

New Zealand Society of Animal Production online archive

This paper is from the New Zealand Society for Animal Production online archive. NZSAP holds a regular annual conference in June or July each year for the presentation of technical and applied topics in animal production. NZSAP plays an important role as a forum fostering research in all areas of animal production including production systems, nutrition, meat science, animal welfare, wool science, animal breeding and genetics.

An invitation is extended to all those involved in the field of animal production to apply for membership of the New Zealand Society of Animal Production at our website www.nzsap.org.nz

[View All Proceedings](#)

[Next Conference](#)

[Join NZSAP](#)

The New Zealand Society of Animal Production in publishing the conference proceedings is engaged in disseminating information, not rendering professional advice or services. The views expressed herein do not necessarily represent the views of the New Zealand Society of Animal Production and the New Zealand Society of Animal Production expressly disclaims any form of liability with respect to anything done or omitted to be done in reliance upon the contents of these proceedings.

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](http://creativecommons.org/licenses/by-nc-nd/4.0/).



You are free to:

Share— copy and redistribute the material in any medium or format

Under the following terms:

Attribution — You must give [appropriate credit](#), provide a link to the license, and [indicate if changes were made](#). You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for [commercial purposes](#).

NoDerivatives — If you [remix, transform, or build upon](#) the material, you may not distribute the modified material.

<http://creativecommons.org.nz/licences/licences-explained/>

Effects of yarding and transport on muscle glycogen concentration in beef cattle

M.G. LAMBERT, T.W. KNIGHT, G.P. COSGROVE, A.F. DEATH AND C.B. ANDERSON

AgResearch, Grasslands Research Centre, PB 11008, Palmerston North, New Zealand.

ABSTRACT

Low ultimate-pH of beef is desirable because it enhances shelf life, colour and tenderness. Pre-slaughter stress is thought to deplete muscle glycogen and in extreme cases lead to higher ultimate pH of beef. Seventeen-month-old steers were allocated to three treatments (n=15): Control (C, grazing on pasture), Yarded (Y, held for 24 hours in cattle yards) and Yarded plus Transported (YT, as for Y but also trucked for 4 hours during the 24-hour yarding period). The Y and YT animals lost weight (average 25.5 kg) during time off pasture. Plasma glucose and lactate did not differ across treatments. Plasma cortisol and creatine kinase concentrations were increased by YT and plasma non-esterified fatty acids concentration by both Y and YT. Despite these indicators of occurrence of mild stress, especially in YT, muscle (*longissimus dorsi*) glycogen concentration was not influenced by treatments. Results suggest that increased emphasis on improved animal handling during yarding and trucking of cattle is unlikely to markedly lower the incidence of high-pH beef.

Keywords: beef; muscle; glycogen; fasting; transport.

INTRODUCTION

Low ultimate-pH of beef increases shelf life and improves colour and tenderness (Purchas and Knight, 1994). Living muscle has a pH of about 7.0, and after slaughter glycogen breakdown to lactic acid within muscle cells results in a decline in beef pH to as low as 5.5. Muscle glycogen concentration is 14 mg/g (80 mmol/g, Tarrant, 1989) to 19 mg/g (Lambert *et al.*, 1998) in resting well-fed cattle. To achieve a beef ultimate pH of 5.5 the concentration must be greater than 10.3 mg/g at slaughter (Tarrant, 1989). A reduction in incidence of high pH ("dark-cutting") beef will ultimately depend on better pre-slaughter management of cattle (Tarrant and Sherington, 1980). Depletion of muscle glycogen is triggered by increased circulating adrenaline and strenuous muscular activity (Tarrant, 1989). Yarding of animals prior to transport, and trucking animals to the processing plant may stress animals and elicit these responses, hence reducing muscle glycogen concentration at slaughter and decreasing potential to achieve low pH post-slaughter.

In this paper we report results of a trial where the effects of yarding/fasting, and short distance trucking of beef cattle on muscle glycogen concentration were measured.

MATERIALS AND METHODS

Seventeen-month old Hereford-cross steers were weighed on 17 February 1999, and randomly allocated within liveweight (LW) bands to three groups of 15 steers with similar average LW (452 - 454 ± 11 kg). These animals had been grazed on pasture at the AgResearch Aorangi Research Station on the Manawatu Plains for several months prior to the trial.

TREATMENTS

Each group was allocated to one each of three treatments: Control (C), Yarded (Y), and Yarded plus Transported (YT). The C group grazed pasture adjacent to the Aorangi cattle yards during the 24-hour treatment period and the Y and YT groups were each contained in pens with drinking water available. The Y group was yarded on the

morning of 3 March and remained there for 24 hours. The YT group was treated similarly apart from also being taken for a 4-hour out-and-back truck ride by a commercial carrier on the afternoon of 3 March.

MEASUREMENTS

Animals were weighed directly off pasture on 25 February and 3 March, then again on 4 March at the conclusion of the trial – at this stage the Y and YT animals had been fasted for 24 hours. Blood samples and a muscle sample from the *longissimus dorsi* were taken on 25 February and again on 4 March. Muscle glycogen concentration (Dreiling *et al.*, 1987) and plasma cortisol, non-esterified fatty acids (NEFA), glucose, lactate and creatine kinase (CK) concentrations were subsequently determined. Non-esterified fatty acids were analysed by the method of Shimizu *et al.* (1980). Glucose, CK and lactate were analysed using a Hitachi biochemical autoanalyser and Boehringer assay kits. Creatine kinase was assayed using the CK-NAC activated EC 2.7.3.2 UV test and glucose by the Gluco-Quant' method using hexokinase. Plasma cortisol was determined using a double-antibody radioimmunoassay, employing an iodinated tracer and a second antibody to precipitate the cortisol bound to the primary antibodies. Standard solutions were prepared in charcoal-stripped bovine plasma. Intra-assay coefficients of variation (CVs) were 7-13% and inter-assay CVs were 7-14%.

DATA ANALYSIS

Data for 4 March were analysed by analysis of variance using GLM procedures (SAS 1990) with values for 25 February included as covariates. Plasma CK data were transformed (\log_e) prior to analysis, but means presented are from non-transformed data.

RESULTS AND DISCUSSION

There were no significant differences ($P>0.05$) among groups in live weight, muscle glycogen concentration or any of the plasma variables on 25 February, 6 days before

treatments were imposed. Live weights at trial commencement on 3 March were also similar (464 – 467 ± 11 kg) among groups.

The Y and YT animals lost about 25 kg LW during their time off pasture (Table 1) as a result of decline in weight of digesta. Plasma glucose and lactate concentrations were not significantly changed by the Y and YT treatments (Table 1). The lack of an effect on lactate concentration suggests the animals were not subjected to vigorous physical stress as occurs during social regrouping of bulls (Tarrant 1989), which is not surprising, as these were relatively quiet steers.

However, plasma cortisol and CK concentrations were increased by YT, and plasma NEFA concentration by both Y and YT (Table 1). Our results concur with those of Warriss *et al.* (1995) who found also that short-duration transport increased plasma cortisol and CK as a result of the psychological and physical stresses experienced during trucking. There was a tendency for CK concentration also to be elevated in the Y group (Table 1), and the number of animals in each group with CK concentrations >200 IU/L was 2, 7, and 12 for C, Y and YT respectively. This suggests that the Y animals indulged in more vigorous activity (e.g., head butting and riding) than the C animals. The elevation in NEFA levels to a similar extent in both Y and YT animals was probably a response to fasting. McVeigh and Tarrant (1982) postulated that the increase in NEFA during fasting is a muscle glycogen-sparing effect.

Muscle glycogen level was not influenced by Y or YT treatments (Table 1), despite evidence from the plasma measurements that especially the YT animals were mildly stressed. However, McVeigh and Tarrant (1982) also found that a 24-hour fast did not affect muscle glycogen concentration.

TABLE 1: Liveweight loss during the 24-hour trial period, plasma glucose, lactate, cortisol, creatine kinase, and non-esterified fatty acids concentrations, and muscle glycogen concentrations for Control, Yarded and Yarded + Transported treatment groups (n=15).

	Control	Yarded	Yarded + Transported	SEM	Signif ¹
Liveweight loss (kg)	1.9 ^a	24.1 ^b	26.8 ^b	1.6	***
Glucose (mmol/L)	3.88	4.24	4.23	0.14	NS
Lactate (mmol/L)	1.70	2.63	2.50	0.34	NS
Cortisol (ng/ml)	18.3 ^a	22.6 ^a	31.6 ^b	3.1	*
Creatine kinase (IU/L)	140 ^a	253 ^a	629 ^b	82	***
Non-esterified fatty acids (mmol/L)	0.28 ^a	0.68 ^b	0.70 ^b	0.05	***
Muscle glycogen (mg/g wet tissue)	19.1	18.3	17.3	0.8	NS

¹Statistical significance of treatment effect: NS not significant * P<0.05, *** P<0.001. Numbers within rows with different superscripts are different at P<0.05

Had the animals been slaughtered at trial conclusion, the treatments would have had little influence on beef ultimate pH, which is in line with conclusions drawn in Tarrant's (1989) review of dark-cutting in beef. Some processing plant operators regard the incidence of high-pH prime beef as being too high. Improved pre-slaughter handling of animals has been thought to be one way of reducing the incidence. We have previously shown that moderate exercise, as might be imposed during mustering,

had no influence on muscle glycogen concentration in well-fed steers (Lambert *et al.*, 1998). The work we report here shows that two other potential pre-slaughter stresses (yarding/fasting and short-haul transport) also do not markedly affect muscle glycogen concentration of well-fed steers. This suggests that increased emphasis on animal handling during mustering, yarding and trucking of beef cattle is unlikely to lower the incidence of high pH beef in mature, well-fed animals. This is borne out by the survey of Graafhuis & Devine (1994) who related incidence of high-pH beef to a range of pre-slaughter factors and concluded that on-farm management factors may be of greater importance than generally believed. Smith *et al.* (1996) speculated that previous poor nutrition or ill health, or infrequent human contact might prejudice the ability of animals to maintain high muscle glycogen concentrations when stressed. Maybe high incidence of high-pH beef occurs when "at risk" animals are subjected to certain pre-slaughter stresses or where the stresses are extreme.

REFERENCES

- Dreiling, C. E.; Brown, D. E.; Casale, L.; Kelly, L. 1987: Muscle glycogen: comparison of iodine binding and enzyme digestion assays and application to meat samples. *Meat Science* **20**: 167-177.
- Graafhuis, A.E.; Devine, C.E. 1994. Incidence of high pH beef and lamb II: Results of an ultimate pH survey of beef and sheep plants in New Zealand. *Proceedings of Twenty Eighth Meat Industry Research Conference* **28**: 133-141.
- Lambert, M.G.; Knight, T.W.; Cosgrove, G.P.; Anderson, C.B.; Death, A.F.; Fisher, A.D. 1998. Exercise effects on muscle glycogen concentration in beef cattle. *Proceedings of the New Zealand Society of Animal Production* **58**: 243-244.
- McVeigh, J.M.; Tarrant, P.V. 1982. Glycogen content and repletion rates in beef muscle, effect of feeding and fasting. *Journal of Nutrition* **112**: 1306-1314.
- Purchas, R.W.; Knight, T.W. 1994. Factors other than disease affecting beef quality. *Proceedings of the Sheep and Beef Cattle Society of the New Zealand Veterinary Association* **159**: 16-32.
- SAS Institute Inc 1990: SAS* Procedure Guide. Version 6, Third Edition. Cary, N.C: SAS Institute Inc.
- Shimizu, S.; Tani, Y.; Yamada, H.; Tabata, M.; Murachi, T. 1980: Enzymatic determination of serum-free fatty acids: A colorimetric method. *Analytical Biochemistry* **107**: 193-198.
- Smith, D.R.; Wright, D.R.; Muir, P.D. 1996. Variation in meat pH in steers and association with other carcass attributes: analysis of a commercial database. *Proceedings of the New Zealand Society of Animal Production* **56**: 187-192.
- Tarrant, P.V. 1989. Animal behaviour and environment in the dark-cutting condition in beef - a review. *Irish Journal of Food Science and Technology* **13**: 1-21.
- Tarrant, P.V.; Sherington, J. 1980. An investigation of ultimate pH in the muscles of commercial beef carcasses. *Meat Science* **4**: 287-297.
- Warriss, P.D.; Brown, S.N.; Knowles, T.G.; Kestin, S.C.; Edwards, J.E.; Dolan, S.K.; Philips, A.J. 1995. Effects on cattle of transport by road for up to 15 hours. *The Veterinary Record*, April 1, pp. 319-323.