THE USE OF SODIUM CHLORIDE AND BETAINE TO IMPROVE HYDRATION STATUS OF LAMBS AT SLAUGHTER

K.L. Pearce[1,2]*, D.G. Masters[1], R.H. Jacob[3], D.L. Hopkins[4] and D.W. Pethick[2]

[1] CSIRO Livestock Industries, Private Bag 5, Wembley, WA 6914, Australia, [2] Division of Veterinary and Biomedical Science, Murdoch University, Murdoch, WA 6150, Australia. [3] Department of Agriculture Western Australia, Baron-Hay Court, South Perth, WA 6151, Australia. [4] NSW Department of Primary Industries, Centre for Sheep Meat Development, PO Box 129, Cowra NSW 2794, Australia., Email: k.pearce@murdoch.edu.au

Keywords: lamb, sodium chloride, betaine, dehydration

Introduction

In Australia lambs are often routinely denied access to water for about 15 h prior to transport from farms to abattoirs. Although water is made available in lairage it is common for sheep not to drink due to the high stress environment (Jacob *et al.*, 2006b). Dehydration can be common at slaughter and corresponds to reductions in the fluid content of meat causing liveweight and carcass weight loss (Cole, 1995; Jacob *et al.*, 2006a). Importantly, Jacob *et al.*, (2006a) showed that dehydration can be averted if sheep drink in lairage. The priority of a dehydrated animal is to actively maintain blood volume which impacts on blood pressure and activates homeostatic mechanisms. Blood volume is maintained by drawing fluid from the muscle interstitial and intracellular fluid stores. The strategic feeding of high levels of sodium chloride and/or betaine in a finishing system prior to low or minimal water intake in lairage may prevent dehydration by increasing blood volume during transport and lairage (Kirkendall *et al.*, 1976). An elevated plasma volume would reduce the need to withdraw fluid from the muscle fluid spaces to maintain homeostatic blood volume and pressure. Less depletion of the muscle fluid stores may result in higher levels of fluid present at slaughter and therefore less muscle fluid loss. The high salt intake on farm will also increase water intake and result in high levels of fluid in the gastrointestinal tract which may act as a water reserve during times of water deprivation. Where sheep do have access to water in lairage, the high salt diet may also stimulate water intake above normal levels whilst in lairage and prevent dehydration. The consumption of betaine in either scenario may also be beneficial. In animals, betaine may have an osmoregulatory function similar to that in plants (Kettunen *et al.*, 2001) and assist in the retention of water in muscle tissue cells. This study evaluated the addition of sodium chloride and or betaine to a diet fed to lambs prior to a period of water deprivation and prior to commercial slaughter where water was made available in lairage.

Materials and Methods

Two separate experiments were conducted. Both experiments were a 2 x 2 factorial design with two levels of sodium chloride added (0 and 5%) and two levels of betaine (0 and 0.6%) in the diets (+salt+betaine, +salt-betaine, -salt+betaine, -salt-betaine). In both experiments, the sheep were allowed *ad lib* access to low salt water during the feeding period. For experiment 1, 96 Poll Dorset-Merino cross wether lambs (mean liveweight of 45.9 ± 0.17kg) were used. The sheep were split into 4 groups of 24 so that the experiment had 4 time replicates (n = 4 x 24 = 96). The sheep were fed 1.5kg/head d. of pellets for 7 days (6 per treatment) after which the 24 sheep were randomly allocated to one of 2 group pens. All sheep remained in these rooms for 48 hours without food or water, after which they were commercially slaughtered. Water intake was measured over the last 3 days of the 7 day feeding period. The lambs were weighed immediately prior to the 48 h period of water deprivation and prior to slaughter. For experiment 2, 204 Merino wether lambs (mean liveweight of 43.1 ± 0.35 kg) were used. The lambs were allocated to 1 of 12 group pens in groups of 17 with each pen being randomly allocated to 1 of the 4 experimental diets. The feed was allocated at 1.5kg/head.d and fed for 7 days. At 10am on the final day (day 8), all sheep were held in one pen with no feed or water prior to transport to the abattoir. Upon arrival at the abattoir the sheep were held in covered lairage yards with *ad lib* access to water available in 1 trough per pen. The lambs were slaughtered at 10am on day 10 after a total period of 48 h off feed and with a 24 h period immediately prior to slaughter with free access to water. The lambs were weighed immediately prior to transportation to the abattoir. For each animal in both experiments the hot carcass weight and GR fat depth were recorded and a 2 g sample taken of the *M. semimembranosis* (SM) and *M. semitendinosis* (ST) muscles within 1 h of slaughter for muscle dry matter content (muscle dry matter = muscle dry weight / wet weight * 100).

Results and Discussion

Under two different commercial scenarios there was no benefit of feeding sodium chloride and or betaine for 7 days prior to farm curfew, lairage and slaughter on liveweight or carcass loss or muscle dry matter. However in both experiments the consumption of the high salt diet did result in a higher (but not significant) fluid content in plasma and gut at the start of the 48 hour water deprivation/transport and lairage period [see (Pearce *et al.*, 2006)]. When no water was made available prior to slaughter (experiment 1) the high salt group excreted all the excess fluid in the plasma to achieve normal blood volume and pressure. In addition, the high salt group did not begin conserving fluid until later than the low salt group. A necessary trigger for fluid conservation is a decrease in blood volume below a homeostatic threshold. As a result of these processes, both groups conserved similar fluid levels in the muscle over the 48 h period.

Had the stimulus to conserve fluid been triggered earlier then it is possible that the fluid content of the muscles at slaughter may have been higher and consequently treatment differences in carcass weight and dressing percentage may have occurred. When water was made available from 24-48 h whilst in lairage (experiment 2), the high salt group drank proportionately more fluid than the low salt group. However at 24 h the high salt group had excreted all the excess fluid so that the high and low salt groups were at a similar hydration status and any water intake in lairage had a similar outcome in both treatment groups and is likely to have maintained blood volume. Betaine did not show any benefit for preventing liveweight and carcass loss. This may be because the levels of betaine in the diets were not high enough or because the osmotic role of betaine is specifically for non-ruminants.

Table 1: The effect of treatment on liveweight, carcass and muscle parameters (Mean ± SEM).

Parameter	Experiment 1						
	Treatment				Significance		
	-salt -betaine	+salt -betaine	-salt +betaine	+salt +betaine	Salt	Betaine	Interaction
Water intake (Litres/lamb.day)	5.4±0.33	8.3±0.69	5.7±0.36	9.1±0.92	<0.001	0.39	0.71
Liveweight prior to 48 h water deprivation period (kg)	46.1±0.27	45.5±0.38	45.9±0.38	45.8±0.38	0.27	0.88	0.56
Liveweight loss after 48 hour water deprivation period (kg)	4.6±0.42	4.9±0.18	4.5±0.38	4.9±0.22	0.31	0.14	0.52
Hot carcass weight (kg)	20.9±0.18	20.5±0.20	20.9±0.22	21.1±0.16	0.88	0.61	0.86
GR fat depth (mm)	12.1±0.41	12.2±0.60	12.7±0.67	13.2±0.49	0.57	0.04	0.02
Dressing percentage (%)	46.0±0.4	45.5±0.5	45.6±0.6	45.2±0.5	0.66	0.86	0.91
SM muscle dry matter (%)	27.8±0.2	27.9±0.2	27.9±0.2	28.1±0.2	0.42	0.47	0.83
ST muscle dry matter (%)	27.6±0.31	28.3±0.31	27.8±0.31	27.6±0.31	0.56	0.56	0.21
	Experiment 2						
Liveweight prior to leaving farm (kg)	43.5±0.77	43.9±0.77	43.8±0.77	44.2±0.77	0.48	0.94	0.55
Hot carcass weight (kg)	16.7±0.33	16.7±0.33	16.7±0.33	16.7±0.33	0.95	0.97	0.88
Dressing percentage (%)	38.4±0.65	38±0.65	37.8±0.65	37.8±0.65	0.56	0.63	0.22
GR Depth (mm)	5.9±0.38	7.2±0.38	6.2±0.38	4.8±0.38	0.95	0.05	0.13
SM muscle dry matter (%)	25.0±0.3	24.7±0.3	24.8±0.3	25.2±0.3	0.78	0.13	0.53
ST muscle dry matter (%)	24.3±0.3	24.2±0.3	24.6±0.3	24.3±0.3	0.35	0.74	0.41

Conclusions

There was no benefit of feeding sodium chloride and or betaine for 7 days prior to farm curfew, lairage and slaughter on liveweight or carcass loss with and without access to water in lairage. In both experiments, the high salt groups excreted all the excess fluid and were at a similar physiological and hydration status to the low salt groups at slaughter.

References

Cole, N.A. (1995). Influence of three-day feed and water deprivation period on gut fill, tissue weights, and tissue composition in mature wethers. *Journal of Animal Science* 73, 2548-2557.

Jacob, R.H., Pethick, D.W., Clark, P., D'Souza, D., Hopkins, D.L. and White J (2006a). Quantifying the hydration status of lambs in relation to carcass characteristics. *Australian Journal of Experimental Agriculture* 46, 429-437.

Jacob, R.H., Pethick, D.W., Ponnampalam, E. Speijers J, Hopkins DL (2006b). The hydration status of lambs after lairage at 2 Australian abattoirs. *Australian Journal of Experimental Agriculture* 46, (in press).

Kettunen H, Peuranen S, Tiihonen K (2001). Betaine aids in the osmoregulation of duodenal epithelium of broiler chicks, and affects the movement of water across the small intestinal epithelium in vitro. *Comparative Biochemistry and Physiology Part A* 129, 595-603.

Kirkendall, W.M., Connor, W.E., Abboud, F., Rastogi, S.P., Anderson, T.A., Fry, M. (1976). The effects of dietary sodium on blood pressure, body fluids, electrolytes, renal function and serum lipids in normosensitive man. *Journal of Clinical Medicine* 87, 418-434.

Pearce, K.L., Jacob, R.H., Masters, D.G., Hopkins, D.L., Pethick, D.W. (2006). The use of sodium chloride and betaine to improve the hydration status of lambs at slaughter. *Livestock Production Science* (Submitted).