EFFECTS OF FINISHING DIET AND FASTING TIME ON THE GLYCOLYTIC POTENTIAL AND QUALITY OF LONGISSIMUS MUSCLE IN CROSSBRED PIGS

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Introduction

Colour and water-holding capacity are important attributes of pork quality. Both quality traits are affected by biochemical processes during the post-slaughter conversion of muscle to meat, where pH is an important factor. The extent of post-mortem pH fall and the ultimate pH of pork are mainly determined by the muscle glycogen content at slaughter. High muscle glycogen levels can result in pork with low ultimate pH, pale colour and decreased water-holding capacity. Muscle glycogen stores are generally expressed as glycolytic potential (GP), which is a measure of the compounds present in the muscle that can be converted to lactic acid and thus contribute to pH decline (Monin and Sellier, 1985). There are some differences in the GP of muscles and pork quality between pig breeds, but differences found between purebred pigs can differ when cross-breeding is applied (Monin and Sellier, 1985; Enfält *et al.*, 1997). The GP of muscles and pork quality can be influenced by the length of fasting before slaughter (Leheska *et al.*, 2003) and by feeding pigs diets of low starch and sugar content (Rosenvold *et al.*, 2001). This study focused on the effects of finishing diet's carbohydrate composition and fasting time on the GP and quality of longissimus muscle in crossbred pigs.

Materials and Methods

One hundred and sixty 25kg pigs were assigned in pairs and sexes separately to a performance experiment to study how the carbohydrate composition of finishing diet and fasting time influence the GP, ultimate pH, colour and drip loss of longissimus muscle in crossbred pigs. Half of the pigs were crosses of Finnish Landrace and Yorkshire (LY) and the other half were crosses of Duroc, Finnish Landrace and Yorkshire (DLY, 25% Duroc). The pigs were fed a barley-soybean meal diet up to the 80kg body weight. Thereafter half of the pigs received a barley-soybean meal control diet and another half received a high-fibre diet which contained barley, barley fibre, faba beans and rapeseed cake. Control and high-fibre diets contained 529 and 405g starch, 35 and 42g sugars, and 183 and 257g neutral detergent fibre per kg dry matter, respectively. The pigs were slaughtered in a commercial slaughterhouse in 106kg body weight. Fasting times averaged 25 and 41h and they were obtained by giving pigs their last meal either 7am on the day of transportation or 3pm the previous day. The pigs were slaughtered the morning after the transportation. Sixteen pigs had been slaughtered during the transportation day and they were removed from the data.

The ultimate pH and colour measurements (L*, Minolta DP301 device) and samples for GP determination were taken from the longissimus muscle 24h after slaughter. Drip loss was determined from a 100g sample of meat before and after the storage in sealed plastic bag at 4°C for three days. Glycogen and lactic acid contents were determined from one randomly selected pig per pen. Glycogen content was analysed as glucose: 10 µl of homogenate (sample in 0.1 M phosphate buffer, pH 7.0) were hydrolysed in 200µl of 0.1M HCl at 100°C for 2h, after which pH was adjusted to 6.5-7.5 and glucose was determined via NADP+ reduction with linked assay involving hexokinase and glucose-6-phosphate dehydrogenase (Glucose (HK) 16-50, Sigma Diagnostics). Lactate concentration was determined from the homogenate via NAD+ reduction with a linked assay involving lactate dehydrogenase and glutamate pyruvate transaminase (Boehringer-Mannheim no. 139 084). The GP was calculated as 2 × (glycogen + glucose + glucose-6-phosphate) + lactic acid (Monin and Sellier, 1985).

The data were analysed separately for LY- and DLY-crosses using the MIXED procedure of SAS and the model which had the fixed effects of sex, fasting time and finishing diet and their interactions and for meat quality measurements the random effect of pen within sex × fasting time × finishing diet interaction.

Results and Discussion

In LY-crosses, several significant or moderate ($P < 0.20$) interactions were found, and therefore the results are presented for each sex and treatment combination in Table 1 and main effects are given in the text when appropriate. There was a sex × finishing diet interaction in the GP ($P = 0.07$) and glycogen ($P = 0.15$) and lactate contents ($P < 0.05$) of longissimus muscle. In gilts, control and high-fibre diets resulted in fairly similar GP (151 vs. 156µmol/g; $P > 0.05$) and glycogen (29 vs. 28µmol/g; $P > 0.05$) and lactate contents (93 vs 99µmol/g; $P > 0.05$). However, the barrows that were fed high-fibre diet had lower GP (134 vs. 162µmol/g; $P < 0.05$) and glycogen (21 vs. 32; $P < 0.05$) and lactate contents (90 vs. 97µmol/g; $P < 0.05$) than those fed the control diet. Longer fasting decreased the GP (153 vs. 148µmol/g; $P < 0.05$) and glycogen content (32 vs. 24µmol/g; $P < 0.05$). However, there was a moderate sex × fasting time interaction in the lactate content ($P = 0.15$). Increasing fasting time decreased muscle lactate content in barrows (97 vs. 90µmol/g;

P < 0.05), but not in gilts (96 vs. 96µmol/g; P > 0.05). There were moderate sex × fasting time (P = 0.06) and finishing diet × fasting time interactions (P = 0.17) in the ultimate pH of longissimus muscle. Longer fasting increased the ultimate pH in barrows (5.56 vs. 5.64; P < 0.05), but not in gilts (5.55 vs. 5.54; P > 0.05). Finishing diet did not affect the ultimate pH in 25h fasting (5.57 vs. 5.57; P > 0.05), but in 41h fasting high-fibre diet resulted in higher ultimate pH than control diet (5.61 vs. 5.54; P < 0.05). The lightness of meat was not affected by the investigated factors (P > 0.05). A moderate sex × fasting time interaction was found in the drip loss (P = 0.11). Longer fasting decreased the drip loss in barrows (4.5 vs. 3.1%; P < 0.05), but not in gilts (3.7 vs. 3.7%; P > 0.05).

Table 1: Effects of sex, finishing diet and fasting on the glycogen metabolism and meat quality in LY-crosses.

	Gilts				Barrows				
	Control		High-fibre		Control		High-fibre		
	25 h	41 h	25 h	41 h	25 h	41 h	25 h	41 h	SEM
GP, µmol/g[F, S×D]	159	143	158	153	179	145	143	124	12
Glycogen, µmol/g[F, S×D]	33	25	30	27	30	25	24	19	5
Lactate, µmol/g [S×D, S×F]	92	92	94	99	99	95	95	85	3
Ultimate pH[S, S×F, D×F]	5.56	5.51	5.55	5.57	5.58	5.63	5.53	5.66	0.04
L*	51.3	50.1	50.8	51.3	50.8	50.1	51.6	49.6	1.4
Drip loss, %[S×F]	3.9	3.6	3.5	3.9	4.6	2.7	4.4	3.6	0.6

[S] The effect of sex is significant (P < 0.05). [F] The effect of fasting time is significant (p < 0.05). [S×F] There is a sex × fasting time interaction (P < 0.20). [D×F] There is a finishing diet × fasting time interaction (P < 0.20).

In DLY-crosses, interactions were scarce and therefore the main effects of sex, finishing diet and fasting time are presented in Table 2. Longer fasting decreased the glycogen content (P < 0.05) and tended to decrease the GP of longissimus muscle (P = 0.06). However, lactate content was not affected by fasting time (P > 0.05). Sex and finishing diet did not affect the GP and glycogen and lactate contents (P > 0.05). The DLY-crosses that were fed high-fibre diet had higher ultimate pH and darker meat colour (P < 0.05) than those fed the control diet. Longer fasting tended to increase the ultimate pH (P = 0.09), but did not affect meat colour (P > 0.05). There was a moderate sex × finishing diet interaction (P = 0.13) in the drip loss. The control diet resulted in similar drip losses in both gilts and barrows (3.8 vs. 3.7%; P > 0.05), whereas barrows that were fed high-fibre diet had lower drip loss than the respective gilts (3.1 vs. 4.4%; P < 0.05).

Table 2: Effects of sex, finishing diet and fasting on the glycogen metabolism and meat quality in DLY-crosses.

	Sex			Finishing diet			Fasting time		
	Gilts	Barrows	SEM	Control	High-fibre	SEM	25 h	41 h	SEM
GP, µmol/g	150	148	5	152	146	5	157	142	5
Glycogen, µmol/g	29	29	2	30	28	2	32^{b}	26^{a}	2
Lactate, µmol/g	93	90	2	92	91	2	93	90	2
Ultimate pH	5.55	5.57	0.02	5.53^{a}	5.60^{b}	0.02	5.54	5.58	0.02
L*	50.6	51.2	0.6	51.7^{b}	50.0^{a}	0.06	50.9	50.8	0.06
Drip loss, %	3.7	3.8	0.3	3.7	3.8	0.3	4.1	3.4	0.3

Conclusions

A high-fibre finishing diet and 41h fasting can lower the glycolytic potential of longissimus muscle and have positive effects on pork quality. However, these effects seem to depend on the crossbreed and sex of pigs.

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