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STRESS INDICATORS AND LEAN TISSUE YIELD IN TRANSPORTED CATTLE TREATED WITH ELECTROLYTES

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INTRODUCTION

Many factors interact to make transportation very stressful to cattle. For example, mixing of unfamiliar animals, removal of feed and water, loading, actual time on the road and lairage are all stressful events. One of the results of transport stress is live weight loss. Jones *et al.* (1992) showed that the full rumen and full intestines weights decreased with increasing time in lairage following four hours of transportation. However, they also showed that the cold carcass weight was reduced as a result of time in lairage. Therefore, live weight loss as a result of transportation and lairage is comprised of a reduction in the gastrointestinal contents as well as tissue loss from the carcass.

Tissue loss from the carcass implies that an increase in muscle protein degradation may be taking place. Two hormones that have been implicated in the control of protein degradation are the thyroid hormones, T_3 and T_4, and the corticosteroid hormones such as cortisol (Millward *et al.*, 1985). Therefore, it is of interest to determine how transportation stress affects the levels of these hormones. In addition, breakdown of muscle tissue may be indicated by enzymatic parameters such as creatine phosphokinase.

Previous research from our laboratory has shown that electrolytes can be used to effectively treat transport stress. Schaefer *et al.* (1992) showed that providing an electrolyte drink to cattle in lairage could reverse some of the physiological effects of transportation stress such increased urine osmolality, elevated numbers of neutrophils and reduced numbers of lymphocytes. Jones *et al.* (1992) also showed that provision of an electrolyte drink could also increase cold carcass weight.

The objectives of this experiment were to examine the effects of handling, transport and electrolyte treatment on pre-slaughter indicators of stress, live weight shrink and lean tissue yield.

MATERIALS AND METHODS

Experiment 1

Experiment 1 was conducted to assess the effects of transport and an electrolyte drench on live weight loss, carcass yield and meat quality. Forty-eight market-weight bulls (500kg) were weighed and given a drench of either water (sham drench) or one of two concentrated electrolyte mixtures (Nutricharge, Triple M Feeds, Red Deer, Alberta, Canada) immediately prior to four hours of transport. After 18 hours in lairage with access to water, all cattle were slaughtered at the Meat Research Centre, where a complete assessment of carcass quality and lean yield was performed.

Experiment 2

Twenty-eight bulls were used to intensively study physiological parameters. Jugular venous blood samples were collected immediately before the animals were loaded onto a trailer. After 24 hours in the trailer with access to food and water, the cattle were unloaded and the food was removed. Following collection of a second jugular venous blood sample, each animal received a drench of either water or a concentrated mixture of electrolytes (Nutricharge, Triple M Feeds, Red Deer, Alberta). Bulls were loaded back onto the trailer, and transported for four hours. Blood samples were collected from the tail vein at 0, 1, and 2 hours after transport. Following an overnight lairage in the trailer with access to water only, a sixth blood sample was collected. Serum was collected from all blood samples by centrifugation. Serum samples were analyzed for cortisol, T_3 and T_4 by radioimmunoassay (Coat-a-Count, Inter Medico, Markham, ON, and Immunocorp, Montreal, PQ, respectively) and for creatine phosphokinase (CPK) activity by an ultraviolet spectrophotometric assay (Sigma procedure no. 47-UV, Sigma Diagnostics, St. Louis, MO, USA).

Statistical Analysis

Data were subjected to an analysis of variance using a general linear model (SAS, 1989). For Experiment 1, the model used included treatment and breed as the main effects. For Experiment 2, the split-plot model used included sampling time as the main effect in the main plot, and treatment and breed as the main effects in the subplot. Treatment, breed, and the interaction between the two were tested against animal nested within treatment*breed as the error term.

RESULTS AND DISCUSSION

Experiment 1

Electrolyte treatment increased the carcass yield (565g hot carcass/kg of farm weight for sham-drenched animals vs 578g/kg for electrolyte-drenched animals; $P<0.05$). Therefore, electrolyte treatment was able to reduce tissue loss in transported cattle.

Experiment 2

Regardless of treatment, confinement on the trailer and transportation increased the levels of cortisol, T_4, and CPK ($P<0.01$, Table 1). Crookshank *et al.* (1979) also reported that handling and 12 hours of transportation increased cortisol levels in weaned calves. They also found that weaning and handling, but not transportation, increased CPK activity. Using older Friesian steers (600kg) Tarrant *et al.* (1992) found that 24 hours of transportation increased cortisol levels by 43% and CPK activity by 818%. Since thyroid hormones and cortisol are purported to be related to protein degradation (Millward *et al.*, 1983) and CPK activity is related to muscular damage (Tarrant, 1990), these hormonal and enzymatic changes observed in transported animals are consistent with the carcass losses that can result from transportation stress. Treatment with electrolytes significantly reduced the overall serum levels of T_4 ($P<0.05$) and tended to reduce T_3 levels ($P<0.10$). If this shift in the levels of thyroid hormones resulted in reduced muscle protein degradation, it could account for at least a portion of the increased carcass weight with electrolyte treatment observed in Experiment 1.

CONCLUSIONS

These data show that the alterations observed in endocrine parameters following transport stress are consistent with the observed decreases in lean tissue yield. They also show that electrolyte treatment can help to reverse the effects of transport on pre-slaughter indicators of stress, which may benefit the welfare of the animals.

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Table 1. Effect of handling and transportation on serum cortisol and thyroid hormone concentrations and creatine phosphokinase (CPK) activity in bulls in Experiment 2 (Least squares means ±SEM).

	Cortisol ($\mu m\ dL^{-1}$)	T_3 ($nm\ dL^{-1}$)	T_4 ($\mu m\ dL^{-1}$)	CPK ($UnitsL^{-1}$)
Time from start of exper. (hours):				
0	2.27^{a} ± 0.17	295^{a} ± 7.64	9.51^{a} ± 0.30	89.1 ± 210.77
24	3.24^{b} ± 0.17	310^{a} ± 7.64	11.8^{b} ± 0.30	546^{ab} ± 210.77
28	3.17^{b} ± 0.22	301^{a} ± 9.85	12.9^{c} ± 0.38	1507^{c} ± 284.91
29	1.35^{c} ± 0.22	300^{a} ± 9.98	12.7^{c} ± 0.39	1119^{bcd} ± 319.02
30	1.12^{c} ± 0.26	304^{a} ± 11.4	12.3^{bc} ± 0.44	1466^{cd} ± 318.86
48	2.14^{a} ± 0.17	320^{a} ± 7.75	13.2^{c} ± 0.30	526^{ab} ± 210.77
Prob.	0.0001	0.2624	0.0001	0.0003

^{a,b,c,d} Values in the same column wit unlike superscripts are significantly different ($P<0.05$).

Table 2. Effect of electrolyte treatment on serum cortisol and thyroid hormone concentrations and CPK activity in bulls in Experiment 2 (Least squares means ±SEM).

Hormone or enzyme	Treatment		
	Sham drench	Electrolyte drench	Probability
Cortisol ($\mu g\ dL^{-1}$)	2.35 ± 0.33	2.08 ± 0.30	0.5734
T_3 ($nm\ dL^{-1}$)	318 ± 13.1	292 ± 11.9	0.1561
T_4 ($\mu m\ dL^{-1}$)	13.0 ± 0.66	11.1 ± 0.59	0.0400
CPK ($UnitsL^{-1}$)	700 ± 182	1052 ± 177	0.1834