THE EFFECT OF HANDLING PRE-SLAUGHTER AND CARCASS PROCESSING RATE POST-SLAUGHTER ON PORK QUALITY

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INTRODUCTION

If pigs are stressed immediately prior to slaughter, muscle glycolysis is increased by adrenergic and direct muscle stimulation mechanisms and results in a high rate of glycogenolysis and a sharp rate of pH decline post-slaughter. An increased rate of glycogenolysis and muscle pH decline post-slaughter while the carcass temperature is still high, can lead to pale, soft, exudative (PSE) pork. The rate of temperature decline in the carcass will affect the glycolytic rate due to the temperature dependence of the reaction. Thus any factors in the slaughter system which affect the rate of temperature decline in the carcass has the potential to cause or exacerbate the PSE condition. The recommended standards for evisceration and carcass processing rate suggest that evisceration of the carcass should commence within 20 min of exsanguination and the maximum time from stunning of the animal to entry of the carcass into the chiller should be less than 45min (P. Maynard *pers. comm.*, 1996). Although the average time from stun to chiller in most Australian pork abattoirs is below 45 min, a recent audit has shown that carcass processing rates can vary from 25 to 70 min (P. Maynard *pers. comm.*, 1996). The main causes of delay in carcass processing are due to pigs being left on the line during staff recesses, manual handling of carcasses and mechanical breakdowns on the evisceration line. The aim of this experiment was to determine the interaction between the effects of negative handling of pigs pre-slaughter and delays in the carcass processing rate post-slaughter on pork quality.

MATERIALS AND METHODS

Forty-eight crossbred (Large White X Landrace) boars averaging 95 ±15 (mean ± SD) kg liveweight were randomly allocated to treatments in a 2x2 factorial design with 4 slaughter replicates. The treatments were (A) handling (minimal and negative handling just prior to slaughter) and (B) post-slaughter carcass processing rate (normal (45min) and delayed (70min)). On the day prior to slaughter pigs were transported 1km to the research abattoir in groups of 3 pigs. After 15 h lairage, the pigs were individually removed from lairage pens, the handling treatments imposed, followed by stunning and slaughter. The minimal handling treatment involved using minimal force (eg. gentle coaxing) to move the pigs from the lairage pens to the slaughter area. Electric goads were not used and negative handling was kept to an absolute minimum. The pigs in the negative handling treatment were given 15 electric shocks with an electric goad 5 min prior to slaughter. Pigs were stunned using a carbon dioxide dip-lift stunner set at 90% CO_2 with total exposure time of 2.2 min, exsanguinated and scalded and the carcasses in the normal processing rate group were eviscerated and split before entering the chillers at approximately 45 min post-slaughter. The carcasses in the delayed processing rate group remained hanging on the slaughter line for 20 min after scalding after which the carcasses were then eviscerated and split before entering the chillers at approximately 70 min post-slaughter. A 1g muscle sample for muscle glycogen analysis was collected at 5 min, 40 min, 70 min and 24 h post-slaughter from the *Longissimus thoracis* (LT) (12th/13th rib), frozen in liquid nitrogen and stored at -20°C. The pH and temperature of the LT was measured at 40 and 70 min post-slaughter. At 24 h post-slaughter, ultimate pH, surface lightness (L^*) and surface exudate (filter paper method) were measured in the LT. Data was analysed by ANOVA using the GENSTAT 5 program.

RESULTS

The treatment effects on muscle glycogen, pH, temperature and meat quality are given in Table 1. Pigs negatively handled just prior to slaughter had lower muscle glycogen concentrations at all times post-slaughter, higher lactic acid concentrations at 5 min, 40 min and 70 min and lower pH and higher muscle temperature at 45 min and 70 min compared to pigs minimally handled prior to slaughter. Negative handling of pigs prior to slaughter resulted in meat which had higher surface exudate, a higher incidence of PSE and a tendency for paler meat, compared to pigs minimally handled prior to slaughter. Delays in the carcass processing rate resulted in reduced muscle glycogen concentrations at all times post-slaughter compared to carcasses processed without any delay. There should have been no differences in muscle glycogen until the treatment was imposed at 70 min. and we are unable to explain why there was a difference. Delays in the carcass processing rate also had an influence on pork quality as the meat was paler in comparison with pig carcasses processed without any delays, although there was no difference in exudate or incidence of PSE.

DISCUSSION

An acute stressor such as the use of an electric goad by stockpersons to move pigs from the lairage pens to the stunning area can stress pigs as evidenced by increased plasma adrenaline and noradrenaline concentrations (Troeger and Woltersdorf, 1989). One of the consequences of increased plasma adrenaline and noradrenaline secretion is increased neuromuscular stimulation and hence increased glycogenolysis (Lister *et al.*, 1981). Increased post-slaughter muscle metabolism occured in negatively handled pigs as indicated by lower muscle glycogen and higher lactic acid concentrations at slaughter, higher post-slaughter muscle temperatures and lower post-slaughter muscle pH. The increased metabolism post-slaughter in negatively handled pigs resulted in inferior pork quality as surface exudate was higher, there was more PSE and a there was also a tendency for paler meat. This is in agreement with Grandin (1980) who reported that acute stress such as electric shocks from an electric goad can result in meat which is of inferior quality.

Delays in carcass evisceration can result in carcasses entering the chillers later than the generally recommended time of ≤ 45min. Unlike negative handling pre-slaughter, delays in carcass processing rate did not have a significant affect on muscle lactic acid, temperature or

muscle pH values but still had an affect on muscle surface lightness. The lack of difference in muscle lactic acid concentrations, pH and temperature in carcasses with delayed processing rates indicate that perhaps the delay in evisceration used in this experiment were not severe enough to significantly influence muscle metabolism. It could also be that the chilling conditions used in this experiment may have helped to overcome problem associated by delays in carcass cooling. Delays in carcass processing rates have previously been reported to result in paler meat (Eldridge *et al.*, 1993) as found in this experiment but they also reported a higher drip loss. However, other researchers have reported that the processing time from stunning to chilling had little effect on the carcass temperature, post-slaughter muscle glycogen and lactic acid concentrations and pork quality (Honkavarra, 1989). Theoretically there should not be any difference in glycogen concentrations at slaughter between the normal and delayed carcass processing treatments. As there was no difference in the rate of glycogen breakdown (results not presented) and since the pigs were randomly allocated to their respective pre- and post-slaughter treatments, and handled and treated the same pre-slaughter, we have no explanation for this result. Based on muscle metabolites, temperature and pork quality results from this experiment it appears that negative handling had a greater influence on the above parameters in comparison with delays in carcass processing rate. Also the lack of interaction between pre-slaughter handling and post-slaughter carcass processing rate suggests that in this case pre-slaughter handling played a pivotal role in determining pork quality and may have masked any effect of carcass processing rate on pork quality.

Overall, the findings from this experiment indicate that acute stress such as negative handling of pigs with an electric goad can lead to increased muscle glycogenolysis, resulting in inferior pork quality and PSE pork. Delays in carcass evisceration also affected pork quality and result in paler meat. Pre-slaughter negative handling appears to have a greater influence on muscle metabolism and pork quality in comparison with delays in carcass evisceration. Optimum pre- and post-slaughter management is required to consistently produce pork of a high quality.

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REFERENCES

Eldridge, G.A., Ball, C.I. and Knowles, H.M. (1993). *In* Manipulating Pig Production IV. Ed. . E.S. Batterham, Australasian Pig Science Association, Attwood, Victoria, Australia, p. 177.

Grandin, T. (1980). *International Journal Studying Animal Problems* **1**, 313-337.

Lister, D., Gregory, N.G. and Warriss, P.D. (1981). *In* Developments in Meat Science - 2. Ed. R.A. Lawrie, Elsevier Applied Science Publishers, p. 61-92.

Honkavarra, M. (1989). *Journal of Agricultural Science in Finland*, **24**; 21-29.

Troeger, K. and Woltersdorf, W. (1986). *Proceedings of the 32nd European Meeting of Meat Research Workers*, p. 73-76.

TABLE 1 Effect of handling pre-slaughter and carcass processing rate post-slaughter on muscle glycogen, lactic acid, pH, temperature and meat quality in the *M. Longissimus thoracis*. (least squares means, sed = standard error of the difference).

Handling (H)[1]		Minimal[1]		Negative[1]			P-value		
Carcass processing rate (CP)[2]		Normal[2]	Delayed[2]	Normal	Delayed	sed	H[3]	CP[3]	HxCP[3]
Glycogen (mg/g)	5min	10.5	9.5	8.3	7.2	0.484	0.001	0.027	0.912
	40min	8.1	6.8	5.9	4.7	0.438	0.001	0.001	0.691
	70min	5.7	5.1	4.2	2.9	0.376	0.001	0.001	0.808
	24h	1.6	1.2	1.1	0.7	0.247	0.001	0.046	0.980
Lactic acid (mg/g)	5 min	2.3	2.1	3.3	2.9	0.255	0.001	0.362	0.920
	40min	3.0	2.9	4.2	3.6	0.241	0.001	0.096	0.715
	70min	3.7	3.8	5.2	4.3	0.288	0.001	0.199	0.173
	24h	8.4	6.8	7.7	7.8	0.485	0.696	0.061	0.056
pH	40min	6.38	6.49	6.39	6.27	0.068	0.002	0.930	0.359
Temperature (^{0}C)	40 min	38.4	38.7	39.5	39.5	0.253	<0.001	0.829	0.612
pH	70min	6.20	6.23	6.20	6.09	0.085	0.033	0.374	0.592
Temperature (^{0}C)	70 min	34.2	34.9	35.1	37.0	0.603	0.002	0.090	0.683
pH	24h	5.61	5.61	5.59	5.56	0.026	0.946	0.847	0.946
Surface exudate (mg)		67.8	74.3	106.4	103.7	10.95	0.001	0.489	0.628
surface lightness (L*)		50.7	51.0	50.4	52.7	0.676	0.069	0.007	0.286
% PSE[4]		10	8	40	42		0.050	0.190	

[1] Minimal = minimal handling treatment just prior to slaughter, Negative = negative handling treatment just prior to slaughter.
[2] Normal = 45 min carcass processing rate, Delayed = 70 min carcass processing rate.
[3] H = handling, CP = carcass processing rate.
[4] Chi square goodness of fit test used.