EFFECT OF GENOTYPE, PRE-SLAUGHTER HANDLING AND STUNNING METHOD ON CARCASS AND MEAT QUALITY OF PIGS.

H.A. Channon, A.M. Pengelly and R.D. Warner
Victorian Institute of Animal Science, Agriculture Victoria, Private Bag 7, Werribee,Victoria, 3030, Australia

Introduction:
Pigs carrying the halothane gene (Nn and nn) are relatively sensitive to changes in the pre-slaughter environment and are therefore more likely to suffer from acute stress than normal (halothane negative, NN) pigs. Some pig breeds, including Landrace, may therefore not benefit in meat quality terms from careful pre-slaughter handling as the trauma of slaughter alone can initiate a severe stress response and the development of pale, soft and exudative (PSE) meat (Tarrant 1989). The method used to stun pigs can also have an influence on meat and carcass quality of pork. Previous studies have investigated the independent effect of genotype, pre-slaughter handling and stunning method on meat and carcass quality. This study aims to determine the effects of halothane genotype, pre-slaughter handling and stunning method on the carcass and meat quality of pigs.

Materials and Methods:
Seventy-six Landrace and four Large White x Landrace pigs of known halothane status (40 pigs were normal (homozygous negative, NN) and 40 pigs were carriers (heterozygous, Nn) for the halothane gene) were obtained from a commercial piggery. Pigs were transported 330 km and slaughtered after overnight lairage. Carrier and normal pigs were randomly allocated within genotype to pre-slaughter handling and stunning treatments according to a 2 x 2 x 2 factorial design. Pre-slaughter handling was either minimal or negative; negative handling involved stressing the animal with an electric goad applied 15 times five minutes prior to slaughter (D'Souza *et al.* 1995). Pigs were stunned using carbon dioxide (90% CO_2) or electrically using a current level of 1.3 Amp applied using head tongs for four seconds. Five slaughters (16 pigs per slaughter) were conducted over two weeks at a research abattoir with two pigs per treatment group slaughtered on each slaughter day. Meat quality analyses were only conducted on the *M. longissimus thoracis et lumborum* (LTL). Muscle pH was determined at 40 minutes, 90 minutes, 3, 6 and 24 hours post slaughter in two sites of the LTL; between the 5th and 6th thoracic vertebrae (Site 1) and at the P2 site (Site 2). Drip loss was determined at 24 hours using the method outlined by Honikel *et al.* (1986). Soft and exudative (SE) pork was classified as meat with a drip loss $\geq$ 5%, whilst meat with an ultimate pH > 6.0 and drip loss < 5% was classified as dark, firm and dry (DFD) pork. All data was analysed by analysis of variance using Genstat 5 program (Payne *et al.* 1987) to determine differences due to genotype, pre-slaughter handling and stunning method.

Results:
Muscle pH of the LTL muscle of carrier pigs was lower at both sites at 40 minutes, 90 minutes, 3 hours and 6 hours post-slaughter compared with those from normal pigs (Table 1). Negative handling produced lower muscle pH at the two sites at all measurement times from 40 minutes to 6 hours post-slaughter compared to minimal handling. Electrically stunned pigs had lower muscle pH at site 1 at 40 minutes, 90 minutes and 3 hours post-slaughter compared to pigs stunned using carbon dioxide. Carrier pigs produced muscle with a higher drip loss than muscle from normal pigs (8.14 and 4.96%, respectively ($P<0.01$)). Muscles from electrically stunned pigs lost more drip than pigs stunned with carbon dioxide (7.28 and 5.82%, respectively ($P<0.01$)). Carrier pigs had a higher incidence of soft, exudative (SE) meat across handling and stunning treatments (60 to 100%) compared to normal pigs (33 to 86%) (Table 2).

No pigs in this experiment produced carcasses exhibiting bone fractures, however, the incidence of ecchymosis affected meat was higher ($P<0.05$) in shoulder primals of electrically stunned pigs than CO_2 stunned pigs (Table 2). The highest amount of ecchymosis affected meat was found in shoulder primals from negatively handled, electrically stunned carrier pigs, with normal pigs tending to have less blemished meat than carrier pigs.

Discussion:
These results highlighted that halothane status of pigs is an important factor influencing pork quality, regardless of pre-slaughter handling or stunning method used. Carrier pigs are more likely to produce SE-pork than normal pigs, regardless of stunning method or pre-slaughter handling treatment. The faster rate of pH decline in carrier pigs compared to normal pigs, as indicated by lower pH from 40 minutes to 6 hours post-slaughter was a major factor influencing the incidence of SE pork. Carrier pigs generally produced muscle of a lower pH at 45 minutes post-slaughter than normal pigs (Jensen and Barton-Gade 1985; Murray and Jones 1992; Leach *et al.* 1996). It appears that genotype was the major factor influencing meat quality in this study, with negative handling of carrier pigs and electrical stunning exacerbating the incidence of SE pork. Previous studies (Jensen and Barton-Gade 1985; Gariepy *et al.* 1989; Lundstrom *et al.* 1989; Murray *et al.* 1989) also found that the halothane gene may have an additive effect on meat quality parameters indicative of PSE.

In this experiment, both pre-slaughter handling and genotype were significant factors influencing drip loss. In previous studies comparing pig genotype LT muscles from carrier pigs had higher drip losses than those from normal pigs (Lundstrom *et al.* 1989; Leach *et al.* 1996). Negatively handled pigs have previously been found to have higher rate of drip loss from the LT muscle compared with muscle from minimally handled normal pigs (D'Souza *et al.* 1995). In this study, electrically stunned pigs, regardless of genotype, also had higher levels of drip loss from LT muscles than those from CO_2 stunned pigs. This finding may have important commercial implications as meat from CO_2 stunned pigs may be more appealing both at the retail level and to further processors of pork than meat from electrically stunned pigs.

In conclusion, genotype, pre-slaughter handling and stunning method all influence the meat and carcass quality of pigs. It was found that pigs carrying the halothane gene are more likely to produce SE pork than normal pigs. It may therefore be suggested that reactors (nn) and carriers (Nn) for the halothane gene should be identified on-farm and halothane status be known at the abattoir to enable them to implement pre- and post-slaughter management systems to minimise the incidence of PSE. Exposure to unfamiliar stress factors, such as electric goads, should also be minimised.

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Table 1 Least square means and standard error of the difference between means (s.e.d.) for the effect of genotype, pre- slaughter handling and stunning method on muscle pH of the *M. longissimus thoracis et lumborum* (LTL) at 40 minutes, 90 minutes, 3 hours and 6 hours post-slaughter measured between the 5th and 6th thoracic vertebrae (Site 1) and at the P2 site (Site 2).

	Muscle pH post-slaughter[1]											
	Genotype				Pre-slaughter handling				Stunning Method			
	Normal	Carrier	s.e.d.[2]	P[3]	Minimal	Negative	s.e.d.	P	CO_2	Elect.	s.e.d.	P
40 minutes												
Site 1	6.37	6.12	0.06	P<0.001	6.32	6.16	0.06	P=0.01	6.35	6.14	0.06	P=0.001
Site 2	6.60	6.10	0.06	P<0.001	6.43	6.26	0.06	P<0.01	6.39	6.31	0.06	n.s.
90 minutes												
Site 1	6.21	6.01	0.06	P<0.001	6.23	5.98	0.06	P<0.001	6.20	6.02	0.06	P<0.01
Site 2	6.42	5.88	0.07	P<0.001	6.30	6.00	0.07	P<0.001	6.16	6.14	0.07	n.s.
3 hours												
Site 1	6.02	5.84	0.07	P<0.01	6.01	5.84	0.07	P<0.05	6.02	5.83	0.07	P<0.01
Site 2	6.19	5.71	0.06	P<0.001	6.06	5.83	0.06	P<0.001	5.98	5.92	0.06	n.s.
6 hours												
Site 1	5.85	5.79	0.06	P=0.001	5.91	5.74	0.06	P<0.05	5.90	5.75	0.06	n.s.
Site 2	5.88	5.60	0.05	P<0.001	5.80	5.68	0.05	P<0.05	5.76	5.72	0.05	n.s.

[1] Least square means, [2] s.e.d. = standard error of the difference, [3] P = P-value where ns = not significant

Table 2 Proportion (%) of each meat quality, the average amount of ecchymosis-affected meat in shoulder primals (g/primal) and the percentage of carcasses with ecchymosis affected meat in each treatment group.

Treatment[1]	Meat quality[2]			Average amount of ecchymosis-affected meat (g/primal)	Percentage of ecchymosis affected carcasses (%)		
	Normal	SE	DFD		0 g	0 - 100 g	> 100 g
C/NH/E	0	100	0	110.2	45	11	44
C/NH/CO_2	22	78	0	7.3	78	22	
N/NH/E	44	56	0	65.8	45	22	33
N/NH/CO_2	56	33	11	0	100		
C/MH/E	10	90	0	70.3	20	60	20
C/MH/CO_2	20	60	20	0	100		
N/MH/E	40	50	10	16.8	60	40	
N/MH/CO_2	33	55	11	0	100		

[1] C = carrier, N = normal, NH = negative handling, MH = minimal handling, CO_2 = CO_2 stunning, E = electrical stunning
[2] classified as either normal, soft and exudative (SE) or dark, firm and dry (DFD)

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