Analysis of the formation of the belly in relation to sex

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ABSTRACT: The aim of the study was to analyse the formation of pig belly in relation to sex. The analysis included in total 193 slaughter pigs of final hybrids currently used in the Czech Republic. The pigs were slaughtered at the age of 166–175 days. The VIA method according to the methodology of Schwerdtfeger *et al*. (1993) was used to evaluate the formation of belly and to estimate the percentage of lean meat. The calculation of the lean meat and its proportion in the belly was based on the equation according to Čítek (2002). The belly in total as well as the EU belly in barrows reached the weight of 7.85 kg and 4.35 kg, respectively, and in gilts 7.66 kg and 4.12 kg, respectively. With almost the same weight of dressed carcasses, the belly in barrows accounted for a higher proportion, i.e. 9.96% compared to 9.56% in gilts. In terms of percentage the gilts had a statistically highly significantly higher proportion of meat in the EU belly, namely by 3.32% compared to barrows. At all points of measurement the higher total area of the belly section was found in barrows compared to gilts. A comparison of the percentage proportion of lean meat area in the total belly area at individual points of measurement indicated statistically significantly higher values in gilts than in barrows. It was confirmed that in the section area from point 1 to point 3 the deposition of fat in barrows was higher with the values of the meat area ranging from 58.15% to 56.09%. On the other hand, in gilts the differences between individual sections were very small: 61.25%, 61.99% and 61.49%.

Keywords: pig; belly; sex; meat percentage

In order to achieve the required higher proportion of lean meat in carcasses it is useful to focus on an increase in the proportion of meat in individual parts of carcasses. In this respect highly interesting seems to be the belly and its quality in terms of the meat : fat ratio. As compared to the other important parts of pig carcasses, in the belly there may be a significant difference in the ratio of lean meat and fat (Vališ *et al*., 2001).

Among the foreign authors, the extraordinary significance of belly meatiness was pointed out e.g. by Pfeiffer *et al*. (1993) and Schreinemachers *et al*. (1999). The lean meat proportion in the belly is an important criterion according to Schwerdtfeger *et al*. (1991).

The actual evaluation of the belly is rather complicated due to the intermixture of fat and lean. The application of some methods to the evaluation of the belly was dealt with e.g. by Baulain *et al*. (1998).

Pfuhl and Glodek (1996) pointed out to the fact that it was impossible to determine the belly meatiness on the basis of the total percentage of lean meat in the carcass (r = 0.53). The subjective evaluation of belly meatiness does not provide exact results either (r = 0.68).

In order to determine the meat : fat ratio in the area of the belly section Tholen *et al*. (1998) used the VIA method (video image analysis), evaluating this value in the area between the 13th and 14th rib. The method using an estimate by means of regression ranges in the interval of r = 0.61–0.81.

According to Sonnichsen *et al*. (2002) in the operational conditions the VIA method proves to be an exact method of estimating both the total propor-

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tion of lean meat and the proportion of lean meat in the belly.

The later studies of Schwerdtfeger *et al*. (1993) used the sections of the belly between 7th–8th, 10th–11th and 13th–14th ribs. The proportion of the meat:fat area was determined by means of the video image analysis. The content of fat in the belly was set on the basis of chemical analysis. The correlation coefficient between the proportion of lean meat in the belly found out by means of VIA and the chemically determined one was $r = 0.81–0.83$. At individual points of measurement the correlation coefficients had the value of $r = 0.37–0.72$, $r = 0.63–0.71$ and $r = 0.68–0.76$.

All qualities of the carcass value are markedly influenced by sex. The proportion of meat in the belly is not an exception either. Barrows show the lowest meatiness, young boars the highest one (Bruwe *et al*., 1991).

Koucký *et al*. (1993) monitored the influence of sex on the indicators of carcass value. The weight of the right half-carcass in the investigated group was 48.0, 47.8 and 45.8 kg, the percentage of lean meat 50.04%, 44.33% and 49.12%, the proportion of ham in the carcass 18.46%, 16.60% and 18.30%, the proportion of belly in the carcass 16.21%, 15.98% and 16.36%. The backfat thickness was 30.4, 33.9 and 28.6 mm, the area of loin meat was 3 910, 3 579 and 3 660 mm^2.

Čítek *et al*. (2001) found out a higher proportion of meat in the belly of gilts by 6.05% as compared to barrows, and with the increasing intensity of growth the meat : fat ratio decreased.

Vališ *et al*. (2001) found out that the proportion of lean meat in the belly determined by dissection at the slaughter weight of 100 kg was 58. 83 ± 1.102% in gilts and 55.21 ± 1.514% in barrows.

MATERIAL AND METHODS

The analysis of the belly was carried out in 193 slaughter pigs of final hybrids tested in 2000 to 2002 at a testing station of the Department of Pig and Poultry Science of the Agronomic Faculty of the Czech University of Agriculture in Prague. The pigs were slaughtered at the age of 166–175 days.

The slaughter pigs included in the test were fed according to the standards of the need of nutrients according to Šimeček *et al*. (2000) ad libitum in three phases with continuous transition to self-feeders Duräumat.

Complete feed mixtures (CFM) used in the tests were three-component mixtures consisting of wheat, barley, soybean meal and a feeding supplement (Table 1). Prior to the beginning of tests the components of the feed mixtures were analysed for the content of nutrients and based on the identified values feed mixtures were formulated in relation to the age and live weight of tested pigs. The feed mixtures were mixed for each pen separately according to the designed scheme of the test.

The pigs were penned according to the methodology for testing thoroughbred and hybrid pigs observing the principle of penning of animals in couples (barrow + gilt).

Belly dissection was made according to the EU methodology, separating the frontal part of the belly between the 4th and 5th rib, the anterior part of the belly was separated by a section made 4 cm caudally

Table 1. Feeding scheme

Nutrients in CFM	Feeding phase		
	>35 kg	35–65 kg	<60 kg
Crude protein (g/kg)	196.70	184.00	156.30
ME (MJ/kg)	13.30	13.20	12.90
Crude fibre (g/kg)	39.84	38.76	40.75
Lysine (g/kg)	11.40	10.20	8.30
Threonine (g/kg)	7.20	6.50	5.40
Methionine (g/kg)	3.20	2.90	2.40
Ca (g/kg)	7.20	6.80	6.10
P (g/kg)	5.50	5.40	4.60

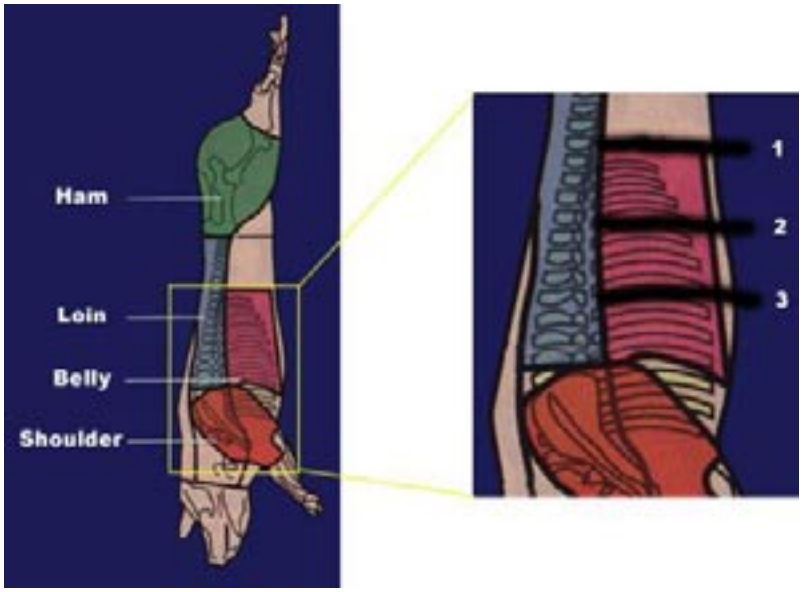

Figure 1. Estimation of the belly sections

behind the last rib first vertically and subsequently cranially close to the row of mammary gland ducts (Figure 1).

In order to evaluate the belly formation with the subsequent estimation of the proportion of lean meat in the belly, radiographs were made of the section of the EU belly at three points according to the methodology of Schwerdtfeger *et al*. (1993), namely section 1 behind the last rib, section 2 between the 10th and 11th rib and section 3 between the 7th and 8th rib. The LUCIA programme of the Laboratory Imaging Ltd. company was used to measure in sections 1, 2 and 3 the area of the belly (mm^2), the area of the lean meat (mm^2) and the ratio of lean meat in the section area of the belly to the total area of the belly (%).

Lean meat and its proportion in the belly were calculated from the equation according to Čítek (2002):

$$y = 42.63841413 + 0.24603687*PLPODIL2 - 3.43803239*HMEU - 0.00098125*PLCELK3 + 0.00254507*PLMASO3 + 0.00088281*PLMASO1$$

$r^2 = 0.857$

where: PLPODIL2 = the ratio of the area of lean meat to the total area of the belly at point of section 2 (%)

HMEU = weight of the belly dissected according to EU (kg)

PLCELK3 = total area of the belly at point of section 3 (mm^2)

PLMASO1 = the area of lean meat at point of section 1 (mm^2)

PLMASO3 = the area of lean meat at point of section 3 (mm^2)

Table 2. Evaluation of the belly according to sex

Indicator	Barrows			Gilts		
	n	$\bar{x} \pm s_{\bar{x}}$	s	n	$\bar{x} \pm s_{\bar{x}}$	s
Weight at the beginning of the test (kg)	95	24.1 ± 0.4	4.0	98	24.9 ± 0.4	4.1
Weight at the end of the test (kg)	95	107.6 ± 0.7	6.8	98	106.3 ± 0.7	6.5
Total daily weight gain within the test (g)	95	891[a] ± 10.0	96	98	864[a] ± 9.0	87

[a]$P < 0.05$

RESULTS AND DISCUSSION

In the introduction to the evaluation of the influence of sex on the formation of the belly in hybrid pigs Table 2 shows the evaluation of selected indicators of fattening performance. The weight of barrows at the beginning and at the end of the test feeding was 24.1 kg and 107.6 kg, respectively, and in gilts 24.9 kg and 106.3 kg, respectively. The weight recorded both at the beginning and at the end of the test was not statistically significant between the tested groups, although higher growth intensity was confirmed in barrows as compared to gilts. This fact is also documented by the achieved average daily gain during the test that was 891 ± 9.88 g in barrows and 864 ± 8.82 g in gilts. The resulting values may be considered as corresponding to the growth of final hybrids of pigs.

Table 3 and Figure 2 show the evaluation of the belly percentage in pig carcasses in relation to sex. It is evident that in the absolute values barrows achieve statistically significantly higher values as compared to gilts. The belly in total and the EU belly reached the weight of 7.85 kg and 4.35 kg, respectively, in barrows and 7.66 kg and 4.12 kg, respectively, in gilts. In percentage terms, mainly in the EU belly the barrows recorded statistically significantly higher values. With practically the same weight of pig carcasses the belly in barrows accounted for a higher proportion, i.e. 9.96% and 55.39%, as compared to 9.56% and 53.84% in gilts.

In the evaluation of the proportion of lean meat in the EU belly both sexes achieved almost identical values, i.e. 2.24 kg and 2.26 kg, respectively. In percentage the proportion of lean meat in the EU belly was statistically significantly higher in gilts, namely by 3.32% as compared to barrows. In the values of the proportion of lean meat in pig carcasses a higher proportion of lean meat was found in gilts as compared to barrows, 57.38% and 54.61%, respectively. These values do not correspond to the proportion of lean meat determined in the belly, the difference in both sexes was approx. 3%.

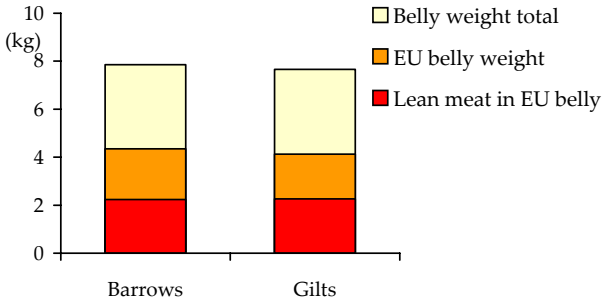

Figure 2. Belly characteristics with respect to sex

It can be stated on the basis of the results that barrows have a higher weight of the belly out of the pig carcasses as compared to gilts. On the other hand, gilts reach a higher proportion of lean meat. The same conclusions were drawn by William *et al*. (1990), Bruwe *et al*. (1991), Čítek *et al*. (2001), Vališ *et al*. (2001) and others.

Table 4 and Figures 3 and 4 summarize the results of measurements of the area of the belly on

Table 3. Evaluation of the belly in pig carcasses in relation to sex

Indicator	Barrows			Gilts		
	n	$\bar{x} \pm s_{\bar{x}}$	*s*	*n*	$\bar{x} \pm s_{\bar{x}}$	*s*
Belly weight, total (kg)	95	$7.85^{a} \pm 0.07$	0.68	98	$7.66^{a} \pm 0.06$	0.55
Total belly proportion in the right half-carcass (%)	95	17.98 ± 0.12	1.21	98	17.76 ± 0.10	0.95
EU belly weight (kg)	95	$4.35^{A} \pm 0.04$	0.41	98	$4.12^{A} \pm 0.04$	0.40
EU belly proportion in the right half-carcass (%)	95	$9.96^{A} \pm 0.09$	0.83	98	$9.56^{A} \pm 0.08$	0.78
EU belly proportion in the total belly (%)	95	$55.39^{A} \pm 0.30$	2.90	98	$53.84^{A} \pm 0.34$	3.40
Lean meat in EU belly (kg)	95	2.24 ± 0.02	0.22	98	2.26 ± 0.02	0.23
Lean meat proportion in EU belly (%)	95	$51.61^{A} \pm 0.45$	4.38	98	$54.93^{A} \pm 0.32$	3.20
Lean meat proportion in pig carcasses (%)	95	$54.61^{A} \pm 0.39$	3.80	98	$57.38^{A} \pm 0.38$	3.78

$^{A}P < 0.01$, $^{a}P < 0.05$

Table 4. Evaluation of the belly in pig carcasses in relation to sex

Indicator	Barrows			Gilts		
	n	$\bar{x} \pm s_{\bar{x}}$	*s*	*n*	$\bar{x} \pm s_{\bar{x}}$	*s*
Total area of belly on section 1 (mm^2)	95	8 796 ± 123	1 200	98	8 495 ± 108	1 066
Total area of belly on section 2 (mm^2)	95	11 261^A ± 151	1 472	98	10 417^A ± 141	1 393
Total area of belly on section 3 (mm^2)	95	12 266^A ± 159	1 553	98	11 466^A ± 138	1 367
Total belly area (points 1–3 average) (mm^2)	95	10 775^A ± 121	1 180	98	10 126^A ± 116	1 150
Lean meat area on section 1 (mm^2)	95	5 099 ± 86	833	98	5 173 ± 69	678
Lean meat area on section 2 (mm^2)	95	6 375 ± 118	1 150	98	6 462 ± 108	1 071
Lean meat area on section 3 (mm^2)	95	6 873 ± 112	1 094	98	7 034 ± 96	954
Lean meat area (points 1–3 average) (mm^2)	95	6 116 ± 90	872	98	6 223 ± 81	803
Proportion of meat area in the total area on section 1 (%)	95	58.15^A ± 0.70	6.80	98	61.25^A ± 0.69	6.83
Proportion of meat area in the total area on section 2 (%)	95	56.74^A ± 0.84	8.21	98	61.99^A ± 0.59	5.81
Proportion of meat area in the total area on section 3 (%)	95	56.09^A ± 0.64	6.22	98	61.49^A ± 0.59	5.79
Proportion of meat area in the total area (points 1–3 average) (%)	95	56.84^A ± 0.63	6.17	98	61.53^A ± 0.50	4.92

$^A P < 0.01$

individual sections. At all points of measurement the total area of the belly was higher in barrows than in gilts. Taking the total area of the belly in gilts as 100%, then barrows achieved the area from point 1 to point 3 of 103.5%, 108.1% and 107%. The increase in the area in barrows ranged between 8 796 ± 123 mm^2 and 12 266 ± 159 mm^2 and in gilts between 8 495 ± 108 mm^2 and 11 466 ± 138 mm^2. If the total area of the belly at point of measurement 1 is 100%, then the other areas reached the values of 128%, 139.4% in barrows and 122.6%, 135% in gilts. The values measured at points 2 and 3 were statistically highly significant.

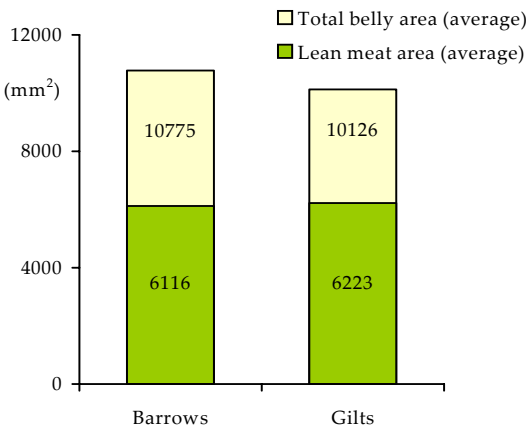

Figure 3. Belly characteristics with respect to sex

When assessing the composition of the belly according to the meat-fat percentage in relation to sex, it is evident that the formation of this meat part differs. The trend of the formation of lean meat in the belly as compared to the total area is opposite and slightly higher values at all three monitored points of measurement were achieved by gilts, namely 5 173 mm^2, 6 462 mm^2, 7 034 mm^2, barrows 5 099 mm^2, 6 375 mm^2 and 6 873 mm^2. It is evident that there were statistically insignificant differences in the meat formation between gilts and barrows at all three monitored points. The comparison of the percentage proportion of the lean meat area with the total area of the belly at individual points of measurement showed that statistically significantly higher values were achieved by gilts as compared to barrows, namely at point 1 by 3.1%, at point 2 by 5.25% and at point 3 by 5.4%. It was confirmed that the fat deposition was higher between point 1 and point 3. This trend was marked mainly in barrows with the values ranging between 58.15% and 56.09%. On the other hand, in gilts the differences

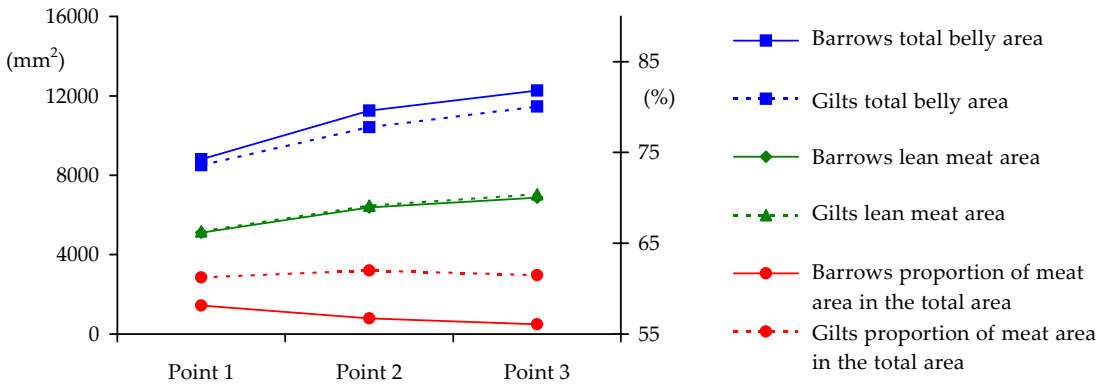

Figure 4. Comparison of belly area with respect to sex

between individual points were very small, namely 61.25%, 61.99% and 61.49%, which proves a relatively even deposition of lean meat and fat in the whole belly. In accordance with Čítek (2002) it may be deduced that the difference in the higher total weight of the belly in barrows as compared to gilts is caused in barrows by an increased fat formation with almost the same total formation of lean meat in this part. It was also proved that gilts deposited lean meat in the belly more evenly, while in barrows the formation of lean meat and fat along the belly is uneven and there is a marked decrease from point 1 to point 3.

The comparison of the percentage proportion of the lean meat area with the total area of the belly at individual points of measurement showed that statistically significantly higher values were achieved by gilts as compared to barrows.

Higher fat deposition from point 1 to point 3 was confirmed in barrows with the values of the lean meat area ranging between 58.15% and 56.09%. By contrast, gilts showed only very small differences between individual points, namely 61.25%, 61.99% and 61.49%, which documents a relatively even deposition of meat and fat in the whole belly.

CONCLUSION

The belly in total and the EU belly in barrows reached the weight of 7.85 kg and 4.35 kg, respectively, and in gilts 7.66 kg and 4.12 kg, respectively.

In barrows the belly accounted for a higher proportion with almost the same weight of pig carcasses, i.e. 9.96% as compared to 9.56% in gilts.

As concerns the percentage of lean meat in the belly, hardly any differences were found between barrows and gilts. Barrows achieved 2.24 kg, gilts 2.26 kg of lean meat in the belly. As a result the higher proportion of the belly in the pig carcasses was caused in barrows by the higher percentage of fat.

In terms of percentage gilts had a statistically significantly higher proportion of lean meat in the EU belly, namely by 3.32%, as compared to barrows.

At all points of measurement a higher total area of belly was found in barrows as compared to gilts.

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ABSTRAKT

Analýza utváření masné partie bok ve vztahu k pohlaví

Cílem práce bylo provést analýzu utváření masné partie bok ve vztahu k pohlaví. K analýze bylo celkem použito 193 kusů jatečných prasat, běžně používaných finálních hybridů v ČR. Prasata byla poražena ve věku 166 až 175 dní. Pro posouzení utváření boku s následným stanovením odhadu podílu svaloviny v jatečném boku bylo využito VIA metody dle metodiky Schwerdtfegera *et al*. (1993). Vlastní výpočet svaloviny a jejího podílu v boku byl proveden na základě rovnice dle Čítka (2002). Bok celkem i bok EU dosáhl u vepříků hmotnosti 7,85 kg resp. 4,35 kg a u prasniček 7,66 kg resp. 4,12 kg. U vepříků tvořil bok při prakticky shodné hmotnosti JUT vyšší podíl, tedy 9,96 % oproti 9,56 % u prasniček. V procentuálním vyjádření měly prasničky statisticky vysoce významně vyšší podíl masa v boku EU, a to o 3,32 % oproti vepříkům. Ve všech místech měření byla zjištěna vyšší celková plocha řezu boku u vepříků oproti prasničkám. Při porovnání procentuálního podílu plochy masa k celkové ploše boku v jednotlivých místech měření bylo zjištěno, že statisticky průkazně vyšší hodnoty dosáhly prasničky oproti vepříkům. Potvrdilo se, že u plochy řezu od místa 1 do místa 3 dochází u vepříků k vyššímu ukládání tuku, kde byly zjištěny hodnoty plochy masa od 58,15 % po 56,09 %. Naproti tomu u prasniček byly rozdíly mezi jednotlivými řezy jen velmi malé – 61,25 %, 61,99 % a 61,49 %.

Klíčová slova: prase; bok; pohlaví; podíl masa

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