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THE EFFECTS OF TRANSPORTATION ON CARCASS YIELD, MEAT QUALITY AND HEMATOLOGY VALUES IN ELECTROLYTE TREATED CATTLE

T. JACOBSEN[1], A.L. SCHAEFER[2], A.K.W. TONG[2], R.K. STANELY[3], S.D.M. JONES[2], W.M. ROBERTSON[2] and R. DYCK[2]

1 Department of Animal Science and Animal Health, The Royal Veterinary and Agricultural University, Copenhagen, Denmark

2 Agriculture Canada Research Station, Lacombe, Alberta, Canada

3 Triple M Great West Feeds, Red Deer, Alberta, Canada

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INTRODUCTION

Transportation and management conditions can be very stressful to cattle due to physical (Stephens, 1980), physiological and social environment changes (Kenny and Tarrant, 1987). In fact, it has been suggested that transport and handling cause more stress to the animals than many other management practices (Johnston and Buckland, 1987). Much can, and has, been done to alleviate marketing stress through the management of the mixing of unfamiliar animals and stocking density (Price and Tennessen, 1981) as well as improving pre-slaughter and lairage nutrition (Wythes *et al.*, 1985; Hutcheson and Cole, 1986). These changes are consistent with the goals put forward by animal welfare groups such as the Canadian Farm Animal Welfare Council (1984).

However, specific physiological insults arising from transport and handling are documented to include dehydration (Wythes *et al.*, 1985) hypoglycemia (Jones, 1976), electrolyte imbalance (Schaefer *et al.*, 1988; 1990a), thermoregulation (Schaefer *et al.*, 1982; 1988) and hematological imbalance (Murata, 1987; Kent and Ewbank, 1986). Collectively, these insults not surprisingly result in a degraded meat quality (Jones and Tong, 1989) and reduced carcass yield (Egbert and Cornforth, 1986; Jones *et al.*, 1988) which has a significant negative economic impact on the cattle industry.

Despite these acknowledged and documented insults, the infrastructure and reality of the beef industry is such that cattle will continue to be handled and transported. In fact, rationalization currently ongoing in the cattle industry world-wide (fewer plants and greater distances between them) will likely increase transport and management stress in cattle. This situation therefore presents a major challenge to the cattle industry in terms of improving both animal welfare, meat quality and carcass yield.

Recent studies at the Agriculture Canada Lacombe Research Station have demonstrated that administration of electrolytes to cattle may be particularly important in treating pre-slaughter stress (Schaefer *et al.*, 1988; 1990a). Initial trials with young bulls showed that electrolyte supplementation increased carcass yield and normalized the animal's physiology which resulted in a decrease in the incidence of dark-cutting meat. These cattle were subjected to mixing and transportation over a 24-hour period prior to slaughter (Schaefer *et al.*, 1990a; 1992).

The purpose of the present study was to investigate the effect of electrolyte therapy on carcass weight loss, meat quality and hematology in long distance (24 to 48 hours) transported animals.

MATERIALS AND METHODS

Animals and management

Sixty-one crossbred yearling beef cattle averaging 500kg were used in the present study. The animals were allocated to one of three treatment groups balanced by sex and weight. The treatments were:
(Treatment 1)[Control]: the cattle were fed a balanced barley-cereal silage diet and water until transport;
(Treatment 2): the animals were fed an electrolyte pre-mix in their ration for 24 hours prior to transport plus ad libitum access to a liquid electrolyte supplement containing salt, sugar and amino acids as previously described (Schaefer *et al.*, 1990a);
(Treatment 3): the cattle were given access to the electrolyte pre-mix only in their feed 24 hours prior to transport.
All treatment groups were given a four hour transport via a commercial carrier, then held overnight on the carrier followed by an additional four hour transport the following day. The treatment group 2 animals were off-loaded and allowed *ad libitum* electrolyte drink following their initial transport.

The animals were not mixed during their transport or lairage and remained with the animals they have been raised with.

On arrival at the abattoir, no feed or water was provided for the animals in the lairage pens pre-slaughter and the animals were held an additional one to four hours before slaughter. Four slaughter dates within a four week period were required to process the animals and each treatment group was represented by a minimum of six animals on each slaughter date. While in lairage all animals were given straw bedding.

Just before and after transport the animals were weighed and while restraining the animals in a headgate, blood was collected by jugular venipuncture into 10ml vacutainers. Hematrocrit was determined using a Cell Dyn 700 analyzer (Sequoia-Turner Corp., Mountain View, CA). Blood smears were stained for white blood cell differential counts.

Carcass and meat quality

The animals were stunned by captive bolt and dressed according to commercial procedures (Jones *et al.*, 1988). The warm carcass, minus the body organs, alimentary tract, body fat deposits and non-carcass parts including head, feet and tail, were weighed and cooled. The pH of the *longissimus dorsi* was measured at the 13th rib using a Corning Model 4 pH temperature meter (Corning Glass Works, Medfield, MA) at 45 minutes, 24 hours and 48 hours (ultimate) post-slaughter. The carcass grading was conducted by ribbing the carcass between the 12th and 13th ribs approximately 24 hours after slaughter followed by a one hour bloom time prior to evaluation. Two meat colour measurements (CIE L*, a* and b* values) were taken on the surface of the *longissimus thorasis* and averaged. The colour co-ordinate L* represents the lightness or luminosity of the sample and the co-ordinates a* and b* define the yellow-blue axis and red-green axis respectively. A higher L* value for beef is associated with a lighter colour while higher a* and b* vales are associated with more yellow and more red.

A 25mm thick steak was removed from the *longissimus dorsi* muscle 96 hours following slaughter. This steak was placed in a styrofoam tray and wrapped with an oxygen-permeable film. Drip and evaporation losses were measured 96 hours after display at 1°C. Shear values were determined by removing a 25mm-thick steak from each loin after six days post-slaughter. For shear values, the steaks were cooked to 80°C in a microwave oven followed by cooling overnight at 1°C. Three 19mm cores were then removed along the lateral axis of the muscle and each core was sheared once, using an Ottawa Texture Measuring System (OTMS, Canners Machinery, Simcoe, ON) equipped with a Warner-Bratzler cell. Peak shear values for the three cores were averaged for each sample.

Leucocyte counts

Total leucocyte differential counts were made on blood smears stained with `camco quick stain.' Two hundred Leucocytes were counted on each smear using a E.Leitz, Wetzler micrscope (Germany) with micrscope lens 45:1 and 90:1.

Statistical analysis

Data were subjected to analysis of variance using a split plot model which included the main plot transportation treatment effect with animal within treatment as the main plot, error and treatment by time interaction in the subplot. All analyses were carried out using the General Linear Model system of SAS (1989).

RESULTS AND DISCUSSION

Prior to treatment, the animals had an average weight of 500kg and there was no significant difference among treatments.

Animals from the control group lost 27.7kg during the journey. Treatment 2 cattle lost 19.5kg and Treatment 3 animals lost 20.8kg (Table 1).

In the present study, the electrolyte-treated cattle retained between 6.9 and 8.2% more body weight than did the non-treated cattle. This difference was also apparent in the carcass yields as a proportion of final farm weight which was lowest in the control animals (53%) compared to either of the two electrolyte treatments (56.0% in T2 and 56.4% in T3) from animals having access to electrolyte solution. As suggested by Goll *et al.* (1992), some of the body weight loss could be explained by the movement of extracellular water into the reticulo-rumen. However, losses of weight appear to be mainly a combination of gut fill, liver and carcass weight loss (Jones *et al.*, 1992). Similar results have been reported by Schaefer *et al.* (1992) demonstrating that electrolyte-treated animals retained 1.1 to 1.9% more live weight than untreated controls. These differences were also apparent in both warm and cold carcass weight demonstrating a three to five kilogram reduction in carcass weight loss in treated cattle.

Meat quality values are presented in Table 2. Of interest was the observation that electrolyte supplementation had relatively few effects in terms of carcass quality. However, the a* value (CIE system) in the T2 animals (*longissimus dorsi*, 24 hours post-stunning) was slightly higher compared to T1 animals (P-0.06) or T3 animals (P=0.03). Also, the 24-hour pH value for T2 cattle (5.630±0.035) was slightly lower than T3 cattle (5.76±0.035) (P=0.05) but not significantly different from controls (5.690±0.038).

Total and differential white blood cell counts were affected by the transportation (Figure 1 and 2.). Significant increases in neutrophiles and significant reductions in lymphocytes were observed in all groups (P<0.01) regardless of treatment. However, this difference was less in the treated animals compared to the non-treated control animals (P=0.03). The increase in neutrophil numbers and decrease in lymphocytes was probably induced by the corticoid response brought on during transport and handling. The observed increase in neutrophiles with transportation agrees with the findings of Murata *et al.* (1987) who demonstrated that the immunosuppressive activity in cattle can be significantly challenged by road transportation.

CONCLUSION

Data from the current study demonstrates that long distance transport can be a significant stressor for cattle. A significant impact on both carcass weight loss and the immunocompetence of the animals is seen. Pre-transport treatment of the animals with electrolytes is seen to reduce the extent of carcass weight loss and the severity of the immunological changes. Treatment of cattle with electrolytes would therefore appear to be beneficial both in terms of economics and animal welfare.

However, compared to some long distance shipping regimes, the present study conditions were comparatively moderate. Had the weather been particularly hot or cold, the effects on the outcome might have been more drastic. Nonetheless, there seems to be good evidence that a pre-transport electrolyte-treatment of cattle prior to long distance hauling can significantly reduce weight loss.

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REFERENCES

EGBERT, W.R., and CORNFORTH, D.P. 1986. Factors influencing colour of dark-cutting beef. *J. Food Sci.* 51.

FARM ANIMAL WELFARE COUNCIL. 1984. *Report of the Welfare of Livestock (Red Meat Animals) at the time of slaughter.* London: HMSO.

GORTEL, K., SCHAEFER, A.L., YOUNG, B.A., and KAWAMOTO, S.C. 1992. Effects of transport stress and electrolyte supplementation on body fluids and weights of bulls. *Can. J. Anim. Sci.* 72:547-553.

HUTCHESON, D.P., and COLE, N.A. 1986. Management of transit-stress syndrome in cattle: Nutritional and environmental effects. *J. Anim. Sci.* 62:555-560.

JOHNSTON, N.E., and BUCKLAND, R.B. 1976. Response of male Holstein calves from seven sires to four management stresses as measured by plasma corticoid levels. *Can. J. Anim. Sci.* 56:727-732.

JONES, C.T. 1976. Hypoglycemia as a stimulus for adrenocorticotrophion secretion in foetal sheep. *J. Endocrin.* 70:321-322.

JONES, S.D.M., SCHAEFER, A.L., TONG, A.K.W., and VINCENT, B.S. 1988. The effect of fasting and transportation on beef cattle. 2. Body components changes, carcass composition and meat quality. *Livest. Prod. Sci.* 20:649-654.

JONES, S.D.M., and TONG, A.K.W. 1989. Factors influencing the commercial incidence of dark-cutting meat. *Can. J. Anim. Sci.* 69:649-654.

JONES, S.D.M., SCHAEFER, A.L., and TONG, A.K.W. 1992. The effects of fasting, electrolyte supplementation and electrical stimulation on carcass yield and meat quality in bulls. *Can. J. Anim. Sci.* 72:791-798.

KENNEY, F.J., and TARRANT, P.V. 1987b. The reaction of young bulls to short-haul road transport. *Appl. Anim. Behav. Sci.* 17:209-227.

KENT, J.E., and EWBANK, R. 1986. The effect of road transportation on the blood constituents and behaviour of calves. III. Three month old. *Brit. Vet. J.* 142:326.

MURATA, H., TAKAHASI, H., and MATSUMOTOT, H. 1987. The effects of road transportation on peripheral blood lymphocyte sub-populations, lymphocyte blastogenesis and neutrophil functions in calves. *Brit. Vet. J.* 143:166-174.

PRICE, M.A., and TENNESSEN, T. 1981. Pre-slaughter management and dark-cutting in the carcasses of young bulls. *Can. J. Anim. Sci.* 61:205-208.

SCHAEFER, A.L., YOUNG, B.A., and TURNER, B.V. 1982. The effects of cold exposure on blood-flow distribution in sheep. *J. Thermog. Bio.* 7:15-21.

SCHAEFER, A.L., JONES, S.D.M., TONG, A.K.W., and VINCENT, B.C. 1988. The effects of fasting and transportation on beef cattle. 1. Acid-base electrolyte balance and infrared heat loss of beef cattle. *Livest. Prod. Sci.* 20:15-24.

SCHAEFER, A.L., JONES, S.D.M., TONG, A.K.W., and YOUNG, B.A. 1990a. Effects of transport and electrolyte supplementation on ion concentrations,carcass yield and quality in bulls. *Can. J. Anim. Sci.* 70:107-119.

SCHAEFER, A.L., JONES, S.D.M., TONG, A.K.W., YOUNG, B.A., MURRAY, N.L., and LEPAGE, P. 1992. Effects of post-transport electrolyte supplementation on tissue electrolytes, hematology, urine osmolality and weight loss in beef bulls. *Livest. Prod. Sci.* 30:333-346.

STEPHENS, D.B. 1980. Stress and its measurement in domestic animals: A review of behaviourial and physiological studies under field and laboratory situations. *Adv. Vet. Sci. Comp. Med.* 24:179-210.

STATISTICAL ANALYSIS SYSTEMS INSTITUTE, INC. 1989 *SAS Users Guide: Basics and Statistics.* Version 6. Edition 4. SAS Institute, Inc. Cary, NC.

WYTHES, J.R., JOHNSTON, G.N., BEAMAN, N., and O'ROURKE, P.K. 1985. Pre-slaughter handling of cattle. The availability of water during the lairage period. *Aust. Vet. J.* 62:163-165.

Table 1. Live weight loss in transported cattle given access to, or denied, electrolyte therapy.

	Control (T1)	T2	T3
Animals, #	16	20	21
Live weight loss, %	4.8[a]	3.3[b]	3.5[b]
Live weight loss, kg	27.7[a]	19.5[b]	20.8[b]

[a,b] $P<0.01$.

Table 2. Meat quality values in transported cattle given access to, or denied, electrolyte therapy.

	Control (T1)	T2	T3
pH, 45min	6.71 ± 0.03	6.72 ± 0.03	6.76 ± 0.03
pH, -24h	5.69 ± 0.04	5.63 ± 0.03	5.76 ± 0.04
pH, +48h	5.70 ± 0.04	5.63 ± 0.03	5.76 ± 0.04
Moisture, g/kg	729.23± 2.79	727.91± 0.40	727.60± 0.39
Objective colour at 24h:			
L*	34.17± 0.39	33.72± 0.38	33.10± 0.39
a*	20.64± 0.43	20.89± 0.40	19.60± 0.40
b*	8.29 ± 0.31	8.42 ± 0.28	7.47 ± 0.29
Objective colour at 48h:			
L*	35.95± 0.39	36.36± 0.35	35.72± 0.36
a*	21.74± 0.30	22.50± 0.30	21.66± 0.30
b*	8.64 ± 0.21	8.90 ± 0.20	8.45 ± 0.20
Shear value, kg	9.23 ± 0.58	9.25 ± 0.53	9.80 ± 0.54