Meat quality in two hybrid slaughter lines of pigs

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ABSTRACT: We evaluated two hybrid slaughter lines, progeny of hybrid parent gilts (LW × L) and D or LW – sire line terminal boars. Within two trials (with a six-month interval between them) the data on 40 animals were acquired; 20 hybrid pigs were sired by Duroc and 20 by LW terminal boars. Post-mortem changes were described by pH, conductivity, redox potential, remission and drip loss. Dry matter, intramuscular fat and myoglobin content were determined. Sensory tests evaluated aroma, flavour and texture. The results can be summarised as follows: *post-mortem* changes were adequate to normal quality meat. Remission values, drip loss and intramuscular fat content were higher in the hybrids sired by D. The hybrids sired by LW showed higher values of myoglobin content and their meat had better aroma. Total sensory evaluation was in favour of the hybrid progeny of D. The differences between the two trials could be explained by the use of different sires, the interval between the trials (6 months), impact of season and slight differences in feeding technique. However, the majority of the values fell within the category "optimal" quality of pork, therefore this trend in hybridisation could become one of the possible ways of pig breeding in the Czech Republic.

Keywords: pig; breed; slaughter hybrid; meat; quality

One of the most important aims of pig breeding is to produce a superior and economically efficient slaughter generation of pigs to meet the requirements of commercial pig producers, pork processors and consumers (Sládek and Čechová, 2001).

Hybrid parent gilts used for production of a slaughter generation both in the Czech Republic and worldwide are mostly F1 crosses of two maternal lines, Large White and Landrace (Sládek, 1999). Svoboda (2002) found the cross combination of Large White x Landrace and reciprocal crossing to be most common in hybrid parent gilts while terminal breeding boars usually combine Pietrain, Hampshire, Large White (sire line), Duroc and Czech Meat pig.

The heritability of meat quality characteristics ranges from low to medium (0.14 to 0.32) so it is possible to improve the quality of pork (the main product of pig production) through breeding (Kuciel and Lahučký, 1996). The characteristics in question are: meat colour, intramuscular fat content, the ability of meat to bind free water and pH value (Kauffman *et al*., 1993). The consumer demands lean meat of a typically pink red colour, neither too pale nor too dark and refuses meat spontaneously dripping juice (Ingr, 2000).

The optimum values of the most important meat quality characteristics range between: remission 13–25%, drip loss 1–5%, $pH_1 > 5.8$ and $pH_{24} < 6.2$ (Pipek, 1995; Ingr, 1996). The best quality meat was found in LW (pH_1 – 6.23) and D (pH_1 – 6.39). Duroc showed the highest content of intramuscular fat – 2.89% (Oliver *et al*., 1993; Armero *et al*., 2002). Mikule *et al*. (2001) found 0.71% of intramuscular fat in LW and 0.85% in L. However, Ševčíková *et al*. (2002) presented 19.18 g/kg of intramuscular fat in LW × L gilts while the drip loss per 24 hours was 3.07%, remission 19.67% and pH_{24} – 5.51. Kováč *et al*. (1999) found the following values of meat quality parameters in slaughter pigs: pH_1 – 5.89, pH_{24} – 5.65, meat remission 27.03%, free water content 7.41%. Warris *et al*. (1991) detected mean electrical conduc-

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tivity 4.46 mS 45 min after slaughter and pH_1 value 6.08 in the experimental group of 224 hybrids. Demo *et al*. (1993) analysed data on 148 slaughtered pigs and presented the mean pH_1 value in MLLT 6.24, electrical conductivity EC_1 – 4.34 and EC_{24} – 4.55. Kleinová and Ingr (1999) studied electrical conductivity in MLLT in detail and their values were EC_1 – 5.49 mS and EC_{24} – 6.61 mS. Naděje *et al*. (2000) found dry matter content 260.5 g/kg, fat content 18.6 g/kg, remission 20% and drip loss 7.2%.

Matoušek (1995) examined intramuscular fat content in the following breeds and hybrids: LW – 2.94%, LW × L – 2.85%. Sensory evaluation was also carried out and the results confirmed its validity as a supplementary method in selection programmes. Blanchard *et al*. (1999) evaluated meat of hybrids with 0, 25 or 50% of the Duroc breed in genotype; the hybrids were combinations of LW × BL gilts mated to LW boars or D × (LW × BL) gilts mated to LW boars or LW × BL gilts mated to D boars. Intramuscular fat content increased with higher proportion of D in genotype. Sensory evaluation revealed that the meat of hybrids with a higher proportion of D had stronger porky odour, and was finer and more desirable than meat of hybrids without D. Candek-Potokar *et al*. (1998) compared the Duroc, Landrace and Large White breeds and found out that Duroc had higher intramuscular fat content, lower drip loss, redder and more intensive colour, more intensive aroma and was finer.

Fischer *et al*. (2000) carried out sensory evaluation of meat in the hybrid progeny of hybrid parent gilts (Large White × German Landrace) mated to terminal boars of the Hampshire, Duroc, Pietrain-NN, Pietrain-nn, Hampshire × Pietrain-nn and Duroc × Hampshire breeds. Hybrids sired by Pietrain-nn showed the worst results while Duroc produced hybrids with the best quality meat. Fernandez *et al*. (1999) and Matoušek (1995) agreed based on degustation tests that optimal intramuscular fat content ranges from 2.5 to 3.5%.

MATERIAL AND METHODS

The experimental slaughter generation hybrids were progeny of Large White × Landrace (LW × L) hybrid gilts that were mated to Large White (LW-sire line) or Duroc (D) terminal boars.

The data were collected in two trials with a six-month interval between them (Trial I and II). A group of 10 animals representing each hybrid line was slaughtered, sampled and evaluated within each trial. Electrical conductivity (EC) and pH values were measured in *musculus longissimus lumborum et thoracis* (MLLT) at the location of the last thoracic vertebra 1 and 24 hours after slaughter. Similarly, redox potential was measured 24 hours after slaughter. Conductivity was determined using the equipment LF 191 F, pH value using Portames 911 Ph – Knick and redox potential using Lavibond Checkit micro equipment.

A sample (app. 500 g) of muscle tissue was collected from the same location of MLLT and transported in a heat-insulated box into a laboratory for analyses. Unprompted drip loss was determined in an intact sample of 150 g of muscle tissue. The sample was weighed, chilled and after 24 hours the weight loss was determined and expressed in percentages. Remission was measured in a fresh meat cut using Spekol 11 at the wave length of 525 nm and expressed as percentage. Dry matter content was determined in a 10 g tissue sample that was ground and dried at the temperature of 105°C for 4 h 30 min till constant weight. Intramuscular fat was extracted using xylene in Soxhlet's extraction equipment for 2 h 30 min and its content was expressed in percentage (Ingr *et al*., 1993). A group of trained assessors (3 men and 3 women) carried out sensory evaluation. The samples were roasted in an electric oven. A ten-point scale was used where 0 signified the worst and 10 expressed the best hedonic evaluation. The following characteristics were assessed: texture (tenderness, juiciness, softness, firmness, toughness), aroma and flavour.

The data were analysed using the computer program Unistat and the results are shown in Table 1.

RESULTS AND DISCUSSION

Mean pH_1 values ranged between 5.88 and 6.41 and pH_{24} values between 5.47 and 5.64. According to Pipek (1995) and Ingr (1996) our values were within the range indicating normal quality meat. Similar pH_1 values were found by Oliver *et al*. (1993) in LW – 6.23 and D – 6.39, by Warris *et al*. (1991) pH 6.8 and Demo *et al*. (1993) pH 6.08. Our H_{24} values were comparable with those of Kováč *et al*. (1999) pH_{24} 5.65 and Ševčíková *et al*. (2002) pH_{24} 5.51.

Electrical conductivity (EC_1) ranged between 3.26 and 4.01 mS. The values in the hybrids sired by Duroc boars were higher in both trial I ($P < 0.01$)

Table 1. Statistical parameters of the observed meat quality characteristics of hybrid pigs

	Trial I				Trial II			
Hybrid (Mother – Father)	(LW × L) × D		(LW × L) × LW sire line		(LW × L) × D		(LW × L) × LW sire line	
Number	$n = 10$		$n = 10$		$n = 10$		$n = 10$	
Quality characteristic	$\bar{x}$	v	$\bar{x}$	v	$\bar{x}$	v	$\bar{x}$	v
pH_1	6.41 A	4.37	6.36 a	3.64	5.88 B	3.54	6.05 b	5.08
pH_{24}	5.51	1.33	5.47 a	1.27	5.59	2.97	5.64 b	2.60
Electrical conductivity (mS/cm) EC_1	4.01	10.29	3.76 a	9.61	3.89 a	12.45	3.26 b	15.89
Electrical conductivity (mS/cm) EC_{24}	17.21	6.08	16.04	24.16	15.61	10.39	14.33	10.96
Redox potential (mV)	181.00 AC	16.75	163.50 B	11.03	333.50 BC	14.92	274.50 C	2.55
Drip loss (%)	3.01	29.83	2.70	26.10	3.12	30.45	2.95	37.73
Remission (%)	28.62 Aa	19.89	23.60 ABCb	12.54	20.17 B	14.50	19.14 ABD	13.23
Dry matter content (%)	26.63	1.70	26.58	2.26	26.30	2.01	26.63	2.73
Intramuscular fat content (%)	3.34 a	22.15	3.01	19.94	2.55 b	16.97	2.52	23.01
Myoglobin content (mg/100 g)	103.60	12.41	116.86	16.48	94.41 a	14.04	113.32 b	16.74
Texture (points)	6.4	23.6	6.6 B	22.0	6.5 B	15.0	5.7 A	16.9
Aroma (points)	6.8 a	16.2	7.1 A	14.8	6.4 b	12.5	6.6 B	10.4
Flavour (points)	6.6	17.3	6.9 A	17.1	6.5	15.6	6.1 B	15.9
Total scores (points)	19.8	19.3	19.4 B	18.3	20.6 B	14.4	18.4 A	15.7

Differences indicated by the same type are statistically significant. A, B, C, D are used for $P \leq 0.01$; a, b are used for $P \leq 0.05$

and trial II ($P < 0.05$). Our mean values were slightly lower than those of Warris *et al*. (1991) EC_1 4.46 mS, Demo *et al*. (1993) EC_1 4.55 mS and Kleinová *et al*. (1999) EC_1 5.49 mS. Our EC_{24} ranged between 14.33 and 17.21 mS and were higher than the values presented by Demo *et al*. (1993) EC_{24} 4.55 mS and Kleinová and Ingr (1999) EC_{24} 6.61 mS.

Mean values of redox potential ranged from 163.5 to 333.5 mV. The hybrids with Duroc sire showed higher values again but the difference was significant ($P < 0.05$) in trial I only.

Drip loss values were within the limits for normal quality meat (Pipek, 1995; Ingr, 1996). They ranged between 2.70 and 3.12%. Somewhat higher values were found in the Duroc sired hybrids but the difference was not statistically significant. On the contrary, Candek-Potokar *et al*. (1998) found lower drip loss values in Duroc compared to Large White and Landrace. Ševčíková *et al*. (2002) presented comparable values 3.07% but higher values were found by Kováč *et al*. (1999) 7.4% and Naděje *et al*. (2000) 7.2%.

Remission ranged from 19.14 to 28.62% and was higher in the Duroc sired hybrids; however the difference was statistically significant ($P < 0.05$) in trial I only when the values exceeded the limits for normal quality meat (Ingr, 1996). Our results corresponded with those of Ševčíková *et al*. (2002) 19.67%, Kováč *et al*. (1999) 27.03%, Naděje *et al*. (2000) 20% and Candek-Potokar *et al*. (1998), who also noted more intensive and redder colour of meat in Duroc compared to Large White and Landrace breeds.

Dry matter content ranged between 26.30 and 26.63%. Somewhat lower values were presented by Naděje *et al*. (2000) 260.05 g/kg.

Intramuscular fat content values (2.52–3.34%) met the requirements for good sensory characteristics of meat defined by Matoušek (1995) and Fernandez *et al*. (1999). Slightly higher values were found in the Duroc sired hybrids but the differences were not statistically significant. Oliver (1993), Candek-Potokar *et al*. (1998), Blanchard (1999), Armero *et al*. (2002) found higher intramuscular fat content in the Duroc breed or its crosses. Our values were comparable to those found by Matoušek (1995) in mother-line breeds (LW – 2.94% and LW × L – 2.85%). On the contrary, the values presented by Mikule *et al*. (2001) LW – 0.71%, L – 0.85% or Ševčíková *et al*. (2002) LW × L – 19.18 g/kg were lower. Naděje *et al*. (2000) also found lower values – 18.6 g/kg.

Myoglobin content ranged between 94.41 and 116.86 mg/100 g. Higher values were found in the hybrids sired by LW-sire line boars; the difference was significant ($P < 0.05$) in trial II.

Finally, sensory evaluation of pork was carried out. Texture ranged between 5.7–6.6 points. In trial II meat of the Duroc progeny got significantly ($P < 0.01$) better evaluation scores (it was fine and more tender) than the hybrids sired by LW-sire line. In trial I the results were vice versa but the differences between lines were not significant. Thus our results were too unequivocal to confirm the conclusions of Candek-Potokar *et al*. (1998) and Blanchard *et al*. (1999) that Duroc produces finer and more tender meat. Aroma was assigned between 6.4–7.1 points. The hybrids sired by LW-sire line got slightly better scores but the differences were not statistically significant. However, Candek-Potokar *et al*. (1998) found a more intensive aroma in Duroc pork compared to the LW breed. Flavour evaluation ranged between 6.1 and 6.9 points. The total sensory evaluation scores ranged from 18.4 to 20.6 points. The hybrids sired by Duroc terminal boars were assigned higher scores, especially in trial II when the differences were statistically significant ($P < 0.01$). Consistently with our results, Candek-Potokar *et al*. (1998), Blanchard *et al*. (1999) and Fischer *et al*. (2000) found pork of Duroc and its hybrids superior in sensory characteristics.

The data were also tested for differences in the observed characteristics between trial I and trial II. In the Duroc sired hybrids there were significant differences in intramuscular fat content ($P < 0.05$), pH_1 value, redox potential, remission and aroma ($P < 0.01$). In the hybrids sired by LW-sire line the differences were found in pH_1, pH_{24}, EC_1 values ($P < 0.05$), redox potential, remission and all sensory characteristics – texture, aroma, flavour, total scores ($P < 0.01$). The differences between the two trials could be explained by the use of different sires, the interval between the trials (6 months), impact of season and slight differences in feeding technique.

Our results indicated a high quality level of pork in the observed hybrid lines. Evaluation of all the observed characteristics (except for the remission in Duroc progeny in trial I) fell within the "optimal" quality level of pork. No important quality deviations (PSE, DFD and Hampshire factor) occurred during post-mortem changes in meat of either hybrid line. This resulted in a low drip loss.

The results of chemical analyses fell within the optimal range. The sensory characteristics of pork in both hybrids were very good. Favourable post-mortem changes and intramuscular fat content

(2.52 and 3.34%) definitely had a positive impact on the high evaluation scores. Hybrid progeny of Duroc terminal boars produced meat with better sensory characteristics.

CONCLUSION

The evaluation of slaughter line hybrids (LW × L) × D and (LW × L) × LW-sire line revealed high quality pork. Optimal values of variables of *post-mortem* changes, chemical analyses and sensory evaluation resulted in good quality meat. Sensory characteristics were more favourable in hybrids sired by Duroc boars. Our results proved Duroc and Large White-sire line to be appropriate breeds for the positions of terminal boars for production of slaughter generation of pigs in the Czech Republic. However, breeding management and profitability aspects must also be considered. If the results in that area are satisfactory, the use of these breeds could be encouraged as a possible way to reduce a great variety of hybrid combinations in the CR which is troublesome both for pig producers and processors.

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ABSTRAKT

Jakost vepřového masa dvou finálních hybridů

Byli hodnoceni finální hybridi, kde matkou finálního hybrida byla prasnička kříženka F_1 BU x L a do otcovské pozice byli zařazeni jedinci plemene duroc (D) a bílé otcovské (BO). Ve dvou pokusech s půlročním intervalem bylo hodnoceno celkem 40 ks, a to 20 kusů po otcích D a 20 po otcích BO. Sledován byl průběh postmortálních změn jakostními ukazateli pH, elektrická vodivost, redox potenciál, remise a ztráta masné šťávy samovolným odkapáním. Dále byl zjišťován obsah sušiny, intramuskulárního tuku a myoglobinu. Při senzorickém hodnocení byla sledována vůně, textura a chuť. Získané výsledky lze shrnout následovně. Průběh postmortálních změn odpovídal normální jakosti. Vyšší hodnoty remise, ztráty masné šťávy samovolným odkapáním a obsahu intramuskulárního tuku vykazovali hybridi po otcích plemene D. Vyšší hodnoty obsahu myoglobinu byly zjištěny u hybridů po otcích BO. Při senzorickém hodnocení vykazovali lepší vůni hybridi po otcích BO. Při celkovém hodnocení sledovaných znaků byli lépe hodnoceni hybridi po otcích D. Rozdíly mezi jednotlivými pokusy lze vysvětlit vlivem různých otců daného plemene, časovým odstupem mezi pokusy (6 měsíců), ročním obdobím a mírnými provozními odlišnostmi v krmení. Pohybovaly se však v rozmezích, která jsou charakteristická pro „optimální" jakost vepřového masa. Z tohoto důvodu lze tento směr hybridizace považovat za jednu z možných cest, kterou by se mohl ubírat chov prasat v ČR.

Klíčová slova: prase; plemeno; jatečný hybrid; maso; kvalita

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