Pig carcass quality in relation to carcass lean meat proportion

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ABSTRACT: The objective of the study was to quantify differences in the carcass composition of pig carcasses with different lean meat proportions. Totally 132 carcasses with lean meat proportions ranging from 45 to 65% were analysed. The average lean meat proportion in the analysed set of carcasses was 55.38% (s = 4.319). The carcasses were classified into the groups according to their lean meat proportion (R, 45.0 to 49.9%; U, 50.0 to 54.9%; E, 55.0 to 59.9%; S, more than 60.0%). Carcasses from each group were cut into primal cuts and the main cuts (leg, loin, shoulder and belly with bones) were further separated into different tissues. Carcass value was markedly enhanced by the increasing carcass lean meat proportion. Average leg percentages in the groups R, U, E and S were 17.88% (s = 0.918), 19.32% (s = 0.889), 20.88% (s = 0.817) and 21.88% (s = 0.827), respectively. Average proportions of fat over leg expressed as percentages of leg weight in these groups were 5.82% (s = 0.402), 4.87% (s = 0.556), 4.05% (s = 0.479) and 3.21% (s = 0.321), respectively. Lean meat proportions of leg weight were improved from 84.93% (s = 1.136) in the group R to 88.12% (s = 0.986) in the group S. The most distinct differences were found in lean proportions of belly weight. The observed averages in the group R and S were 43.90% (s = 2.729) and 62.10% (s = 2.219), respectively. Actually, in carcasses with a high classification score the belly can be considered as a cut with the predominant muscle tissue. The results of the study proved the efficiency of carcass evaluation based on the lean meat proportion. Such a method can significantly contribute to the overall improvement of pig production.

Keywords: pig; carcass; lean meat proportion; evaluation

Pig carcass quality determination is based on the demand to evaluate carcasses as quickly as possible at the time of sale as it is required by economic relationships between the supplier of slaughter animals and the processing industry. This problem could not be satisfactorily solved until the methods determining lean meat proportions in whole pig carcasses were introduced in the EU countries. More accurate carcass evaluation would have to be based on determination of individual cut percentages as the importance of different cuts for further processing is highly variable. Thus, it is logical that in this case the final information on pig carcass quality would be based on yields of high priced and low priced cuts. Such information can only be obtained with a certain delay after slaughter and it is quite a labour-consuming process.

Determination of lean meat proportion in the whole carcass is therefore the only method used in standard practice of the meat processing industry. Its employment has benefits for business relations between suppliers and processors and particularly for satisfying consumers' requirements. Such an assessment of final product quality is generally beneficial for further improvement of pig production (Matoušek et al., 1995). As indicated by Pulkrábek et al. (1999), pig meatiness in the Czech Republic had been markedly improved even before the system was introduced and when its application in standard practice was only in the phase of consideration. The methods of carcass lean meat estimation were mostly elaborated by German researchers (Sack, 1982; Branscheid et al., 1987; Oster et al., 1987). Afterwards, this problem was investi-

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gated by Engel and Walstra (1991), Branscheid et al. (1992), Daumas et al. (1998) and others. In the Czech Republic, the first study dealing with this research topic was that of Pulkrábek et al. (1994).

In the course of time, the apparatus used for the above-mentioned methods of pig carcass quality evaluation has been improved as well as the approaches of pig breeding and hybridization which resulted in the production of high-quality final hybrids.

It reflects a continual necessity to adjust and improve the used evaluation techniques (Login et al., 1995; Pulkrábek and Pavlík, 2003) and particularly regression equations used for different methods. The development of these equations is based on the results of detailed carcass analyses. The set of analysed carcasses should represent a particular geographic area and a specific period of time.

The objective of the present study was to quantify the changes in pig carcass composition in carcasses with different lean meat proportions. The carcass composition was described by percentages of different carcass cuts. In addition, the most important cuts were analysed with respect to their lean meat content.

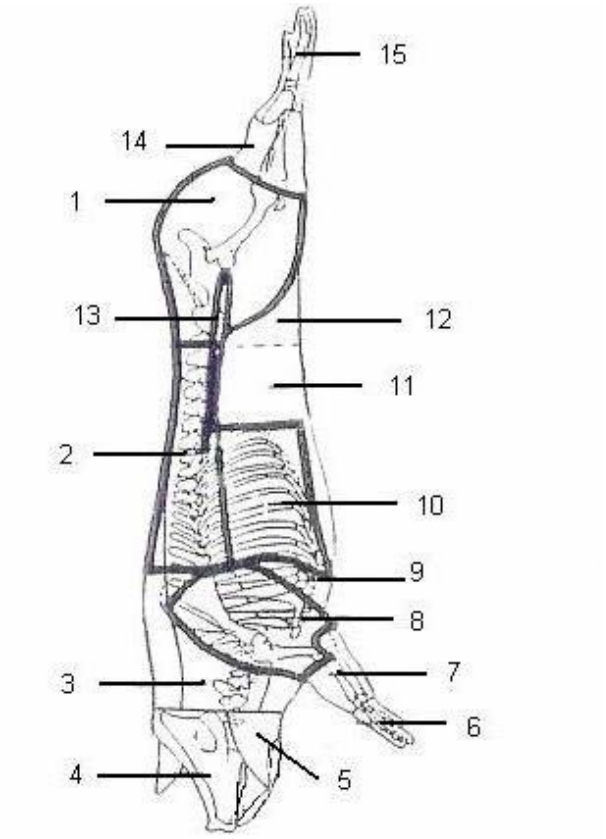

Figure 1. Scheme of carcass dissection

1– Leg; 2 – Loin; 3 – Neck; 4 + 5 – Head + cheek; 6 + 7 – Front shank + front foot; 8 – Shoulder; 9 – Jawl; 10 – Belly with bones; 11– Ventral part of belly; 12 – Tenderloin; 14 + 15 – Hind shank + hind foot

MATERIAL AND METHODS

Totally 132 pig carcasses were included in the analysis. The carcasses originated from final hybrids of crossbreeding combinations commonly used in the Czech Republic. Crossbred sows Large White × Landrace were always used as dams which were sired by purebred or crossbred boars from populations originally imported from the United States, Belgium and Great Britain. The animals used in the experiment were fattened under conditions common in the Czech pig production. They were slaughtered and carcass analyses were carried out in a single abattoir.

After slaughter, carcass weights were recorded and some measures characterising carcass length, number of vertebrae, backfat thickness and back muscle development were taken. Afterwards, the carcasses were divided into primal cuts and the carcass lean meat proportion was determined according to the method described by Walstra and Merkus (1995). The schema of carcass dissection is illustrated in Figure 1. Different cuts were expressed as proportions of carcass weight. In addition, compositions of leg, loin, shoulder and belly with bones were analysed and lean meat proportions were calculated as percentages of their weights.

The carcasses were classified into different groups according to their lean meat proportions which generally ranged from 45.6% to 64.8%. The total range of lean meat proportions in the analysed carcasses was used when determining the number of groups. The carcasses were classified into four groups (S, E, U and R) with the following intervals of lean meat percentage:

S – more than 60.0%
E – 55.0 to 59.9%
U – 50.0 to 54.9%
R – 45.0 to 49.9%

In comparison with the basic scale used in the European Union, the scale used in the present study does not take into account the two classes used for carcasses with the lean meat proportion below 45.0%. It is related to the fact that the introduc-

Table 1. Carcass measurements

Trait	Carcass lean meat proportion (%)							
	45.0 to 49.9 n = 15		50.0 to 54.9 n = 48		55.0 to 59.9 n = 51		more than 60.0 n = 18	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Carcass length 1 (mm)	995.0[a]	51.962	985.1[a]	40.277	991.4[a]	42.884	985.8[a]	43.933
Carcass length 2 (mm)	834.7[a]	42.150	830.7[a]	31.708	839.2[a]	33.621	828.9[a]	35.668
Number of thoracic and lumbar vertebrae	21.33[a]	0.724	21.46[a]	0.617	21.47[a]	0.542	21.38[a]	0.698
MLLT area (mm^2)	4523[a]	779.9	4697[b]	613.3	5124[c]	586.9	5393[d]	554.8
Fat thickness 1 (over 2nd thoracic vertebra; mm)	42.9[a]	5.317	38.3[b]	4.221	34.2[c]	3.372	31.8[d]	4.292
Fat thickness 2 (over the last thoracic vertebra; mm)	27.3[a]	3.575	24.1[b]	4.191	20.4[c]	4.517	17.7[d]	4.715
Fat thickness 3 (over 1st sacral vertebra; mm)	25.9[a]	4.832	20.8[b]	4.299	17.4[c]	4.262	12.6[d]	4.258
Average fat thickness (mm)	32.0[a]	3.688	27.7[b]	3.075	24.0[c]	3.315	20.7[d]	3.850

Carcass length 1: from the cranial edge of *symphysis pelvina* to the cranial edge of atlas; carcass length 2: from the cranial edge of *symphysis pelvina* to the greatest arch of the first rib (*costa I*); differences in means marked with the same letters are not significant ($P > 0.05$)

tion of new methods for pig carcass evaluation has already resulted in a considerable improvement of carcass quality. At present, it is impossible to obtain sufficiently numerous pig carcasses classified into the two groups with the poorest quality used in the EU countries. It is evidenced by the study of Pulkrábek and Pavlík (2003) where the carcasses included in these two groups represented only 1% of all the classified carcasses. Statistical analyses were performed using the PROC. MEANS and the PROC.GLM of SAS (SAS, 2001).

RESULTS AND DISCUSSION

At first, basic parameters commonly used in the pig carcass evaluation are given. The average carcass weight and lean meat proportion were 90.8 kg (s = 10.467) and 55.38% (s = 4.319), respectively. It is widely in agreement with Pulkrábek et al. (2003), who reported that the average carcass weight and lean meat proportion of 37 716 pigs fattened under common production conditions were 91.7 kg (s = 13.01) and 54.36% (s = 4.273), respectively. Thus, we may state that the set of carcasses used for the analysis corresponded to the present pig population in the Czech Republic (Čechová and Mikule, 2004).

From the analysed set of carcasses, 11.4% were included in the group R with lean meat proportion ranging from 45.0 to 49.9%. The other groups in ascending order were represented by 36.4, 38.6 and 13.6% of carcasses, respectively.

Table 1 shows some dimensions measured on carcasses. These rather auxiliary measurements were previously used as a part of more simple methods of pig carcass evaluation. No significant differences between the groups were found in carcass length and in the number of thoracic and lumbar vertebrae. It was clearly confirmed that these measurements were in no relationship with the parameters of pig carcass meatiness. They were discussed in the past when the meaty type of pigs was not as explicitly differentiated as it is at present. Longer carcasses of Landrace pigs yielded more meat in comparison with most populations used at that time (Pavlík, 1985).

On the other hand, the means of the remaining measures differed significantly. It particularly concerns fat thickness measured over the first sacral vertebra which was reduced by 50% in the group S in comparison with R.

The results of carcass analyses are given in Table 2 and shown in Figure 2. In agreement with Branscheid et al. (1987) and Oster et al. (1987), the carcass lean meat proportion proved its usability

Table 2. Percentage of different carcass cuts

Percentage of carcass weight (%)	Carcass lean meat proportion (%)							
	45.0 to 49.9 n = 15		50.0 to 54.9 n = 48		55.0 to 59.9 n = 51		more than 60.0 n = 18	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Leg	17.88^{a}	0.918	19.32^{b}	0.889	20.88^{c}	0.817	21.88^{d}	0.827
Fat cover from leg	5.82^{a}	0.402	4.87^{b}	0.556	4.05^{c}	0.479	3.21^{d}	0.321
Loin	10.93^{a}	0.588	11.77^{b}	0.553	12.58^{c}	0.592	13.28^{d}	0.735
Backfat	5.81^{a}	0.621	5.14^{b}	0.691	3.93^{c}	0.636	3.19^{d}	0.550
Shoulder	10.16^{a}	0.494	10.74^{b}	0.533	11.25^{c}	0.606	11.86^{d}	0.673
Fat cover from shoulder	2.95^{a}	0.423	2.70^{b}	0.347	2.26^{c}	0.330	1.82^{d}	0.295
Tenderloin	1.26^{a}	0.098	1.35^{b}	0.135	1.53^{c}	0.127	1.60^{c}	0.107
Neck	7.43^{a}	0.471	7.63^{b}	0.474	7.86^{c}	0.430	8.15^{d}	0.431
Neckfat	2.04^{a}	0.231	1.60^{b}	0.307	1.32^{c}	0.290	1.08^{d}	0.246
Belly with bones	10.74^{a}	0.869	10.25^{b}	0.862	10.02^{bc}	0.715	9.74^{c}	0.821
Jawl	3.19^{a}	0.363	3.32^{a}	0.502	3.31^{a}	0.427	3.22^{a}	0.362
Ventral part of belly	4.19^{a}	0.586	3.87^{b}	0.558	3.77^{b}	0.562	3.64^{b}	0.669
Head	5.57^{a}	0.449	4.58^{a}	0.537	4.51^{a}	0.413	4.81^{a}	0.497
Cheek	3.70^{a}	0.349	3.59^{a}	0.382	3.50^{a}	0.383	3.28^{b}	0.369
Shanks	4.72^{a}	0.224	4.80^{ab}	0.340	4.90^{bc}	0.301	5.02^{c}	0.259
Feet	2.19^{a}	0.168	2.18^{a}	0.167	2.17^{a}	0.175	2.22^{a}	0.224
To ventral part of belly	2.42^{a}	0.255	2.29^{ab}	0.284	2.16^{bc}	0.369	2.00^{c}	0.207

Differences in means marked with the same letters are not significant ($P > 0.05$)

for determination of carcass quality. This fact is particularly related to high priced cuts from pig carcasses. Their percentage regularly increased together with the carcass lean meat proportion. Logically, proportions of the fat cover over these cuts were reduced. All the differences between groups were statistically significant. To quantify the results, it can be concluded that percentages of

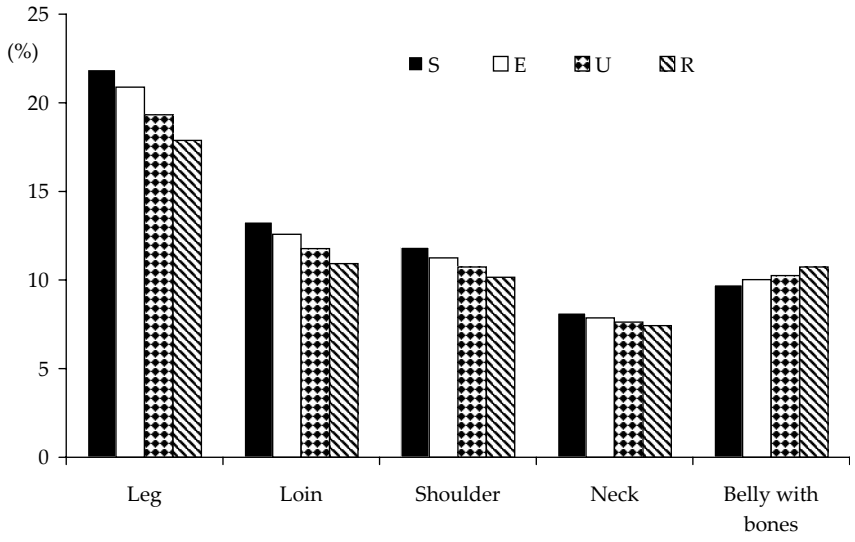

Figure 2. Percentage of the carcass weight of different cuts according to classes S, E, U and R

Table 3. Lean meat proportions in leg, loin, shoulder and belly with bones

Lean meat proportion (%)	Carcass lean meat proportion (%)							
	45.0 to 49.9 n = 15		50.0 to 54.9 n = 48		55.0 to 59.9 n = 51		more than 60.0 n = 18	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
– in leg	84.93[a]	1.136	86.30[b]	0.973	87.27[c]	0.975	88.12[d]	0.986
– in loin	72.90[a]	2.324	75.84[b]	1.981	78.29[c]	2.031	80.52[d]	1.832
– in shoulder	76.99[a]	2.444	78.64[b]	2.145	80.68[c]	2.152	81.86[d]	1.705
– in belly with bones	43.90[a]	2.729	49.31[b]	3.049	55.65[c]	3.104	62.10[d]	2.219

Differences in means marked with the same letters are not significant ($P > 0.05$)

leg, loin and shoulder in the group R compared to the group S were increased by 4.00, 2.35 and 1.70%, respectively. Similar tendencies were also observed in the other cuts with a high content of lean meat (tenderloin). On the other hand, fat percentages from leg, loin and shoulder were reduced by 2.61, 2.62 and 1.13%, respectively.

Different conclusions resulted from the evaluation of cuts with higher contents of intermuscular and subcutaneous fat. The most important of them are the three parts of belly, i.e. belly with bones, belly without bones – ventral part of belly and tip of belly – jawl. They represent a relatively great part of carcass mostly exceeding one sixth of the total weight. In comparison with the above discussed meaty parts of carcass, their weight percentages tended to decrease with the growing carcass lean meat proportion. However, differences between the groups were rather small and insignificant. The proportion of belly with bones was similar to that reported by Höreth (1995), who analyzed proportions of different cuts in dependance on total meat yield.

No significant differences between the groups were found in the other cuts. Similarly to the meaty parts, percentages of the cuts consisting mostly of bones (head, feet) tended to increase but the differences were very small.

Table 3 shows lean meat proportions in leg, loin, shoulder and belly with bones. It was confirmed that the composition of these cuts was improved by the increasing proportion of carcass lean meat. The greatest difference in lean meat proportions between group R and S was observed in belly with bones (43.90 and 62.10%, respectively). It refers to a considerable variability of the lean meat to fat ratio which is important for further utilisation of belly in the meat processing industry. The same conclusions were reported by Pfeiffer et al. (1993) and Baulain et al. (1998).

The results of the present study indicate considerable differences in pig carcass quality and confirm the efficiency of carcass evaluation based on the lean meat proportion. This evaluation method represents an important motivation element contributing to the improvement of pig production.

REFERENCES

Baulain U., Henning M., Tholen E., Wittmann W., Peschke W. (1998): Objektive Erfassung des Fleischanteils im Schweinebauch. Züchtungskunde, *70*, 205–212.

Branscheid W., Komender P., Oster A., Sack E., Fewson D. (1987): Utersuchungen über die Eignung einzelner Slachtkörpermesse und Messstellenkombinationen für die Klassifizierung von Schweinehälften nach dem Muskelfleischanteil. Züchtungskunde, *59*, 258–267.

Branscheid W., Dobrowolski A., Höreth R. (1992): Die neue Handelklasseneinstufung von Schweinehälften unter Praxisverhältnissen. Fleischwirtschaft, *72*, 1–3.

Čechová M., Mikule V. (2004): The analysis of carcass value in pigs of different genotypes. Czech J. Anim. Sci., *49*, 383–388.

Daumas G., Causeur D., Shodne T., Schollhammer E. (1998): Les méthodes de classement des carcasses de porc autorisées en France en 1997. J. Rech. Porcine France, *30*, 1–6.

Engel B., Walstra P. (1991): A simple method to increase precision or reduce expense in regression experiments to predict the proportion of lean meat of carcasses. Anim. Prod., *53*, 353–359.

Höreth R. (1995): Zusammensetzung von Schweineschlachtkörpern und der Anteil der Teilstücke nach Änderung der 4./6. DVO. Mitt.-Bl. BAFF, *34*, 5–12.

Login L., Bencová E., Chudý J., Pavlovič M. (1995): Objective approach to slaughter pig classification in the Slovak Republic (in Czech). Živoč. Výr., *40*, 369–373.

Matoušek V., Kernerová N., Václavovský J., Vejčík A. (1995): Aparativní třídění jatečných těl hybridních prasat. In: Sbor. JČU, ZF, České Budějovice, řada zootechnická, 1–12.

Oster A., Fewson D., Komender P., Branscheid W., Sack E. (1987): Schätzung des Muskelgewebeanteils beim Schwein aufgrund Forchheimer Teilstückzerlegung sowie üblicher Schlachtkörpermasse. Züchtungskunde, *59*, 281–295.

Pavlík J. (1985): Genetická hlediska při využívání produkčních znaků prasat v hybridizačním programu. Monografie, VŠZ, Praha. 1–178.

Pfeiffer H., Brendel B., Lengerken G. (1993): Zur Bewertung der Bauchqualität beim Schwein. Arch. Tierz., Dummerstorf, *36*, 397–407.

Pulkrábek J., Pavlík J. (2003): The method of partial dissection for determination of lean meat proportion in pig carcasses. Scientia Agric. Bohemica, *34*, 55–57.

Pulkrábek J., Fiedler J., Smital J., Houška L., Adamec T. (1994): Tissue percentages in the side of pork of pig breeds raised in the Czech Republic (in Czech). Živoč. Výr., *39*, 743–751.

Pulkrábek J., Pavlík J., Smital J. (1999): Progressive tendency of lean – meat percentage in carcasses of pigs in the Czech Republic. Scientia Agric. Bohemica, *30*, 231–237.

Pulkrábek J., Pavlík J., Vališ L., Čechová M. (2003): Pig carcass classification based on the lean meat content. In: Sbor. MZLU, Brno, *51*, 109–113.

Sack E. (1982): Apparative Klassifizierung Beitrag zum Schlachtwert von Schweinen. Kulmbach, 42–73.

SAS (2001): Release 8.2 (TS2MO) of the SAS® System for Microsoft® Windows®. SAS Institute Inc., Cary, NC.

Walstra P., Merkus G.S.M. (1995): Procedure for assessment of the lean meat percentage as a consequence of the new EU reference dissection method in pig carcass classification. DLO – Research Institute for Animal Science and Health Research Branch, Zeist, The Netherlands. 22 pp.

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