51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

Animal Welfare and Environment

EFFECT OF CHASSIS VIBRATION DURING ROAD TRANSPORT ON CATTLE WELFARE AND MEAT QUALITY

Markku Honkavaara[*1], Elina Helynranta[2], Jari Ylönen[3] and Tuula Pudas[3]

*Finnish Meat Research Institute[*1], Meat processing company Atria Oy[2],
University of Oulu[3]*

Key Words: cattle transport, vibration, heart rate, meat quality

Introduction

Road transport in a vehicle is thought to be harmful for animal welfare. In fact, there is a lack of data on animal stress evaluation during transport. In this study, the effect of chassis vibration on cattle welfare was evaluated continuously by heart rate monitoring in normally used vehicles during transport. To do that, cattle were loaded, transported, unloaded, lairaged and slaughtered following the commercial practice in Finland.

Objectives

The objective was to evaluate the effect of chassis vibration during road transport on cattle welfare and meat quality. For animal welfare evaluation, the correlation between chassis vibration and heart rate was analysed in a moving vehicle. Meat quality was analysed after slaughter.

Methodology

Six short (under 2 hours), six medium (under 8 hours) and six long distance (under 14 hours) transports were made by the usual vehicles: one lorry for short and three road trains for medium and long distances. In all 486 cattle were transported.

Before transport, a vibration data logger was installed with two clamps onto the right-hand frame of the chassis of the vehicle just below the floor of the transport box. Vibration was measured with an accelerometer that measured the vertical acceleration in the range of 0 to 10 G (frequence 3 – 40 Hz, Noreltek Oy, Finland). The location of the logger was in the middle of the longitudinal axis of the transport box. The logger was programmed to store acceleration values higher than 0.1 G every two seconds during the estimated transport time (2 – 14 hours). After unloading, the logger was removed and data was stored in a computer for further analysis. The stored data was then entered in an Excel table by time intervals of two minutes.

In this study, heart rate monitors were installed in 117 sample animals at the farm. Heart rates were monitored for one day at the farm, during transport and overnight lairage up to stunning, in all for about 40 hours (beats/min, Polar Vantage NV, Finland; Honkavaara et al. 1999). The monitors were removed after stunning before debleeding. Data from farm up to unloading was received for 47 sample animals. The collected data on heart rates and vibration was combined and processed for regression analysis.

In addition, stress levels of the above 117 cattle were evaluated by blood samples collected by jugular venepuncture into heparinised tubes on the farm one day before loading and after transport during unloading. Blood was analysed for creatine kinase (UV method, Nordic Enzyme Committee, Honkavaara et al. 1999 and 2003).

Carcass bruisings were evaluated during classification 45 min post mortem (none, slight or severe including their location; Honkavaara et al. 2003). Post mortem meat quality of the 107 sample animals was analysed by pH of the M. longissimus dorsi on the 11^{th} rib 24 hours pm, and by tenderness (Warner Brazler shear force, 8 days pm). Conventional statistical methods were used to calculate means and standard deviations.

Results & Discussion

In this study, the mean chassis vibration measured as vertical acceleration values from moving vehicles was in most cases below 2.0 G, higher values indicated an uncomfortable journey in three or four axle vehicles which can load from 14 to 20 adult cattle. This 2.0 G value is based on our earlier results with long distance transport vehicles. In practice, these accelerometer values indicate differences in road quality .

It was found that chassis vibration was higher during collection than in a full loaded vehicle. This resulted from the ”bumpy” small roads near farms compared to the smooth main roads after collection up to the slaughterhouse as indicated by the values for the vehicles: the short distance lorry had the highest average chassis vibration (G-load of 60 – 96 G/hour), followed by the medium distance road train (G-load of 46 G/hour) and the long distance road train (G-load of 22 – 30 G/hour; Table 1). All vehicles had air suspension, only the front axle of the short distance lorry did not have air suspension. Moreover, chassis vibration was lower in winter than in summer, perhaps due to the snow cover of the small roads near the farms.

Postural stability of untied cattle is important for animal welfare during transport. In order to minimise aggressive behaviour of loaded animals and carcass damages resulting from animal movement during transport, single- and two-animals pens are used in Finland.

The correlation coefficient between heart rate and G-value was calculated for the 47 sample animals whose heart rate was measured. If it was significant, a simple regression equation was calculated between heart rate (dependent variable) and chassis vibration (independent variable). Ten significant correlations between heart rate and vibration were discovered in the 47 sample animals. This showed that in most cases (79 %) vibration had no effect on heart rate during transport. Furthermore, animals which had a positive correlation between heart rate and vibration produced normal meat quality. However, one DFD bull had a negative correlation between heart rate and chassis vibration (Tables 1 and 2).

In Table 2, bull (2) differed from the others by having the highest increase in CK activity from farm to unloading (from 118 to 3655 U/l), and it developed DFD meat (ultimate pH value of 6.57 24 h pm). Moreover, that bull had slight bruising of the back. In this work, the occurrence of carcasses without any damages was highest after long transports, lower after medium and lowest after short transports. The rates of occurrence of no, slight and severe bruising were 66.4, 26.5 and 7.1 %, respectively (465 cattle). The most common damage type was slight perianal (severity/location).

The M. longissimus dorsi of bulls (1) and (5) and heifer (2) was a little tough. However, they were of normal tenderness as their shear force values were 8.6, 7.4 and 6.6 kg/cm^2, respectively. Very tender meat has a shear force value of 5.8 kg/cm^2 or lower, normal meat values range from 5.8 to 8.7 kg/cm^2, and tough meat exceeds 8.7 kg/cm^2 (Augustini and Spindler 2000).

Conclusions

The measured accelerometer values indicate road quality differences between animal collection and transport of the full loaded vehicle to the abattoir. Chassis vibration was lower in winter than in summer, perhaps due to the snow cover of the small roads near the farms. In most cases chassis vibration had no significant effect on the heart rate of cattle. That suggests that from the animal welfare and meat quality point of view, external factors like animal handling at the farm, during loading, transport, unloading and lairage are more significant than chassis vibration during transport.

References

Augustini, C. and Spindler, M. 2000. Shear force measurements of beef after different times of ageing. Wissenschaftlige Beiträge aus der Bundesanstalt für Fleischforschung, 39 (147), 539–542.

Honkavaara, M., Leppävuori, A., Rintasalo, E., Eloranta, E. and Ylönen, J. 1999. Evaluation of animal stress and welfare during long distance transport of cattle in Finland. Proceedings of the 45th International Congress of Meat Science and Technology, Yokohama, Japan, paper 2-P2, pp. 62–63.

Honkavaara, M., Rintasalo, E., Ylönen, J. and Pudas, T. 2003. Meat quality and transport stress of cattle. German Veterinary Journal 110 (3): 125–128.

Tables and Figures

Table 1. Regression equations and significance of the correlation between heart rate and chassis vibration in moving vehicles.

Animal	Transport time hours	Mean heart rate bpm	Total G-load G	G-load/h G/h	**Regression equation** Heart rate = a • G value + b
Heifer (1)	0.7	169	64.2	95.5	11.2 • G value + 128.0 *
Bull (1)	1.3	129	76.6	59.9	21.6 • G value + 73.0 ***
Bull (2)	7.7	111	353.8	45.8	–12.3 • G value + 133.9 ***
Bull (3)	10.1	87	250.6	25.1	11.9 • G value + 78.0 ***
Bull (4)	9.8	102	215.7	22.1	6.5 • G value + 95.4 *
Bull (5)	11.6	86	333.5	28.7	3.9 • G value + 79.5 **
Bull (6)	12.6	90	378.4	30.0	6.0 • G value + 82.1 *
Heifer (2)	12.6	82	378.4	30.0	6.4 • G value + 75.0 **
Bull (7)	12.6	93	378.4	30.0	11.6 • G value + 78.5 ***
Bull (8)	11.6	81	333.5	28.7	4.5 • G value + 76.4 *

Significance of the correlation * $P<0.05$, ** $P<0.01$ or *** $P<0.001$.

Table 2. Blood serum creatine kinase, CK activity and meat quality of the studied animals.

Animal	Transport time hours	**CK activity, U/l**			pH value 24 h pm	Shear force kg / cm^2	Carcass brusings
		Farm	Unloading	Change %			
Heifer (1)	0.7	102	268	163	5.59	2.7	None
Bull (1)	1.3	62	91	47	5.65	8.6	None
Bull (2)	7.7	118	3655	2998	6.57	–	Slight back
Bull (3)	10.1	113	319	182	5.56	5.9	None
Bull (4)	9.8	113	371	228	5.58	3.1	None
Bull (5)	11.6	122	150	23	5.62	7.4	None
Bull (6)	12.6	63	110	75	5.57	5.6	Slight perianal
Heifer (2)	12.6	86	172	100	5.58	6.6	None
Bull (7)	12.6	182	295	62	5.66	–	None
Bull (8)	11.6	94	138	47	5.60	–	None
Mean (n = 117)		112	268	139	5.57	5.5	–

Acknowledgements

This study was a part of the Catra project funded by the European Commission contract QLRT-1999-01507 during the years 2000–2003.