The effect of sex and slaughter weight on intramuscular fat content and its relationship to carcass traits of pigs

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ABSTRACT: Carcass quality and intramuscular fat content of castrates and gilts are compared and a possible dependence of intramuscular fat content on sex and slaughter weight is determined in the pig population of the Slovak Republic. A total of 129 pigs of three different genotypes were included in the experiment. After slaughter, the carcasses were weighed and backfat thickness was measured. On the next day, carcass dissection described by Walstra and Merkus (1995) was determined. Four prime cuts (shoulder, loin, ham and belly) were further dissected to meat, bones and fat with skin. Intramuscular fat content was analysed in a laboratory from the samples (100 g) of *musculus longissimus dorsi*. The results were statistically analysed using SAS/STAT and a linear model was used to find the dependence of intramuscular fat content. Correlation coefficients between carcass traits and intramuscular fat were also calculated. Sex of pigs, and particularly weight of lean meat and weight of fatty parts had a significant effect on intramuscular fat content ($P < 0.0001$ and $P = 0.0022$) while no effect of the genotype and slaughter weight was observed. Significant differences between castrates and gilts were found in almost all observed traits, e.g. average backfat thickness (29.01 vs. 25.56 mm), percentage of meat (52.77 vs. 57.68%), intramuscular fat content (2.49 vs. 2.00%). Generally, the intramuscular fat in the pig population is not sufficient (2.25%), therefore it would be desirable to include this trait in selection strategies in pig breeding.

Keywords: pig; carcass; intramuscular fat; sex; slaughter weight; correlations

Selection strategies focused on increased lean meat content have caused a reduction not only in subcutaneous fat thickness but also in intramuscular fat content (Schwörer et al., 1995). It has had an undesirable impact on the eating quality of pork because it decreased its sensory properties such as juiciness, tenderness, taste (Hertzmann et al., 1988; Barton-Gade, 1990; Gispert et al., 1990).

In the last years, intramuscular fat content has become an important indicator of meat quality and in many countries the consumers demand fresh pork of high quality (colour, taste, water-holding capacity, tenderness) (Kaufmann and Warner, 1993). The recommended intramuscular fat content to meet consumer demands ranges from 2.0 to 4.0% (Verbeke et al., 1999). The majority of the authors concluded that poorer sensory quality traits were associated with the intramuscular fat content below 2.5% (Enser and Wood, 1991; Fernandez et al., 1999).

As shown by the results of investigations, the intramuscular fat content depends on various factors – breed type, slaughter weight, sex of pigs. However, the careful study of available literature brings about contradictory results. Some authors reported a significant effect of sex, slaughter weight or breed type on intramuscular fat content (Cameron et al., 1990; Edwards et al., 1992; Oliver et al., 1994; Čandek-Potokar et al., 1998; Brewer et al., 2002; Latorre et al., 2003), whereas the others did not (Cisneros et al., 1996; Enfält et al., 1997; Hamilton et al., 2000; Faucitano et al., 2004; Latorre et al., 2004). These discrepancies might be due to different conditions of single experiments, comparing the genotypes more or less differing from each other in the deposition and distribution of intramuscular fat in muscles. The effect of nutrition could also play an important role in different intramuscular fat content.

The aim of this study was to compare the carcass quality and intramuscular fat content of castrates and gilts and to determine a possible dependence of intramuscular fat content on sex, live weight and/or breed combination in commercially produced pigs in the Slovak Republic.

MATERIAL AND METHODS

A total of 129 pigs of three different genotypes were included in the experiment. They originated from the crossing of sows of White Meaty breed and purebred or crossbred boars of Landrace (n = 32), Hampshire × Pietrain (n = 80) and Yorkshire × Pietrain (n = 17) breeds. Pigs were housed in conditions of an experimental test station and fed a commercial feed mixture. They were slaughtered at average live weight 108.0 kg in an experimental abattoir of RIAP. After slaughter, the carcasses were weighed and backfat thickness was measured. On the next day, carcass dissection described by Walstra and Merkus (1995) was determined. Four prime cuts (shoulder, loin, ham and belly) were further dissected to meat, bones and fat with skin. Afterwards, percentages of lean meat and fatty parts were calculated. The following carcass traits were analysed:

Slaughter weight – SW (kg)
Carcass weight – CW (kg)
Weight of half-carcass – HC (kg)
Backfat thickness – BF, mm – given as the average of three measurements (above the second and the last thoracic vertebra, and above the first sacral vertebra)
Weight of meat from shoulder – SHD (kg)
Weight of meat from loin – LOIN (kg)
Weight of meat from ham – HAM (kg)
Weight of meat from belly – BELLY (kg)
Weight of tenderloin – TEND (kg)
Weight of meat (MEAT) – (from shoulder, loin, ham, belly and tenderloin) (kg)
Percentage of meat from carcass weight – PMEAT (%)
Weight of fatty parts (FAT) – (weight of intermuscular and subcutaneous fat with skin from shoulder, loin, ham, belly and tenderloin and of flare fat) (kg)
Percentage of fatty parts from carcass weight – PFAT (%)
Intramuscular fat content – IMF (%)

Intramuscular fat content was analysed in a laboratory from the samples (100 g) of *musculus longissimus dorsi* taken twenty-four hours after slaughter at the level of the last rib by Infratec (Germany).

The results were statistically analysed using SAS/STAT (2002–2003), procedure MEANS was used to calculate basic statistical characteristics, procedure CORR was applied for the calculation of Pearson correlation coefficients. Based on the results of procedure REG the following linear model was used:

$$y_{ij} = SEX_i + b_{1(i)} (MEAT_{ij} – MEAT_{ij}) + b_{2(i)} (FAT_{ij} – FAT_{ij}) + e_{ij}$$

Table 1. Basic statistics in the whole set (n = 129)

Trait	Mean	SD	s_e	v (%)	Min – Max
SW (kg)	107.92	10.48	0.74	9.71	90.0–126.0
CW (kg)	87.73	7.48	0.66	8.53	74.0–102.0
HC (kg)	43.60	3.58	0.32	8.21	37.05–50.55
BF (mm)	27.36	5.22	0.46	19.08	16.67–39.67
SHD (kg)	3.98	0.49	0.04	12.22	3.03–5.34
LOIN (kg)	3.82	0.58	0.05	15.08	2.69–5.66
HAM (kg)	7.68	1.02	0.09	13.25	5.80–10.25
BELLY (kg)	2.43	0.35	0.03	14.28	1.78–3.42
TEND (kg)	0.58	0.10	0.01	16.45	0.31–0.82
MEAT (kg)	18.49	2.15	0.19	11.65	14.18–24.04
PMEAT (%)	55.13	4.54	0.40	8.23	45.63–66.37
FAT (kg)	8.60	1.98	0.17	23.05	4.33–14.24
PFAT (%)	19.69	4.06	0.36	20.62	11.04–29.79
IMF (%)	2.25	0.68	0.06	30.17	1.10–4.30

where:

y_{ij} = dependent variable IMF

SEX_i = fixed effect of sex (gilts or castrates), i = 1, 2

$b_{1(i)}$ = regression coefficient on meat content nested within sex

$b_{2(i)}$ = regression coefficient on fat content nested within sex

e_{ij} = random error N (0, δ^2_{ij})

RESULTS AND DISCUSSION

Basic statistics for carcass traits in the whole set are given in Table 1. The average percentage of lean meat (PMEAT) was 55.13% at carcass weight (CW) 87.73 kg. Pulkrábek et al. (2006) reported very similar results from the evaluation of carcass value of final hybrids commonly produced in the Czech Republic (55.38% lean meat content at 90.8 kg carcass weight). The average backfat thickness (BF) of pigs in our experiment reached 27.36 mm. The average content of intramuscular fat (IMF) was 2.25%. The highest coefficients of variation were found for IMF, FAT (weight of fatty parts) and PFAT (percentage of fatty parts) (30.17, 23.05 and 20.62%, respectively). Faucitano et al. (2005) reported lower IMF content in pigs of three different genotypes (1.22–2.01%).

Considerable differences between castrates and gilts were observed in almost all carcass traits (Table 2). Compared to castrates gilts had significantly higher weight of meat from the four prime cuts (shoulder, loin, ham and belly) resulting in higher PMEAT (57.68 vs. 52.77%). However, castrates produced more subcutaneous fat. Average BF, FAT and PFAT of castrates were significantly higher than those of gilts (29.01 vs. 25.56 mm, 9.57 vs. 7.55 kg and 21.79 vs. 17.43%, respectively). The results are in agreement with previous reports on sex differences (Larzul et al., 1997; Tischendorf et al., 2002; Cassady et al., 2004). However, Mohrmann et al. (2006) did not find any significant differences between the sexes (gilts and barrows), but gilts tended to have higher lean meat content. Our results document the better ability of gilts to deposit more lean meat compared to castrates that produce fattier carcasses. It is due to genetic aspects and castration of males resulting in different metabolism of both sexes. On the other hand, the content of intramuscular fat was significantly higher in castrates than in gilts (2.49 vs. 2.00%), which was in agreement with Oliver et al. (1994), Latorre et al. (2003), and Correa et al. (2006). Opposite results were reported by Cisneros et al. (1996), Enfält et al. (1997), Hamilton et al. (2000), Faucitano et al. (2004) and Latorre et al. (2004), who did not find any significant effect of sex on IMF.

Correlation coefficients between evaluated traits are given in Tables 4–6. Slaughter weight (SW) correlated with percentage of lean meat non-sig-

Table 2. Carcass value and intramuscular fat of pigs according to sex

Trait	Castrates (n = 67)			Gilts (n = 62)		
	mean	SD	v (%)	mean	SD	v (%)
SW (kg)	107.94	10.24	9.49	107.86	8.86	8.21
CW (kg)	87.76	8.06	9.18	87.69	6.86	7.83
HC (kg)	43.75	3.86	8.81	43.44	3.28	7.55
BF (mm)	29.01^a	5.70	19.64	25.56^b	3.97	15.52
SHD (kg)	3.87^a	0.49	12.74	4.09^b	0.46	11.17
LOIN (kg)	3.59^a	0.48	13.51	4.07^b	0.57	13.90
HAM (kg)	7.36^a	0.93	12.69	8.02^b	1.00	12.45
BELLY (kg)	2.36^a	0.34	14.32	2.51^b	0.34	13.73
TEND (kg)	0.56^a	0.09	16.19	0.60^b	0.10	15.77
MEAT (kg)	17.74^a	1.97	11.10	19.29^b	2.07	10.71
PMEAT (%)	52.77^a	3.94	7.47	57.68^b	3.69	6.40
FAT (kg)	9.57^a	2.04	21.36	7.55^b	1.25	16.62
PFAT (%)	21.79^a	3.89	17.87	17.43^b	2.86	16.40
IMF (%)	2.49^a	0.63	25.33	2.00^b	0.64	32.16

$^{a,b}P < 0.05$

Table 3. Carcass value and intramuscular fat of pigs according to slaughter weight

Trait	90.0–99.0 kg (n = 20)		100.0–110.0 kg (n = 55)		>110.0 kg (n = 54)	
	mean	S.D.	mean	S.D.	mean	S.D.
SW (kg)	94.77[a]	2.14	103.81[b]	3.74	116.94[c]	5.02
CW (kg)	77.05[a]	1.76	84.40[b]	2.53	95.07[c]	4.24
HC (kg)	38.60[a]	0.98	42.02[b]	1.32	47.06[c]	2.13
BF (mm)	24.93[a]	3.45	26.04[a]	5.40	29.60[b]	4.76
SHD (kg)	3.47[a]	0.22	3.80[b]	0.28	4.35[c]	0.45
LOIN (kg)	3.37[a]	0.27	3.66[a]	0.47	4.15[b]	0.58
HAM (kg)	6.70[a]	0.45	7.36[b]	0.67	8.36[c]	1.01
BELLY (kg)	2.23[a]	0.25	2.32a	0.26	2.62[b]	0.37
TEND (kg)	0.53[a]	0.07	0.57	0.10	0.61[b]	0.09
MEAT (kg)	16.29[a]	0.86	17.71[b]	1.33	20.09[c]	2.01
PMEAT (%)	54.89	3.15	54.82	4.15	55.53	5.32
FAT (kg)	7.52[a]	1.25	8.38	1.71	9.21[b]	2.25
PFAT (%)	19.47	3.04	19.92	3.84	19.55	4.63
IMF (%)	2.31	0.50	2.34	0.73	2.14	0.68

[a,b,c]$P < 0.05$

nificantly (0.03), negatively in castrates (–0.09) and positively in gilts (0.21). A similar trend was found between HC and PMEAT (–0.02, –0.11 and 0.16). The relations of both weights (SW, HC) with IMF were closer in gilts than in castrates (–0.36 and –0.38 vs. –0.01 and –0.04).

Average BF correlated negatively with PMEAT (total –0.50, castrates –0.46 and gilts –0.31) and positively with IMF (0.33, 0.32, 0.15).

Weights of four prime cuts and tenderloin correlated with MEAT and PMEAT highly significantly in all pigs (0.55 to 0.96 and 0.45 to 0.70), castrates (0.56 to 0.96 and 0.34 to 0.59) and gilts (0.46 to 0.94 and 0.37 to 0.73). Weight of ham showed the highest correlations and weight of tenderloin the lowest. The relations of HAM, LOIN, SHD, BELLY and TEND to IMF content were negative and significant in almost all cases in castrates and gilts (–0.16 to –0.38 and/or –0.18 to –0.46). Similarly, the correlations of MEAT and PMEAT to IMF were negative and significantly different in both sexes (–0.33, –0.46 and/or –0.47, –0.34). These correlations are undesirable and suggest a decrease in intramuscular fat content in muscles with increasing lean meat content of pigs.

Weight of fatty parts (FAT) and percentage of fatty parts (PFAT) correlated with IMF positively and more strongly in castrates than in gilts (0.38, 0.49 and/or 0.20, 0.38).

As mentioned above, the model was created to find out the factors influencing the content of intramuscular fat in pigs. As no significant effect of genotype was found, we did not use this factor in the model. These results are consistent with the findings of Cisneros et al. (1996). On the contrary, Edwards et al. (1992), Oliver et al. (1994) and Latorre et al. (2003) found a significant influence of breed type on IMF content. Duroc breed, which has a genetic base for higher intramuscular fat content, was used in crossing in all those cases.

The slaughter weight of pigs did not have any impact on intramuscular fat content in our experiment (Table 3) as reported by Latorre et al. (2004) and Correa et al. (2006). The model that included the fixed effect of sex, weight of lean meat and weight of fatty parts in relation to the sex influencing intramuscular fat of pigs was selected (Table 7). The weight of lean meat of gilts was higher by about 1.5 kg than in castrates and it resulted in the much higher percentage of lean meat (57.68 vs. 52.77%). On the other hand, castrates had higher weight and percentage of fatty parts than gilts. Better meatiness of gilts resulted in lower intramuscular fat content. The data suggest a marked effect of sex, mainly on an increase in the level of meatiness at decreasing intramuscular fat content in pig carcasses. This fact is supported by regression coef-

Table 4. Correlations between traits in the whole set (n = 129)

Trait	2	3	4	5	6	7	8	9	10	11	12	13
1. SW (kg)	0.98	0.36	0.75	0.52	0.66	0.48	0.29	0.71	0.03	0.37	0.02	–0.15
2. HC (kg)		0.35	0.72	0.50	0.63	0.48	0.30	0.69	–0.02	0.41	0.07	–0.14
3. BF (mm)			0.08	–0.13	–0.12	–0.12	–0.35	–0.11	–0.50	0.65	0.58	0.33
4. SHD (kg)				0.60	0.80	0.47	0.36	0.86	0.48	–0.12	–0.41	–0.34
5. LOIN (kg)					0.71	0.42	0.51	0.83	0.66	–0.35	–0.58	–0.47
6. HAM (kg)						0.57	0.48	0.96	0.70	–0.35	–0.62	–0.44
7. BELLY (kg)							0.41	0.67	0.45	–0.16	–0.35	–0.32
8. TEND (kg)								0.55	0.47	–0.26	–0.40	–0.37
9. MEAT (kg)									0.71	–0.32	–0.62	–0.48
10. PMEAT (%)										–0.85	–0.92	–0.53
11. FAT (kg)											0.93	0.45
12. PFAT (%)												0.55
13. IMF (%)												–

The values printed in italics are non–significant, the other values are significant min. $P < 0.05$ (Fisher's Z–test)

Table 5. Correlations between traits for castrates (n = 67)

Trait	2	3	4	5	6	7	8	9	10	11	12	13
1. SW (kg)	0.98	0.48	0.75	0.56	0.68	0.44	0.31	0.73	–0.09	0.55	0.20	–0.01
2. HC (kg)		0.44	0.74	0.56	0.68	0.43	0.32	0.73	–0.11	0.57	0.21	–0.04
3. BF (mm)			0.21	0.05	0.03	–0.10	–0.34	0.05	–0.46	0.66	0.59	0.32
4. SHD (kg)				0.52	0.78	0.40	0.36	0.83	0.34	0.09	–0.23	–0.16
5. LOIN (kg)					0.72	0.41	0.50	0.81	0.52	–0.10	–0.38	–0.31
6. HAM (kg)						0.54	0.48	0.96	0.59	–0.14	–0.47	–0.34
7. BELLY (kg)							0.47	0.65	0.44	–0.05	–0.26	–0.21
8. TEND (kg)								0.56	0.45	–0.20	–0.38	–0.38
9. MEAT (kg)									0.59	–0.08	–0.44	–0.33
10. PMEAT (%)										–0.80	–0.90	–0.46
11. FAT (kg)											0.92	0.38
12. PFAT (%)												0.49
13. IMF (%)												–

The values printed in italics are non-significant, the other values are significant min. $P < 0.05$ (Fisher's Z-test)

Table 6. Correlations between traits for gilts (n = 62)

Trait	2	3	4	5	6	7	8	9	10	11	12	13
1. SW (kg)	0.98	0.20	0.81	0.61	0.73	0.57	0.30	0.81	0.21	0.17	–0.29	–0.36
2. HC (kg)		0.18	0.77	0.60	0.71	0.58	0.34	0.79	0.16	0.23	–0.24	–0.38
3. BF (mm)			0.08	–0.05	–0.09	–0.02	–0.24	–0.05	–0.31	0.41	0.34	0.15
4. SHD (kg)				0.64	0.81	0.51	0.30	0.89	0.57	–0.19	–0.55	–0.46
5. LOIN (kg)					0.61	0.35	0.43	0.79	0.61	–0.32	–0.60	–0.39
6. HAM (kg)						0.56	0.39	0.94	0.73	–0.39	–0.71	–0.40
7. BELLY (kg)							0.28	0.66	0.40	–0.10	–0.36	–0.36
8. TEND (kg)								0.46	0.37	–0.09	–0.25	–0.18
9. MEAT (kg)									0.73	–0.34	–0.70	–0.47
10. PMEAT (%)										–0.81	–0.87	–0.34
11. FAT (kg)											0.89	0.20
12. PFAT (%)												0.38
13. IMF (%)												–

The values printed in italics are non–significant, the remaining values are significant min0. $P < 00.05$ (Fisher's Z–test)

ficients of castrates and/or gilts MEAT on on IMT, which were negative (Table 8). These results are in agreement with the study of Eikelenboom et al. (1996), and Brewer et al. (2002). However, Villé et al. (1997) reported that high carcass quality – lean meat content – can be combined with high meat quality – sufficient intramuscular fat content. The authors did not find a relationship between intramuscular fat content and backfat thickness. For that reason it is possible to combine selection for low backfat thickness with selection for higher IMF. The absence of the relationship between carcass fatness and intramuscular fat content was also confirmed by Sellier (1998) and Faucitano et al. (2005). Almost identical results were reached in our experiment when the relationship between BF and IMF in gilts was non-significant (0.15), but in castrates it was closer and significant (0.32).

As mentioned above, the intramuscular fat content is of high importance for the eating quality of pork. For that reason, some countries attempt to include this trait into selection programs –USA (Leaflet et al., 2006), the Netherlands (Bergsma, 2004), Switzerland (Rohr et al., 1999). Cameron (1998) recommended periodical evaluations of nucleus herds for meat and eating quality including intramuscular fat to breeding companies in the United Kingdom. Intentional selection for intramuscular fat content may improve this trait. Newcom et al. (2003) found out that after one generation of selection, the average percentage of IMF in a selected line was 0.50 higher than in the control line of pigs. After four generations of selection, the difference between selected and control line was 1.03% in favour of the selected line (Schwab et al., 2005). This selection resulted in slightly more backfat and smaller loin muscle area without significant impact on growth and other meat quality traits.

The results of this study document large differences in carcass quality and intramuscular fat content between castrates and gilts. The level of meatiness of gilts and/or castrates had a significant impact on the content of intramuscular fat, however, slaughter weight had no effect on this trait. Generally, the level of intramuscular fat of pigs in the analysed set was low, both in castrates and gilts. Based on these results, and also on our previous studies, it would be desirable to include the intramuscular fat content as a very important trait influencing the eating characteristics in selection programs in pig breeding.

Table 7. Analysis of covariance for a regression model

Source of variability	DF	Mean square	Fisher's F-test
Sex	1	0.45430037	0.2317
Regresion coefficient MEAT within sex – $b_{1(i)}$	2	3.54162641	< 0.0001
Regresion coefficient FAT within sex – $b_{2(i)}$	2	4.04433799	0.0022

Table 8. Estimates of regression coefficients

Parameter	Estimate	Standard error
b_1 castrates (MEAT)	–0.098713	0.035152
b_1 gilts (MEAT)	–0.141433	0.036964
b_2 castrates (FAT)	0.120850	0.033902
b_2 gilts (FAT)	0.023981	0.060855

REFERENCES

Barton-Gade P.A. (1990): Pork quality in genetic improvement programmes – the Danish experience. Proc. Natl. Swine Improv. Fed. Ann. Mtg. Des Moines, Iowa, USA.

Bergsma R. (2004): Added value of carcass measurements in EBV. In: Int. Workshop on Data Management and Evaluation in Pigs. 16–17 April 2004, Domžale, Slovenia.

Brewer M.S., Jensen J., Sosnicki A.A., Fields B., Wilson E., McKeith F.K. (2002): The effect of pig genetics on palatability, colour and physical characteristics of fresh pork loin chops. Meat Sci., 61, 249–256.

Cameron N.D. (1998): Meat and eating quality: no change with selection? Pig Prog., 14, 33–35.

Cameron N.D., Warris P.D., Porter S.J., Enser M.B. (1990): Comparison of duroc and British landrace pigs for meat and eating quality. Danish Meat Research Institute. Roskilde, Denmark, 720E.

Cassady J.P., Robison O.W., Johnson R.K., Mabry J.W., Christian L.L., Tokach M.D., Miller R.K., Goodwinn R.N. (2004): National pork producers council maternal line genetic evaluation: A comparison of growth and carcass traits in terminal progeny. J. Anim. Sci., 82, 3482–3485.

Cisneros F., Ellis M., McKeith F.K., McCaw J., Fernando R.L. (1996): Influence of slaughter weight on growth and carcass characteristics, commercial cutting and curing yields, and meat quality of barrows and gilts from two genotypes. J. Anim. Sci., 74, 925–933.

Correa J.A., Faucitano L., Laforest J.P., Rivest J., Marcoux M., Gariépy C. (2006): Effects of slaughter weight on carcass composition and meat quality in pigs of two different growth rates. Meat Sci., 72, 91–99.

Čandek-Potokar M., Žlender B., Lefaucheur L., Bonneau M. (1998): Effects of age and/or weight at slaughter on *longissimus dorsi* muscle: Biochemical traits and sensory quality in pigs. Meat Sci., 48, 287–300.

Edwards S.A., Wood J.D., Moncrieff C.B., Porter S.J. (1992): Comparison of the Duroc and Large White as terminal sire breeds and their effect in pig meat quality. Anim. Prod., 54, 289–297.

Eikelenboom G., Hoving-Bolink A.H., van der Wal P.G. (1996): The eating quality of pork. 2. The influence of intramuscular fat. Fleischwirtschaft, 76, 517–518.

Enfält, A.-Ch., Lundström K., Hansson I., Lundeheim N., Nyström P.-E. (1997): Effects of outdoor rearing and sire breed (Duroc or Yorkshire) on carcass composition and sensory and technological meat quality. Meat Sci., 45, 1–15.

Enser M., Wood J.D. (1991): Factors controlling fat quality in pigs. Berlin, Germany. EAAP, 42, 32 pp.

Faucitano L., Rivest J., Daigle J.P., Lévesque J., Gariepy C. (2004): Distribution of intramuscular fat content and marbling within the longissimus muscle of pigs. Can. J. Anim. Sci., 84, 57–61.

Faucitano L., Huff P., Teuscher F., Gariepy C., Wegner J. (2005): Application of computer image analysis to measure pork marbling characteristics. Meat Sci., 69, 537–543.

Fernandez X., Monin G., Talmant A., Mourot J., Lebret B. (1999): Influence of intramuscular fat content on the quality of pig meat – 2. Consumer acceptability of *m. longissimus lumborum*. Meat Sci., 53, 67–72.

Gispert M., Diaz I., Oliver M.A., Tibaus J., Distre A. (1990): The effect of breed on intramuscular fat and fatty acids of subcutaneous fat. In: 41st Annual Meeting of EAAP, 8–12 July, Toulouse, France.

Hamilton D.N., Ellis M., Miller K.D., McKeith F.K, Parrett D.F. (2000): The effect of the Halothane and Rendement Napole genes on carcass and meat quality characteristics of pigs. J. Anim. Sci., 78, 2862–2867.

Hertzmann C., Göransson L., Ruderus H. (1988): Influence of fishmeal, rape-seed, and rape seed meal in feed on the fatty acid composition and storage stability of porcine body fat. Meat sci., 23, 37–53.

Kaufmann R.G., Warner R.D. (1993): Evaluating pork carcasses for composition and quality. In: Hollis G.R. (ed.): Growth of the Pig. CABI, Oxon, England. 141 pp.

Larzul C., Lefaucheur L., Ecolan P., Gogue J., Talmant A., Sellier P., Le Roy P., Monin G. (1997): Phenotypic and genetic parameters for longissimus muscle fibre characteristics in relation to growth, carcass, and meat quality traits in Large White pigs. J. Anim. Sci., 75, 3126–3137.

Latorre M.A., Lázaro R., Gracia M.I., Nieto M., Mateos G.G. (2003): Effect of sex and terminal sire genotype on performance, carcass characteristics, and meat quality of pigs slaughtered at 117 kg body weight. Meat Sci., 65, 1369–1377.

Latorre M.A., Lázaro R., Valencia D.G., Medel P., Mateos G.G. (2004): The effects of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs. J. Anim. Sci., 82, 526–533.

Leaflet A.S., Schwab C.R., Baas T.J. (2006): Development of a model to predict intramuscular fat in live pigs using real-time ultrasound. Iowa State Univ. Anim. Industry Rep., USA.

Mohrmann M., Roehe R., Susenbeth A., Baulain U., Knap P.W., Looft H., Plastow G.S., Kalm E. (2006): Association between body composition of growing pigs determined by magnetic resonance imaging, deuterium dilution technique, and chemical analysis. Meat Sci., 72, 518–531.

Newcom D.W., Baas T.J., Stalder K.J. (2003): Genetics of pork quality. Available at: http://www.nsif.com/Conferences/2003/pdf%5CGeneticsPorkQuality.pdf

Oliver M.A., Gou P., Gispert M., Diestre A., Arnau J., Noguera J.L., Blasco A. (1994): Comparison of five types of pig crosses. II. Fresh meat quality and sensory characteristics of dry cured ham. Liv. Prod. Sci., 40, 179–185.

Pulkrábek J., Pavlík J., Vališ L., Vítek M. (2006): Pig carcass quality in relation to carcass lean meat proportion. Czech J. Anim. Sci., 51, 18–23.

Rohr J. von, Hofer A., Künzi N. (1999): Economic values for meat quality traits in pigs. J. Anim. Sci., 77, 2633–2640.

SAS/STAT (2002–2003): SAS Institute Inc., Version 9.3.1, Cary, NC., USA.

Sellier P. (1998): Genetics of meat and carcass traits. In: Rothschild M.F., Ruvinski A. (eds.): The Genetics of the Pig. CAB International. Wallingford, UK. 463–509.

Schwab C.R., Baas T.J., Berry N.L., Mote B.E., Stalder K.J. (2005): Selection for intramuscular fat in Duroc swine – An update. Available at: http://www.nsif.com/Conferences/2005/pdf%5CSelectionIntramuscular Fat.pdf

Schwörer D.A., Rebsamen A., Lorenz D. (1995): Selection of intramuscular fat in Swiss pig breeds and the importance of fatty tissue quality. In: Proc. 2nd Dummerstorf Muscle Workshop on Growth and Meat Quality, Rostock.

Tischendorf F., Schöne F., Kirchheim U., Jahreis G. (2002): Influence of conjugated linoleic acid mixture on growth, organ, weights, carcass traits and meat quality in growing pigs. J. Anim. Physiol., 86, 117–128.

Verbeke W., Oeckel van M.J., Warnants N., Viaene J., Boucqué Ch.V. (1999): Consumer perception, facts and possibilities to improve acceptability of health and sensory characteristics of pork. Meat Sci., 53, 77–99.

Villé H., Rombouts G., Hecke van P., Perremans S., Maes G., Spincemaille G., Geers R. (1997): An evaluation of ultrasound and nuclear magnetic resonance spectroscopy to measure *in vivo* intramuscular fat content of longissimus muscle of pigs. J. Anim. Sci., 75, 2942–2949.

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, Netherlands, 22 pp.

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