The gilts had higher ability to deposit fat in all the monitored parts compared to barrows (Stupka et al., 2008).

How is evident from Table 1, the obtained values of crude protein in barrows were in interval from 19.71 to 23.30% when the highest value was assessed in loin, further in ham, shoulder and neck. Crude protein content gilts occurred in range 19.81 – 23.21% which is the same tendency of presence. In regard to neck, barrows had lower value than gilts. Conversely, higher content of crude protein in ham and loin was observed in barrows. Identical values (20.08%) for crude protein content in barrows as well as in gilts were assessed in shoulder. As for the evaluation of sex influence on crude protein content, all differences were not statistically significant.

This results are consistent with those of Okrouhlá et al. (2006) and Stupka et al. (2008) who observed no effect of sex on crude protein content. Content of crude protein was very well balanced in the groups (23.18 – 23.64%). Only in the group of barrows with live weight over 115.1 kg the values of crude protein content were higher than in the gilts. On the contrary, Latorre et al. (2004) found out that gilts had significant ($P<0.05$) more protein in *musculus longissimus* in contrast to barrows. Boars had about 0.20% less protein than gilts (Poltársky and Palanská, 1991). Beattie et al. (1999) detected higher ($P<0.001$) values of crude protein in gilts, too.

Table 1 monitors obtained ash matter content in main meat parts depending on sex. From the Table it is resulting that in barrows the highest value of ash matter content was in ham (1.53%), further loin (1.36%), neck (1.14%) and the lowest one in shoulder (1.12%). Similar tendency was found out in gilts, i. e. ham (1.44%), chop (1.40%), neck (1.18%) and shoulder (1.15%). How it is further evident from above mentioned results, the higher values of ash matter content were determined in gilts, with exception of ham.

Table 1. Chemical composition in the main meat parts pork meat

Sex	Carcass part	Barrows	Gilts	Total	Significance
		$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	
Water (%)	**neck**	69.42 $^{\alpha}$±0.31	70.43 $^{\alpha}$±0.25	69.97±0.20	0.0120
	ham	71.21±0.20	71.22±0.17	71.21±0.13	0.9666
	loin	72.48±0.21	72.46±0.21	72.47±0.15	0.9677
	shoulder	73.59±0.27	74.07±0.26	73.84±0.19	0.2029
IMF (%)	**neck**	9.25±0.41	8.18±0.37	8.70±0.27	0.0515
	ham	3.87±0.15	3.79±0.14	3.82±0.10	0.6988
	loin	1.81±0.06	1.65±0.07	1.73±0.04	0.1020
	shoulder	4.14 ^{A}±0.14	3.38 ^{A}±0.13	3.74±0.09	<0.0001
CP (%)	**neck**	19.71±0.13	19.81±0.12	19.76±0.09	0.5846
	ham	21.88±0.10	21.85±0.12	21.86±0.08	0.8209
	loin	23.30±0.09	23.21±0.12	23.26±0.08	0.5454
	shoulder	20.08±0.11	20.08±0.15	20.08±0.10	0.9829
Ash (%)	**neck**	1.14±0.02	1.18±0.02	1.16±0.01	0.1258
	ham	1.53 $^{\alpha}$±0.03	1.44 $^{\alpha}$±0.03	1.48±0.02	0.0494
	loin	1.36±0.02	1.40±0.02	1.38±0.01	0.0861
	shoulder	1.12±0.02	1.15±0.02	1.14±0.02	0.3785

$\bar{x}$ = mean; SD = standard error of the mean

Statistically significant differences were ascertained in ham. Barrows had significantly (P<0.0494) higher share of ash in ham than gilts (1.53 versus 1.44%). In addition, significant (P<0.001) influence of sex on dry matter content showed Beattie et al. (1999) who found more dry matter in gilts compared to boars.

Following Tables 2, 3, 4 and 5 document the amino acids content values in various parts of carcass. From the results of the measuring it is evident, that there are no statistically significant differences between barrows and gilts.

It was assessed that valine, leucine, lysine, arginine, aspartic acid, serine, glutamic acid, proline, glycine and alanine content in neck were higher in barrows than in gilts (Table 2). From the data mentioned in Table 3 (ham) it is resulting that the values of threonine, valine, isoleucine, phenylalanine, serine, glutamic acid, proline, glycine and alanine were lower in barrows compared with gilts. Only the aspartic acid had the same value for all sexes (11.79%). Table 4 shows the amino acids content in loin.

It is possible to state that valine, isoleucine, leucine, phenylalanine, lysine, arginine, aspartic acid, serine and glutamic acid contents were higher in barrows compared to gilts. While threonine content (6.41%) was the same for both sexes.

Table 2. Neck amino acid contents in pigs

Sex	Barrows	Gilts	Total	Significance
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	Sex
Essential and semi-essential amino acids (%)				
Threonine	5.34 ± 0.17	5.36 ± 0.21	5.35 ± 0.14	0.9389
Valine	5.10 ± 0.14	5.05 ± 0.17	5.08 ± 0.11	0.8374
Isoleucine	4.61 ± 0.13	4.72 ± 0.23	4.67 ± 0.13	0.6785
Leucin	8.33 ± 0.28	8.13 ± 0.29	8.23 ± 0.20	0.6287
Phenylalanine	0.97 ± 0.03	1.33 ± 0.34	1.15 ± 0.17	0.2921
Lysin	9.62 ± 0.36	9.23 ± 0.36	9.43 ± 0.26	0.4527
Arginine	8.34 ± 0.34	8.23 ± 0.37	8.29 ± 0.25	0.8182
Nonessential amino acids (%)				
Aspartic acid	10.36 ± 0.41	10.20 ± 0.35	10.28 ± 0.27	0.7634
Serine	5.07 ± 0.27	4.82 ± 0.18	4.95 ± 0.16	0.4483
Glutamic acid	12.37 ± 0.60	12.19 ± 0.48	12.29 ± 0.38	0.8214
Proline	5.09 ± 0.20	4.99 ± 0.23	5.04 ± 0.15	0.7499
Glycine	5.28 ± 0.17	5.04 ± 0.16	5.17 ± 0.12	0.3119
Alanine	6.73 ± 0.20	6.53 ± 0.19	6.63 ± 0.14	0.4777

$\bar{x}$ = mean; SD = standard error of the mean

Table 3. Ham amino acid contents in pigs

Sex	Barrows	Gilts	Total	Significance
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	Sex
Essential and semi-essential amino acids (%)				
Threonine	6.36 ± 0.27	6.38 ± 0.26	6.37 ± 0.19	0.9543
Valine	6.06 ± 0.21	6.27 ± 0.23	6.17 ± 0.16	0.5103
Isoleucine	5.45 ± 0.17	5.68 ± 0.21	5.57 ± 0.14	0.4066
Leucin	9.53 ± 0.35	9.02 ± 0.36	9.28 ± 0.25	0.3425
Phenylalanine	1.47 ± 0.06	1.54 ± 0.09	1.51 ± 0.06	0.5250
Lysin	10.20 ± 0.35	10.10 ± 0.39	10.15 ± 0.27	0.0920
Arginine	9.25 ± 0.35	9.23 ± 0.49	9.25 ± 0.30	0.9752
Nonessential amino acids (%)				
Aspartic acid	11.79 ± 0.57	11.79 ± 0.39	11.79 ± 0.35	0.9950
Serine	5.60 ± 0.21	5.73 ± 0.22	5.67 ± 0.15	0.6793
Glutamic acid	12.24 ± 0.91	12.71 ± 0.75	12.48 ± 0.58	0.6951
Proline	4.94 ± 0.14	5.36 ± 0.24	5.16 ± 0.14	0.1438
Glycine	5.94 ± 0.24	6.18 ± 0.21	6.06 ± 0.16	0.4554
Alanine	7.91 ± 0.34	8.19 ± 0.28	8.06 ± 0.22	0.5352

$\bar{x}$ = mean; SD = standard error of the mean.

Table 4. Loin amino acid contents in pigs

Sex	Barrows	Gilts	Total	Significance
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	Sex
Essential and semi-essential amino acids (%)				
Threonine	6.41 ± 0.21	6.41 ± 0.19	6.41 ± 0.14	0.7574
Valine	6.17 ± 0.20	6.06 ± 0.22	6.11 ± 0.15	0.5458
Isoleucine	5.78 ± 0.24	5.65 ± 0.17	5.71 ± 0.15	0.5492
Leucin	8.90 ± 0.26	8.86 ± 0.31	8.88 ± 0.20	0.5165
Phenylalanine	1.33 ± 0.05	1.27 ± 0.06	1.30 ± 0.04	0.9961
Lysin	9.79 ± 0.30	9.22 ± 0.38	9.50 ± 0.24	0.5738
Arginine	9.71 ± 0.33	8.82 ± 0.29	9.27 ± 0.21	0.8956
Nonessential amino acids (%)				
Aspartic acid	10.55 ± 0.30	10.46 ± 0.36	10.50 ± 0.23	0.6602
Serine	5.79 ± 0.19	5.76 ± 0.17	5.78 ± 0.12	0.7251
Glutamic acid	12.98 ± 0.40	12.47 ± 0.53	12.72 ± 0.33	0.9553
Proline	4.93 ± 0.22	5.30 ± 0.20	5.12 ± 0.15	0.9464
Glycine	5.65 ± 0.14	5.75 ± 0.17	5.70 ± 0.11	0.9974
Alanine	7.75 ± 0.18	7.89 ± 0.22	7.82 ± 0.14	0.6814

$\bar{x}$ = mean; SD = standard error of the mean

Summary values of amino acid content measuring in shoulder are presented in last Table 5. The values of all amino acids, except phenylalanine and glycine, which had same values in both sexes were statistically nosignificantly higher in favour of barrows.

In our previous study we were analysed amino acid composition of loin in relation o sex. Statistically significant difference between sexes (group 115.1 kg and more) was recorded only in lysine. Finally, differences ($P < 0.05$) between males and females were detected in aspartic acid, glycine, proline and phenylalanine contents. Higher values was ascertained in males. According to this, males would have higher taste intensity for a given sire type (Armero et al., 1999).

Table 5. Shoulder amino acid contents in pigs

Sex	Barrows	Gilts	Total	Significance
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	Sex
Essential and semi-essential amino acids (%)				
Threonine	5.48 ± 0.16	5.41 ± 0.13	5.45 ± 0.11	0.9929
Valine	5.36 ± 0.15	5.24 ± 0.12	5.31 ± 0.10	0.7165
Isoleucine	4.88 ± 0.14	4.77 ± 0.11	4.83 ± 0.09	0.6831
Leucin	9.55 ± 0.27	9.31 ± 0.23	9.43 ± 0.18	0.9330
Phenylalanine	1.07 ± 0.05	1.07 ± 0.06	1.07 ± 0.04	0.4382
Lysin	10.40 ± 0.31	10.16 ± 0.27	10.29 ± 0.21	0.3782
Arginine	8.46 ± 0.31	8.40 ± 0.29	8.44 ± 0.21	0.7955
Nonessential amino acids (%)				
Aspartic acid	11.98 ± 0.35	11.77 ± 0.29	11.88 ± 0.23	0.8415
Serine	5.03 ± 0.15	4.97 ± 0.12	5.00 ± 0.97	0.9028
Glutamic acid	12.08 ± 0.51	12.04 ± 0.55	12.07 ± 0.37	0.4610
Proline	4.68 ± 0.20	4.66 ± 0.20	4.67 ± 0.14	0.2327
Glycine	5.67 ± 0.16	5.67 ± 0.17	5.67 ± 0.12	0.6650
Alanine	7.13 ± 0.19	7.02 ± 0.17	7.08 ± 0,13	0.6418

$\bar{x}$ = mean; SD = standard error of the mean

Conclusion

On the base of the obtained results of measuring it can be documented, that barrows attained lower water content in the carcass part of neck, ham and shoulder than gilts. There was found out statistically highly significant ($P<0.0001$) differences in IMF in shoulder. Barrows had higher value than gilts (4.14% *versus* 3.38%). No statistically significant differences were detected between sexes in CP content in all evaluated MMP. The values ranged in barrows, resp. gilts in the interval 19.71 – 23.30%, resp. 19.81 – 23.21%. Barrows had significantly ($P<0.0494$) higher share of ash in ham than gilts (1.53 versus 1.44%). No influence of sex was observed for aminoacid contents in the MMP. Total highest/lowest value of the essential and semi-essential AA 10.40/0.97 % was assessed for lysine (ham, barrows)/ phenylalanine (neck, barrows). The highest value of nonessential AA was obtained for glutamic acid (chop, barrows, 12.98 %), the lowest for proline (shoulder, gilts, 4.66 %).

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