THE EFFECT OF DIETARY MAGNESIUM ASPARTATE SUPPLEMENTATION AND HANDLING PRE-SLAUGHTER ON PORK QUALITY

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INTRODUCTION

The national incidence of PSE and DFD pork in Australia has been reported to be approximately 23% and 19% respectively (Eldridge *et al.*, 1995) and PSE alone is estimated to cost the Australian pig industry approximately $24 million annually. As a consequence, considerable research has been directed towards determining the 'best practices' for optimising pork quality. Often these 'best practices' are difficult and expensive to implement in a commercial situation hence innovative approaches to improving pork quality are required. Dietary magnesium supplementation is effective in reducing the effect of stress by reducing plasma cortisol, noradrenaline, adrenaline and dopamine concentrations (Niemack *et al.*, 1979). Magnesium may antagonise calcium and reduce the effects of stress by reducing neuromuscular stimulation which reduces catecholamines secretion (Kietzman and Jablonski, 1985). This has led to the use of magnesium supplementation as a viable option for improving pork quality (Kuhn *et al.* 1981) and reducing the incidence of PSE (Schaefer *et al.*, 1993; Otten *et al.*, 1992). Electric goads are commonly used pre-slaughter in the commercial industry and this practice has potential to increase the incidence of PSE. The use of electric goads pre-slaughter was proposed as a model for simulating commercial practice in a pilot abattoir environment and was postulated to induce 'stressed' pigs. The aim of this experiment was to investigate the effects of dietary magnesium aspartate (MgAsp) supplementation and pre-slaughter handling on pork quality.

MATERIALS AND METHODS

Forty-eight crossbred (Large White X Landrace) boars were randomly allocated in a 2x2 factorial design to dietary and handling treatments. The dietary treatments were imposed for 5 days pre-transport and were; (a) Control - finisher diet pre-slaughter, (b) MgAsp - 40g MgAsp/pig/day supplemented finisher diet. At the completion of the dietary treatments, the pigs were transported 1 km to the abattoir and slaughtered after overnight lairage. The handling treatments imposed just prior to slaughter were (a) minimum (minimum force) and (b) negative (15 shocks with an electric goad) handling. Pigs were stunned using a carbon dioxide dip-lift stunner set at 90% CO_2 with total exposure time of 2.2 min. Exanguination and dressing of the carcass conducted according to standard industry practice and carcasses were split before entering the chiller. A 1g muscle sample for muscle glycogen analysis was collected at 5min post-slaughter from the *M. longissimus thoracis* (LT) (12th/13th) rib, frozen in liquid nitrogen and stored at -20°C. Blood samples were collected at slaughter to determine plasma adrenaline, noradrenaline and magnesium concentrations. The pH of the LT was measured at 40min post-slaughter. At 24 h post-slaughter, ultimate pH, surface lightness (L^*) and drip loss were measured in the LT. Data was analysed by ANOVA (analysis of variance) using the GENSTAT5 program. Pigs were classified as PSE if the LT muscle had drip loss values > 5 % and surface lightness L^* values > 50 or DFD if the LT muscle had pHu values > 6.0, drip loss values < 1 % and surface lightness $L^* < 45$ (Warner *et al.*,1993).

RESULTS

The treatment means and their respective standard error of the difference (sed) are given in Table 1. Pigs fed the MgAsp supplemented diet had lower plasma noradrenaline, higher plasma magnesium and similar plasma adrenaline concentrations at slaughter compared to pigs fed the control diet. Plasma magnesium concentrations were also higher in pigs that were negatively handled at the abattoir prior to slaughter compared to pigs that were minimally handled prior to slaughter, but adrenaline and noradrenaline levels were not different. Pigs fed the the MgAsp supplemented diet had similar muscle glycogen concentrations and higher lactic acid concentration at slaughter compared to pigs fed the control diet. Pigs which were fed MgAsp supplemented diet had higher muscle pH at 40 min and 24 h post-slaughter, lower drip loss, less pale meat and a lower occurrence of PSE meat compared to pigs which were fed the control diet.

Negative handling reduced the muscle glycogen concentration and increased the muscle lactic acid level at slaughter compared to pigs receiving minimal handling pre-slaughter. Negative handling of pigs also resulted in an increase in drip loss and paler meat compared to minimally handled pigs. Although the occurrence of PSE meat was not different between minimally and negatively handled pigs, there was a suggestion of an interaction such that MgAsp treated pigs exhibited no PSE regardless of handling treatment whereas control diet pigs which were negatively handled had a much higher occurrence of PSE (33%) then minimally handled pigs (8%).

DISCUSSION

Short-term acute stress such as excitement and fighting amongst unfamiliar pigs just prior to slaughter can lead to increased muscle glycogen breakdown and a rapid build up of muscle lactic acid. Negative handling of pigs prior to slaughter using an electric goad had a detrimental effect on muscle metabolism and inferior pork quality as measured by lower muscle pH, paler pork, higher % drip loss and a higher occurrence of PSE pork.

Dietary MgAsp supplementation of pigs was sufficient to increase plasma magnesium levels by 6% above the control group, which is lower then reported by Schaefer *et al.* (1993) where plasma magnesium levels in the MgAsp treatment group pigs were 14 % higher compared to the control values. Even though the rise in plasma magnesium concentrations in this experiment were small, dietary MgAsp supplementation reduced plasma noradrenaline levels but not plasma adrenaline. Otten *et al.* (1993) has similarly reported that chronic dietary magnesium fumarate supplementation reduced plasma concentrations of noradrenaline but not adrenaline in pigs. At the abattoir the pig is confronted by a number of pre-slaughter stressors such as handling, noise, novel environment as well as the stunning procedure. As plasma catecholamine concentrations in this experiment were determined in blood samples obtained at slaughter, it is possible that any differences in adrenaline levels between the pigs in the control and MgAsp diet treatments could have been masked as a consequence of stunning and slaughtering procedure. However, this does not appear to be the case for noradrenaline.

Increases in catecholamine secretion due to stress just prior to slaughter can increase the rate of glycogen breakdown and increase the rate of glycolysis post-slaughter. Dietary MgAsp supplementation reduced the effect of catecholamines on muscle glycogenolysis as pigs fed the MgAsp supplemented diet had lower muscle lactic acid at slaughter. The beneficial effect of dietary magnesium supplementation on reducing the effects of stress was further emphasised by significant improvements in pork quality. These data indicate that dietary MgAsp supplementation can greatly improve pork quality in 'stressed' pigs as evidenced by the reduced % drip loss and incidence of PSE carcasses. While negative handling significantly increased the % drip loss in pigs fed the control diet, this was ameliorated by dietary MgAsp. The bebeneficial effects of MgAsp were more pronounced then previously observed during cChronic dietary magnesium fumarate supplementation (Otten *et al.*, 1992) and short-term dietary MgAsp supplementation (Schaefer *et al.*, 1993).

This experiment has confirmed that 'acute stress' such as the use of electric goads just prior to slaughter can lead to inferior meat quality. The results have also demonstrated that dietary MgAsp supplementation in pigs can improve meat quality and reduce the incidence of PSE pork in stressed and unstressed pigs. Dietary magnesium aspartate may also be a viable method for improving the quality of pork from 'stressed' animals.

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REFERENCES

Eldridge, D.A., Maynard, P., Warner, R.D., Pengelly, A. and Knowles, H.M. (1995). In *Manipulating Pig Production V.* Eds. D.P. Hennessy and P.D. Cranwell, Australasian Pig Science Association, Attwood, Victoria, Australia, p. 256.

Kietzmann, M. and Jablonski,, H. (1985). *Praktische Tierzucht.* **661**, 331-335.

Kuhn, G., Nowak, A., Otto, E., Albrecht, V., Gassmann, B., Sandner, E., Przybilski, H. and Zahn, L. (1981). *Arch. Tierzucht.* **24**, 217-225.

Niemack, E.A., Stockli, F., Husmann, E., Sanderegger, J., Classen, H.G. and Helbig, J. (1979). *Magnesium Bulletin* **3**, 195-198.

Otten, W., Berrer, A., Hartmann, S., Bergerhoff, T. and Eichinger, H.M. (1992). *Proceedings of the 38th International Congress of Meat Science and Technology*, Clermont-Ferrand, France, pp. 117-120.

Schaefer, A.L., Murray, A.C., Tong, A.K.W., Jones, S.D.M. and Sather, A.P. (1993). *Canadian Journal of Animal Science* **73**, 231-240.

Warner, R.D., Kauffman, R.G. and Russell, R.L. 1993. *Meat Science* **33**, 359-372.

TABLE 1 Effect of dietary magnesium aspartate (MgAsp) supplementation and pre-slaughter handling on plasma metabolites at slaughter, muscle metabolites post-slaughter and quality measurements in the *Longissimus thoracis* (LT).

DIET (D)[1]	Control[1]		MgAsp[1]			P-value		
HANDLING (H)[2]	Minimum[2]	Negative[2]	Minimum	Negative	sed	D[1]	H[2]	DxH
Magnesium[3] (mg/L)	21.4	23.2	23.0	24.5	0.782	0.011	0.005	0.785
Noradrenaline[3] (nmol/ml)	1.8	1.2	0.9	1.1	0.380	0.048	0.470	0.194
Adrenaline[3] (nmol/ml)	0.4	0.4	0.3	0.3	0.085	0.150	0.729	0.945
LT Glycogen (mg/g)	8.4	6.9	9.6	9.4	1.22	0.454	0.045	0.110
LT Lactic acid (mg/g)	3.8	4.2	3.2	3.5	0.270	0.001	0.015	0.554
LT pH 40min	6.60	6.59	6.79	6.69	0.058	0.018	0.045	0.574
24h	5.48	5.51	5.61	5.57	0.030	0.017	0.434	0.470
LT % Drip Loss	4.0	6.4	3.5	3.5	0.630	0.054	0.003	0.437
LT Lightness L*	48.7	49.1	45.2	47.4	0.840	0.042	0.047	0.624
% PSE[4]	8	33	0	0		0.010	0.280	0.093

[1] D = diet; Control = control diet; MgAsp = MgAsp supplemented diet
[2] H = handling, Minimal = minimal handling treatment just prior to slaughter, Negative = negative handling treatment just prior to slaughter
[3] Determined at slaughter
[4] Chi square goodness of fit test used.