4-P27

EFFECT OF WASHING CATTLE PRE-SLAUGHTER ON GLYCOGEN LEVELS OF *M. SEMITENDINOSUS* AND *M. SEMIMEMBRANOSUS*.

Peter Walker, Robyn Warner, Paul Weston, Matthew Kerr
Victorian Institute of Animal Science, Agriculture Victoria, Private Bag 7, Sneydes Rd. Werribee, Vic 3030, Australia.

Background:
Low muscle glycogen levels in cattle at slaughter are responsible for the dark-firm-dry condition in beef carcasses known as dark-cutting (Lawrie, 1991). Much of the published data contends that the rate of muscle glycogen depletion in cattle is slow (McVeigh and Tarrant, 1982; Tarrant and Lacourt, 1984) and will only impact on levels of dark-cutting after at least one hour of exposure to stress. Thus, stressors immediately pre-slaughter are not considered as important in depleting muscle glycogen as those stresses imposed upon cattle during the period from mustering to arrival at the abattoir. In the predominantly pasture based cattle producti systems in Australia, muscle glycogen levels can be inherently lower than fully grain-fed steers (Pethick *et al.*, 1995). It was hypothesized that the short-term pre-slaughter stresses at the abattoir may predispose pasture fed cattle to a greater risk of dark-cutting when muscle glycogen is already marginal. Washing of cattle is a routine pre-slaughter procedure in Australian abattoirs remove loose dirt and reduce the level of contamination on the carcass during hide removal. Observation of cattle washing procedures at abattoirs indicates a greater exposure of cattle to stock handlers and higher levels of potential stressors (eg physical exertion avoiding sprays, exposure to cold).

Objectives:
To determine the effect of pre-slaughter washing of cattle at a commercial abattoir on the depletion of muscle glycogen during tw different seasons.

Materials and methods:
Twenty-five consignments of domestic trade weight cattle (n=10 cattle per consignment, 170 - 250 kg hot carcass weight) were randomly selected from consignments arriving at an abattoir. Genotype (British breeds and British X European breeds), liveweig range (320-480 kg), mixed sexes (castrates and females) and age (10-24 months) were typical of cattle used for the domestic trad The experiment was conducted in two distinct seasons, summer and winter, to assess any influence of season and weather/ambien temperature. Fifteen replicates were conducted in summer on days meeting the criteria of 25° to 33° C and sunny conditions. Ten replicates were conducted in winter on days meeting the criteria of 10° to 15° C and overcast/showery conditions.

All consignments were kept in overnight lairage at the abattoir. On the day of slaughter, each consignment was randomly split int two groups just prior to washing and randomly assigned to one of the two treatments:
I: Slaughtered after receiving no washing prior to slaughter.
II: Slaughtered after receiving the usual washing procedures used at the abattoir prior to slaughter.

The washing practice at the abattoir consisted, initially, of a high pressure wash yard where jets in the floor sprayed water ventral onto the cattle for 40 seconds. This occurred at approximately 30 mins prior to slaughter. Follow up washing was conducted by person using a high pressure hose directed indiscriminately at the cattle in the collection pens prior to slaughter (up to five minut extra hosing before stunning and about 5-10 minutes pre-slaughter).

Cattle were handled as per normal practice at the abattoir prior to and after washing before being stunned using a captive bolt pist and exsanguinated at two minutes post stunning.

Samples of the ST (*M. semitendinosus)* and SM (*M. semimembranosus)* muscles (about 1g) were taken at ten minutes post slaug after low voltage stimulation and after skinning of first hind leg and snap frozen in liquid nitrogen. Samples were later assayed f lactate and glycogen content. Total glucose concentration was calculated as the sum of glycogen and lactate concentrations by weight. This approximates the number of glucose units available for glycolysis in the muscle at the time of slaughter (neglecting small contribution of glucose-6-phosphate).

Sex, hot carcass weight, P8 fat depth and dentition were recorded for each consignment and confirmed that all cattle were typical domestic trade cattle. Results were analysed separately for the summer and winter seasons using analysis of variance with block for each consignment. The greater variability in total glucose results for the winter season precluded the statistical analysis of th combined results.

Results:
The effect of washing on muscle glycogen levels over the fifteen consignments sampled during summer is shown in Table 1. Th total glucose concentration of the SM muscle was significantly lower ($P<0.05$) in the washed cattle than the unwashed groups. lactate content of the SM at the time of sampling also tended to be lower ($P=0.052$) in the washed groups compared to the unwas cattle although the glycogen content was similar ($P>0.05$). Metabolites in the ST muscle did not show any response ($P>0.05$) to washing in summer. The total glucose concentration in the ST was lower than in the SM muscle due to the higher proportion of

IIb muscle fibres in the SM muscle. In addition, at the time of sampling, the ST had lower glycogen and higher lactate levels than the SM.

The effect of washing on muscle glycogen levels over the ten consignments sampled during winter is shown in Table 2. As for the summer replicates, the winter replicates had lower ($P<0.01$) SM muscle lactate levels for washed cattle compared to unwashed cattle although the total glucose and glycogen concentrations were not significantly different ($P>0.05$) between treatments. In addition, the ST responded to washing with lower lactate ($P<0.01$) and tended to have lower total glucose content ($P=0.077$).

Table 1: Glycogen, lactate and total glucose concentration (mg/g muscle) for *m. semimembranosus* (SM) and *m. semitendinosus* (ST) for cattle undergoing the washing treatment (washed and unwashed) in summer.

Assay result	Unwashed	Washed	sed	P - value
SM-Glycogen content (mg/g)	4.12	3.95	0.22	0.456
SM-Lactate content (mg/g)	5.11	4.64	0.22	0.052
SM-Total glucose cont. (mg/g)	9.22	8.59	0.28	0.039
ST-Glycogen content (mg/g)	1.97	2.25	0.18	0.143
ST-Lactate content (mg/g)	6.03	5.66	0.23	0.125
ST-Total glucose cont (mg/g)	8.01	7.92	0.25	0.736

Table 2: Glycogen, lactate and total glucose concentration (mg/g muscle) for *m. semimembranosus* (SM) and *m. semitendinosus* (ST) for cattle undergoing the washing treatment (washed and unwashed) in winter.

Assay result	Unwashed	Washed	sed	P - value
SM-Glycogen content (mg/g)	4.22	4.40	0.48	0.710
SM-Lactate content (mg/g)	5.45	4.84	0.15	0.004
SM-Total glucose cont. (mg/g)	9.66	9.24	0.39	0.312
ST-Glycogen content (mg/g)	3.65	3.68	0.45	0.942
ST-Lactate content (mg/g)	5.94	5.24	0.21	0.009
ST-Total glucose cont (mg/g)	9.58	8.91	0.34	0.077

The effects of washing cattle pre-slaughter on muscle lactate content (at 10 minutes post-slaughter) appear to be consistent between the two seasons for the SM and the ST. Yet the results show that the total glucose content of washed cattle is lower than unwashed cattle for the SM only in summer and lower in the ST only in winter. The ST has a greater proportion of type IIa muscle fibres than the ST and would be expected to show higher levels of glycogen depletion in response to the stress of washing than the SM. This was observed to occur only in winter. The most likely explanation for the decrease in muscle lactate at sampling is that a stress response of the cattle to washing would involve glycogenolysis in the muscle and liver through the release of adrenaline/noradrenaline. Subsequent stimulation of glycolysis in the muscle would result in removal of lactate via the hepatic system. Any subsequent stress of pre-slaughter handling and stunning would induce less of a physiological response since lactate has already been mobilised from the muscle resulting in the lower lactate levels in the washed cattle.

Alternatively, the response of muscle lactate levels to washing may be associated with an element of conditioning of the cattle to ensuing stresses following washing. Their responses to further pre-slaughter stresses may have been modified by prior exposure to the stress of washing and subsequent stresses invoked a smaller catecholamine release than those in the unwashed groups. Hence, lactate accretion in the muscle may be lower after slaughter in the washed groups given that washing occurred at least 20 minutes pre-slaughter.

Conclusion:

Since washing of cattle pre-slaughter did indicate a decline in total muscle glucose for the SM in summer and for the ST in winter, it would appear that acute stressors close to slaughter may play a more important role in contributing to dark-cutting than previously considered. The lower levels of muscle lactate in washed cattle will have implications for muscle pH decline during rigor development with unwashed cattle possibly developing lower ultimate meat pH.

References:

Lawrie, R.A. (1991). The eating quality of meat. In *Meat Science. Edition 5,* Pergamon Press, Oxford, UK pp. 184-224.

McVeigh, J.M. and Tarrant, P.V. (1982). Glycogen content and repletion rates in beef muscle, effect of feeding and fasting. *Journal of Nutrition* **112,** 1306-1314.

Tarrant, P.V. and Lacourt, A. (1984). Effect of glucocorticoid, insulin and glucose treatment on muscle glycogen content in stressed young bulls. *British Veterinary Journal* **140,** 337-346.

Pethick, D.W., Rowe, J.B. and Tudor, G. (1995). Glycogen metabolism and meat quality. *Recent Advances in Animal Nutrition in Australia. Proceedings from July 1995.* 97-103.