EFFECTS OF GROWTH RATE, SEX AND SLAUGHTER WEIGHT ON CARCASS COMPOSITION AND MEAT QUALITY IN COMMERCIAL PIGS

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Background

Little is known about the combined or interactive effect of growth rate and final weight of pigs on pork carcass and meat quality characteristics. Increasing slaughter weight has the advantage of reducing overhead costs per unit weight of output for producer, slaughterer and processor, increasing carcass yields, improving meat to bone ratio and reducing chilling and processing losses (Ellis and Bertol, 2001). However, research showed that starting from 100 kg live weight each increment of 10 kg in body weight leads to a slightly lower average daily gain, a significant deterioration in feed efficiency, reduced lean deposition and poorer meat quality (Albar et al., 1990; Cisneros et al., 1996; Latorre et al., 2004). To get to heavier weights without affecting carcass leanness, the simplest approach is to restrict the amount of feed supplied to the animal, especially in the later stage of the finishing period when fat deposition rates increase dramatically (Ellis et al., 1996; Candek-Potokar et al., 1998). However, this practice may eventually lead to negative age-related effects, such as slower growth rate and reduced intramuscular fat content and, consequently, poorer quality of pork meat (Candek-Potokar et al., 1998). The use of modern, high-lean growth potential genotypes may represent a valid solution as in theory they can be taken to heavier weights without compromising growth performances and carcass traits.

Objectives

The aim of this project was to evaluate the effects of growth rate, sex and slaughter weight on carcass and meat quality traits in commercial pigs.

Materials and methods

A total of three hundred and forty (340) Duroc x (Landrace x Yorkshire) crossbred piglets were allotted into 28 pens and raised until slaughter at the experimental farm of the Centre de développement du porc du Québec (CDPQ) in Deschambault (QC, Canada). The animals were equally distributed according to an experimental design including the following independent variables: 1) growth rate, which was set according to two different EBVs (estimated breeding values) for age at 100 kg (fast growth: around -10 days and slow growth: around + 2 days) of the sire-line, 2) the sex (barrows and gilts) and 3) the liveweight at slaughter (107, 115 and 125 kg). The selected sire-lines had similar EBVs for backfat thickness at 100 kg slaughter weight. At the end of the finishing period, a sub-population of 119 pigs (10 carcasses per treatment) was selected for the carcass and meat quality evaluation trials.
After slaughter, warm carcass weight (kg) and loin eye area (cm^2) between the 3rd and 4th last ribs level were recorded. After conventional overnight chilling, one side of each carcass was dissected in order to estimate the effects of the treatments on the proportions of the lean, fat and bone tissue in the carcass. Full dissection did not include the front shank and the belly. Meat quality was assessed on the *longissimus* (L) muscle by measuring pH1 on the day of slaughter (45 min. post mortem) and ultimate pH (pHu), drip loss (%) and light reflectance (Minolta Chromameter CR 300) at 24 h post mortem. Furthermore, L muscle chops were ground and frozen pending the analysis of dry matter,

collagen and collagen heat-solubility, protein and intramuscular fat (IMF) content (Soxtec extraction with ethanol and dichloromethane). All analyses were conducted as described by AOAC (1990). Data were analysed according to a 2 x 2 x 3 factorial design by using the GLM Procedure of the SAS System (SAS, 1999).

Results and discussion

The selection by the EBV for growth rate of the sire-line successfully led to a difference in the age at slaughter, with pigs from the high growth rate line being a week younger than the slower growth rate ones. As liveweight at slaughter increased there were significant increases in hot carcass weight ($p<0.001$) and dressing percentage ($p<0.05$) (Table 1). These results are in agreement with those reported by Garcia-Macias et al. (1996) and Candek-Potokar et al. (1998). However, contrary to Garcia-Macias et al. (1996) and Beattie et al. (1999), in our study the increase of carcass weight did not result in a variation of lean and fat proportions (%). Globally, loin eye area (LEA) increased ($p<0.001$) with weight and gilts showed greater loin eye area than barrows. Loin eye area was dependant on a significant triple interaction of treatments. LEA increased with weight and this effect was more pronounced and larger in gilts. Main variation, however, arose from fast growing barrows which have readily completed their cross sectional muscle growth as they reached 115 kg, while, in opposite, a late but rapid development occurred from 115 to 125 in the slow growing ones which attained a LEA comparable to that of gilts of the same group. Final LEA of fast growing barrows was much smaller at 125 kg than that of the three other sex and growth rate combination of treatments at the same weight. Bone proportion was globally affected ($p<0.05$) by sex and growth rate, with gilts and slower growing pigs having higher proportions than barrows and fast growing pigs, respectively. However, a significant triple interaction also characterizes bone content (%). Percentage in gilts increased with weight, but the slope was more pronounced in the fast growing group, although slower gilts displayed a larger overall content. Slower growing barrows had lower bone content than their female counterpart and the changes from 107 to 125 kg followed a "V" shape pattern, while the opposite characterized faster growing barrows. These results are in contrast with Beattie et al. (1999) who reported a clear effect of weight increase on bone proportion in the carcass.

As already observed by Cisneros et al. (1996) and Eggert et al. (1996), gilt carcasses had higher ($p>0.001$) lean proportion and, thus, lower ($p>0.001$) fat proportion than barrow. Furthermore, slower growing pigs had a higher lean and lower fat proportion compared to high growth rate pigs, similar to McGloughlin et al. (1988) who have reported a negative relationship between high growth rate and carcass quality in Duroc parental line of pigs.

Muscle pH, drip loss and reflectance values were not affected by growth rate, sex and slaughter weight (Table 2). Except for Latorre et al. (2004), who reported a higher initial pH in the semimembranosus muscle and a lower L* value in the longissimus muscle with a weight increase from 116 to 133 kg, no consistent pattern of changes in these pork quality traits with weight have been reported in the literature (Eggert et al., 1996; Ellis and Bertol, 2001).

Only protein, IMF and collagen contents were affected by the factors under study. Protein was affected by slaughter weight and sex. Indeed, a lower ($p<0.05$) muscle protein content was found at 107 kg compared to 115 and 125 kg in the L muscle of both growth rate pigs. The effect of weight on protein content is in disagreement with a number of studies which showed inconsistent changes in protein content with slaughter weight (Ellis and Bertol, 2001; Latorre et al., 2004). In accordance with Latorre et al. (2004), muscle protein content was higher ($p<0.05$) in gilts than in barrows. As reported by several authors (Beattie et al., 1999; Ellis and Bertol, 2001; Latorre et al., 2004), no change in IMF was observed with increasing slaughter weight. On the other hand, IMF content was higher in barrows ($p<0.01$) than in gilts, as found by Barton-Gade (1987) and Van Oeckel and Warnants (2003). Contrary to Candek-Potokar et al. (1998) and Beattie et al. (1999), slaughter weight did not influence dry matter and total collagen content. However, the content of heat-soluble collagen content decreased ($p<0.001$) with weight. This may mean that tenderness of cooked pork could be somewhat reduced in heavier animals, as already reported by Ellis et al. (1996) and Candek-Potokar et al. (1998).

Conclusions

Generally, the results of this study suggest that pigs can be slaughtered at heavier weights without compromising carcass quality and meat quality. However, given the lower lean proportion found in the fast growing genotypes used in this study, the increase in slaughter weight should be combined with appropriate genetics in order to avoid economical losses.

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Table 1. Least Squares Means for growth rate, sex and slaughter weight for carcass composition.

Slaughter weight (W)[c]	107 kg				115 kg				125 kg				Significance			Interactions
Growth rate (GR)[a]	A		B		A		B		A		B					
Sex (S)[b]	B	G	B	G	B	G	B	G	B	G	B	G	GR	S	W	GR*S*W
Carcass weight (kg)	85,6	85,6	86,3	84,7	92,0	92,2	92,2	91,7	100,2	99,1	101,4	99,2	NS	NS	***	NS
Dressing (%)	79,2	79,8	80,1	79,7	80,2	80,0	80,5	80,4	80,7	79,8	80,8	80,5	NS	NS	*	NS
Loin eye area (cm^2)	42,4	45,3	43,2	45,7	46,4	48,1	43,8	49,0	45,4	54,4	48,9	50,1	NS	***	***	**
Total lean (%)	42,9	45,5	46,1	47,1	43,7	46,0	44,3	48,1	41,8	46,8	45,0	48,4	***	***	NS	NS
Total fat (%)	23,6	20,5	20,5	19,8	22,1	20,8	21,9	19,1	24,4	19,9	22,0	19,0	***	***	NS	NS
Total bone (%)	8,1	8,0	8,4	8,5	8,5	8,2	8,0	8,6	7,7	8,5	8,2	8,6	*	*	NS	*

[a] GR : Growth rate = A :fast, B : slow, [b] S : Sex = B : barrows, G : Gilts [c] W :Slaughter weight

NS : Not significant, * : p < 0,05, ** : p < 0,01, ***: p < 0,001.

Table 2. Least Squares Means for growth rate, sex and slaughter weight for meat quality characteristics

Slaughter weight (W)[c]	107 kg				115 kg				125 kg				Significance		
Growth rate (GR)[a]	A		B		A		B		A		B				
Sex (S)[b]	B	G	B	G	B	G	B	G	B	G	B	G	GR	S	W
45min. pH	6,2	6,3	6,1	6,2	6,2	6,3	6,3	6,3	6,2	6,3	6,3	6,3	NS	NS	NS
Ultimate pH	5,6	5,7	5,7	5,6	5,6	5,6	5,7	5,6	5,7	5,6	5,6	5,6	NS	NS	NS
L*	51,5	50,8	49,9	51,1	50,9	50,3	50,2	50,0	50,3	51,0	50,5	50,0	NS	NS	NS
Drip loss (%)	5,1	4,5	4,9	5,4	5,6	5,8	4,9	5,8	4,9	5,1	4,8	5,5	NS	NS	NS
Dry matter (%)	26,1	26,2	26,1	26,0	26,0	25,7	26,2	26,2	26,4	26,1	26,4	25,9	NS	NS	NS
Protein (%)	23,3	23,7	23,2	23,5	23,8	23,6	23,6	23,9	23,4	23,8	23,9	23,9	NS	*	*
IMF (%)	2,2	2,0	2,2	1,8	1,7	1,5	2,0	1,8	2,3	1,7	2,2	1,5	NS	**	NS
Soluble collagen (%)	13,5	13,3	13,2	13,4	12,9	11,9	12,4	11,8	11,4	11,5	10,8	11,2	NS	NS	***
Total collagen ($g\ 100g^{-1}$)	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,5	0,4	0,5	0,5	0,5	NS	NS	NS

[a] GR : Growth rate = A :fast, B : slow, [b] S : Sex = B : barrows, G : Gilts [c] W :Slaughter weight

NS : Not significant, * : p < 0,05, ** : p < 0,01, ***: p < 0,001.