The Effects of Road Transportation on Some Physiological Stress Measures in Goats

M. A. Rajion[1], I. Mohamed Saat[1], I. Zulkifli* and Y. M. Goh[1]
Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

ABSTRACT : A study to assess the physiological stress responses in goats that were subjected to road transportation was carried out using 10 Kacang crossbred does. Five does were transported in the morning with another five transported in the afternoon covering a distance of 46 km in an open-truck at an average speed of 55 km/h. Immediately following the road transportation, there were dramatic increases in neutrophil:lymphocyte ratios and plasma glucose concentrations but plasma cholesterol concentrations and body temperature were not affected. The neutrophil:lymphocyte ratios and plasma glucose concentrations appear to be reliable indicators of stress in goats. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 9 : 1250-1252)*

Key Words : Road Transportation, Stress Responses, Physiology, Goats

INTRODUCTION

Goat production in Malaysia which has been mostly carried out by smallholder farmers is shifting towards commercial production (Rajion et al., 1993) and the goat industry inevitably involves transportation of live animals either for transfer between farms or for marketing of the animals. The animals in transport may be exposed to a variety of physical and psychological stimuli, many of which are novel and some of which are aversive. Consequently, transport of animals is recognized as a common cause of stress (Fraser and Broom, 1997). While there is substantial work (Rollin, 1995) on effects of handling and transportation of cattle, pigs and poultry, little work has been carried out to assess the extent of stress in transported goats. To the best of our knowledge, the effects of road transportation on stress reactions of goats under the hot and humid tropical conditions have not been studied previously. Heat stress has been recognised as one of the most common problems encountered during road transportation of livestock (Mitchell and Kettlewell, 1998). This study was carried out to investigate the impact of road transportation at different time of day on body temperature, neutrophil:lymphocyte ratios, plasma glucose and cholesterol concentrations in goats. The four physiological parameters have been proposed as sensitive indices of physiological stress response in animals that encountered short-term welfare problems such as handling and transport (Broom and Johnson, 1993).

MATERIALS AND METHODS

Kacang crossbred does aged between 4 to 10 mo and weighing between 4 to 10 kg were used in the experiment. All the animals were from a similar flock and raised semi-intensively on grass and commercial concentrates. They were divided into two groups, each consisting of five animals. One group was transported in the morning between 07:00 to 08:30 with an ambient temperature of 25°C. Another group was transported on a sunny afternoon between 12:30 to 14:00 with an ambient temperature of 29°C to assess if the higher afternoon temperature produced greater stress reactions. The animals were not restrained and transported in a truck with no covers with a floor space measuring 3×2 m. The journey (1.5 h) covered villages, farms, highways, roads with heavy traffic and traffic lights, covering a total distance of about 46 km with an average speed of 55 km/h.

Rectal temperatures were recorded before transportation (Pre), immediately after transportation (0 h) and at 6 and 12 h following transportation. Blood samples (5 mL) were taken from each goat by venipuncture into tubes containing EDTA as the anticoagulant prior to transportation (Pre), immediately after transportation (0 h), and 6 and 12 h after transportation. Blood smears were prepared using Wright's stain, and neutrophil (N) and lymphocytes (L) were counted to a total of 100 cells (Gross and Siegel, 1983). The blood samples for total glucose and cholesterol were centrifuged at 3,500 rpm for 5 min to obtain the plasma which was stored at -20°C. Plasma glucose concentrations were determined using the enzymatic colorometric test with glucose oxidase and a peroxidase catalysed indicator reaction available in diagnostic kits UNMATE 7 Gluc PAP (Roche Diagnostica). Plasma cholesterol concentrations were determined using standard biochemical test kits (Roche Diagnostica) measured on a chemistry analyser (Cobass Mira S. Roche).

Data were statistically analysed using an analysis of variance (ANOVA) (SPSS, 1998). Significant differences were determined at $p<0.05$ and the comparison of treatments was carried out according to the Duncan's

* Address reprint request to I. Zulkifli. E-mail: zulkifli@agri.upm.edu.my.
[1] Faculty of Veterinary Medicine Universiti Putra Malaysia 43400 UPM Serdang, Selangor, Malaysia.
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multiple range test (Steel and Torrie, 1980).

RESULTS

Body temperature

The mean body temperatures measured before and after transportation in the morning and afternoon are presented in table 1. There were no significant differences in the mean body temperatures measured before and at different periods after transportation. However, the mean body temperature recorded in the afternoon (39.6±0.19°C) was significantly higher ($p<0.05$) than that recorded in the morning (38.9±0.15°C).

Neutrophil : lymphocyte ratios

The effect of transportation on the N:L ratios was significant ($p<0.05$) (table 1). Immediately following both morning and afternoon transportation, there was a dramatic increase ($p<0.05$) in N:L ratios and remained elevated 6 h after the transportation. The ratios, however, returned to the pre-transportation levels within 12 h. There was no significant difference in N:L ratios between animals transported in the morning (1.22±0.13) and afternoon (1.11 ± 0.13).

Table 1. Effect of transportation on body temperature, neutrophil:lymphocyte ratio (N:L ratio) plasma glucose and cholesterol concentrations in goats (Mean ± S.E.M.)

	Before transportation	After transportation		
		0 h	6 h	12 h
A. Morning transportation				
Body temperature (°C)	38.8±0.32[a]	38.4 ±0.28[a]	39.4 ±0.22[a]	39.0 ±0.29[a]
N:L ratio	0.74±0.06[a]	1.64 ±0.27[b]	1.39 ±0.29[b]	1.10 ±0.22[a]
Plasma glucose (mmol/L)	5.00±0.65[a]	14.03 ±1.25[b]	3.80 ±0.24[a]	4.50 ±0.33[a]
Plasma cholesterol (mmol/L)	2.04±0.45[a]	2.17 ±0.61[a]	1.85 ±0.36[a]	1.83 ±0.33[a]
B. Afternoon transportation				
Body temperature (°C)	39.4±0.42[a]	40.0 ±0.27[a]	39.5 ±0.48[a]	39.4 ±0.42[a]
N:L ratio	0.59±0.05[a]	1.43 ±0.34[b]	1.35 ±0.27[b]	0.59 ±0.05[a]
Plasma glucose (mmol/L)	4.87±0.72[a]	13.21 ±1.85[b]	5.23 ±0.75[a]	4.87 ±0.72[a]
Plasma cholesterol (mmol/L)	1.84±0.28[a]	1.78 ± 0.17[a]	1.61 ±0.21[a]	1.84 ±0.28[a]

[a,b] Mean within the same row with no common superscripts are significantly different ($p<0.05$)

Plasma glucose concentrations

Irrespective of the time of transportation, immediately following transportation the goats exhibited a marked rise ($p<0.05$) in plasma glucose concentrations but showed recovery within 6 h and the values remained constant thereafter (table 1). Time of transportation produced no significant effect on the mean plasma glucose concentrations which was 6.84±1.02 mmol/L in the morning and 6.89±0.98 mmol/L in the afternoon.

Plasma cholesterol concentrations

Neither the morning nor afternoon transportation had significant effect on plasma levels of cholesterol at all periods of measurement. No significant difference in plasma cholesterol concentrations was detected between the morning (1.97±0.21 mmol/L) and afternoon (1.71±0.10 mmol/L) transportation.

DISCUSSION

The study reported here strengthen the notion that road transportation may elicit physiological stress responses in animals. The heterophil:lymphocyte ratio have been proposed as a sensitive index of stress in the avian species (Gross and Siegel, 1983), because exposure to stressors and/or corticosterone treatment caused it to increase progressively. In the goats, the N:L ratios were dramatically increased immediately following the road transportation and continued for 6 h. A similar increase in the neutrophil:lymphocyte and heterophil:lymphocyte ratios have also been reported for calves (Fraser and Broom, 1990), and broiler chickens (Zulkifli et al., 2000), respectively, subjected to road transportation. Elicitation of adrenocotical activity is known to precede neutrophilia (or heterophila) and lymphopenia (Siegel, 1985).

In the present study, it appears that the goats require about 12 h after exposure to a stressful event for the N:L ratios to return to pres-stress values. Heterophil:lymphocyte responses in chickens have been shown to decline following 30 h after onset of exposure to a short duration sound (104 decibels) (Gross, 1990). These variable findings may be explainable on the basis of differences in the perceived magnitude of the stressors.

Measures of corticosteroid response is of considerable value when assessing stress reaction in farm animals. However, a growing body of evidence has accumulated on the inconsistency and inadequacy of plasma corticosteroid concentrations as a biological index of stress (Zulkifli and Siegel, 1995). It is widely accepted that the H:L ratio is a less variable and more reliable than corticosteroid levels (Gross and Siegel, 1983; Zulkifli and Siegel, 1995). Data in the present study suggest that N:L ratio could be a reliable indicator of the perceived magnitude of stress in goats.

There was a drastic increase (280% in the morning, 217% in the afternoon) in the plasma glucose concentrations immediately after transportation although the levels returned to pre-transportation levels within 6 h after transportation. This increase could be due to increased glycogenolysis stimulated by increased secretions of catecholamines which are under sympathetic nervous control and also glucocorticoid hormones from the adrenal cortical tissues (Knowles et al., 1995). A stress induced increase of plasma glucose stimulated by glucoregulatory hormones in rats have also been reported by Yamada et al. (1993).

One of the many outward symptoms associated with physiological stress response is hypercholesteremia (Sapolsky, 1992). Transportation in this study, although augmented N:L ratio response, did not produce significant effects on the mean plasma cholesterol concentrations. It is possible that the measuring period may be too short to detect any changes since Knowles et al. (1995) detected maximum increases in plasma cholesterol in sheep only after 18 hours of transportation during a 24-hour journey.

The body temperature of the goats remained constant throughout the study. Although the goats that were transported in the afternoon had a higher body temperature than those transported in the morning, the former group exhibited lower N:L ratios and plasma levels of glucose, suggesting that the increase in body temperature was not high enough to result in greater stress reactions. These findings could be attributed to the duration of the journey (1.5 h) which is considered short.

CONCLUSION

The dramatic increases in neutrophil:lymphocyte ratios and plasma glucose observed in the animals subjected to the effects of road transportation suggest that these two parameters may be reliable indicators of stress in goats.

REFERENCES

Broom, D. M., J. A. Goode, S. J. G. Hall, D. M. Lloyd and R. F. Parrott.1996. Hormonal and physiological effects of a 15 hour road journey in sheep: Comparison with the responses to loading, handling and penning in the absence of transport. Br. Vet. J. 152:593-603.

Broom, D. M. and K. G. Johnson. 1993. Stress and Animal Welfare. Chapman and Hall, London, U.K.

Fraser, A. F. and D. M. Broom. 1990. Farm Animal Behaviour and Welfare. 3rd edn. CAB International, Wallingford, U.K.

Gross, W. B. 1990. Effect of exposure to a short-duration sound on the stress response of chickens. Avi. Dis. 34:759-761.

Gross, W. B. and H. S. Siegel. 1983. Evaluation of the heterophil/lymphocyte ratio as a measurement of stress in chickens. Avi. Dis. 27: 972-979.

Hoffbrand, A. V. and J. E. Pettit. 1985. Essential haematology. 2nd edn. Blackwell Scientific Publications, Williston, Vermont, U.S.A.

Knowles, T. G., S. N. Brown, P. D. Warriss, A. J. Phillips, S. K. Dolan, P. Hunt, J. E. Ford, J. E. Edwards and P. E. Watkins. 1995. Effects on sheep of transport by road for up to 24 hours. Vet. Rec. 36:431-438.

Mitchell, M. A. and P. J. Kettlewell. 1998. Physiological stress and welfare of broiler chickens in transit: solutions not problems! Poult. Sci. 77:1803-1814.

Rajion, M. A., A. R. Alimon, and M. P. Davis.1993. Goat and sheep production. In: Animal Industry In Malaysia (Ed. C. T. N. I. Fatimah, A. H. Ramlah and A. R. Bahaman). Faculty of Veterinary Medicine and Animal Science, Universiti Pertanian Malaysia. pp. 51-67.

Rollin, B. E. 1995. Farm Animal Welfare. Iowa State University Press, Ames Iowa, U.S.A.

Sapolsky, R. M. 1992. Neurobiology of the stress response. In: Behavioural Endocrinology (Ed. J. B. Becker, S. M. Breedlove, and D. Crews). MIT Press, MT, U.S.A., pp. 287-324

SPSS. 1998. SPSS Base 8.0 Applications Guide, SPSS Inc., USA.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and Procedures of Statistics: A Biometrical Approach. 2nd edn. McGraw-Hill Book Company, New York.

Yamada, F., S. Inoue, T. Saitoh and K. Tanaka. 1993. Glucoregulatory hormones in the immobilization stress-induced increase of plasma glucose in fasted and fed rats. The Endocrine Society. 132:2199-2205.

Zulkifli, I. and P. B. Siegel. 1995. Is there a positive side to stress? World's Poult. Sci. J. 51:63-76.

Zulkifli, I., M. T. Che Norma, C. H. Chong and T. C. Loh. 2001. The effects of crating and road transportation on stress and fear responses of broiler chickens treated with ascorbic acid. Arch. Geflügelk. 65(1):33-37.