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Technical note

Effect of transportation on plasma cortisol and packed cell volume in different genotypes of sheep

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Abstract

Differences in physiological responses to transportation for 45–90 min were investigated using 94 sheep of eight genotypes representing upland and lowland types. Fourteen journeys were made and blood samples were taken before and after each journey to compare pre- and post-transportation plasma cortisol concentration and packed cell volume (haematocrit; PCV). Overall, during the journeys cortisol concentration increased significantly (from 57.3 to 71.3 mmol/l) and PCV declined significantly (from 35.1 to 33.9%) but there was considerable individual variation. Plasma cortisol concentration in sheep of predominantly upland genotype showed a greater response than in sheep of predominantly lowland genotype. Genotypes compared in this way were Suffolk × blackfaced hill breed (50% upland genotype) with threequarter-bred Rouge de l'Ouest (25% upland genotype), and Derbyshire Gritstone (100% upland genotype) with Suffolk × Rouge de l'Ouest (100% lowland genotype) with further information from Charollais, Suffolk, Jacob × Texel and Manx Loghtan. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

Welfare codes and legislation for transportation of livestock should take into account differences both between species, and between classes of animals within species (Anonymous, 1995). The next stage is to consider whether there may be differences between breeds or genotypes which could have implications for welfare. No studies have been made on this subject in sheep unlike in pigs, where the halothane genotype is associated with poorer welfare during transportation (Geers et al., 1994; Nyberg et al., 1988).

Experimental studies have demonstrated clear differences among breeds of sheep in behavioural responses to various situations (Hohenboken, 1986) mostly relating to social and maternal behaviour. In transportation, sheep encounter many stressors (see for example, Broom and Johnson, 1993) and a definitive study of breed differences would involve contemporary comparisons of responses of animals reared and challenged under standardised conditions,

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to specific transportation-related stressors. However, before undertaking such a study, it is important to know whether such differences are likely to exist. The present pilot study investigates this possibility.

2. Methods

A total of 94 unshorn sheep of eight genotypes were subjected to periods of transportation in a twin-axle automobile-towed livestock trailer (Ifor Williams, Corwen, UK, model TA5G). Space allowance was 0.32 m^2/sheep (more generous than that customary in commercial practice in the UK for sheep of this kind, which is about 0.2 m^2/sheep; S.J.G. Hall, unpublished observations). Blood samples were taken by jugular venepuncture before loading and after unloading (heparinised syringes: Sarstedt Monovette 9 ml) and were kept on ice for up to 3 h. Packed cell volume (haematocrit; PCV) was then measured using a Hawksley microhaematocrit centrifuge (10 min, 18 000 rpm). Plasma was separated by centrifugation and stored at −17°C before assay of cortisol as described by Parrott and Goode (1992).

Five trials were conducted (Table 1). Genotypes were as follows, the sire breed being given first: Trial 1: (a) threequarter-bred Rouge de l'Ouest, i.e., progeny of Rouge de l'Ouest rams mated with crossbred (Rouge de l'Ouest × blackfaced hill breed) ewes, (b) Suffolk × black faced hill breed; Trial 2: (a) Suffolk × Rouge de l'Ouest, (b) purebred Derbyshire Gritstone; Trial 3: (a) Charollais rams, (b) Suffolk rams; Trial 4: Jacob × Texel; Trial 5: purebred Manx Loghtan. In Trials 1 and 2, the genotype that was more upland in character was, respectively, the Suffolk × blackfaced hill breed, and the purebred Derbyshire Gritstone. It was not known for certain which blackfaced hill breed was represented in this way, but it was probably the Swaledale.

In Trials 1 and 2, two batches each of 10 lambs were collected together from Farm A where they had been kept in separate flocks. Each batch was loaded into a separate pen in the trailer and transported to Farm F. After a week in confinement undergoing behavioural observations each batch was loaded into a separate pen in the trailer and transported to an abattoir.

In Trial 3, each batch was collected separately from a different farm and taken to Farm F. After a week in confinement undergoing behavioural observations each batch was loaded into a separate pen in the trailer and transported to an abattoir. Finally, in Trial 4, 21 sheep were taken 50 km (70 min) to an abattoir and in Trial 5, 21 ewes were transported around secondary roads for 50 km (70 min).

The Rouge de l'Ouest, Suffolk, Charollais and Texel are of lowland character, having been selected as meat breeds adapted to benign environments. Black faced hill breeds are adapted to more rigorous, extensive conditions, and the Jacob and Manx Logh-

Table 1
Experimental journeys

Trial	Batch	Genotype (% upland character)[a]	Sheep[b]	Farm of origin	Journey 1 (to Farm F)	Journey 2 (to abattoir)	Number of before–after journey comparisons
1 Feb 1995	a	3/4 Rouge (25)	10 lambs	A	15 km (45 min)	60 km (90 min)	20
	b	Suffolk × BF (50)	10 lambs	A	15 km (45 min)	60 km (90 min)	20
2 Feb 1995	a	Suffolk × Rouge (0)	10 lambs	A	15 km (45 min)	60 km (90 min)	20
	b	Derby Gritstone (100)	10 lambs	A	15 km (45 min)	60 km (90 min)	20
3 Feb 1995	a	Charollais (0)	6 adult rams	B	15 km (45 min)	60 km (90 min)	12
	b	Suffolk (0)	6 adult rams	C	40 km (60 min)	60 km (90 min)	12
4 Jul 1995		Jacob × Texel (50)	21 yearlings	D	see text	–	21
5 Dec 1994		Manx Loghtan (100)	21 ewes	E	see text	–	21
Totals		8 genotypes	94 sheep				146 comparisons

[a] See text for explanation of genotypes and upland character.
[b] Animals in Trials 1 and 2 were weaned female and castrate lambs, age 9 months, body weight approximately 38 kg. Animals in Trial 4 were female and castrated sheep, age 15 months.

tan, though now regarded as relatively non-commercial, 'hobby' sheep, have strong genetic affinities with the primitive breeds of coastal, western Britain (Hall and Clutton-Brock, 1988).

Descriptive statistics were calculated and comparisons made using the paired-sample *t*-test (two-tailed). PCV value (a percentage) was transformed to arcsine to permit parametric tests. For Trials 1 and 2, supplementary statistical analysis was by analysis of covariance (SAS, 1979). The cortisol concentration after transportation was the dependent variable. The hypothesis was that the dependent variable was determined by the following factors: genotype, journey (whether collection or delivery), by the interaction of these factors, and by the covariate (cortisol concentration before transportation).

3. Results

Combining all before–after journey comparisons ($n = 146$, Table 1), mean plasma concentration (SEM in brackets) before journeys was 57.33 (3.52) and after journeys 71.28 (3.64) nmol/l; these differed significantly ($t = 4.082$, $df = 145$, $p < 0.001$). Mean PCV value before journeys was 35.07 (0.28), and after, 33.97 (0.28); the difference is significant ($t = 6.466$, $p < 0.001$, $df = 145$). Percentage change in cortisol concentration ranged from +2387% (from 4.06 to 100.98 nmol/l) to −83.3% (from 42.94 to 7.18 nmol/l). In 85 of the 146 comparisons there was an increase, in one there was no change, and in 60 a decrease. Percentage change in PCV ranged from +10.3% (from 29 to 32) to −22.3% (from 35 to 27). In 26 of 146 comparisons there was an increase, in 31 there was no change, and in 89 a decrease.

Considering Trials 1 and 2, when the response of a genotype predominantly upland in character was compared with that of a lowland genotype, the latter showed a weaker cortisol response in both experiments (Table 2). Least-squares means, representing the post-journey plasma cortisol concentration corrected for the covariate and the other factor were as follows: Trial 1, 25% upland character 47.5, 50% upland character, 76.1 nmol/l; Trial 2, 0% upland character 18.8, 100% upland character 68.5 nmol/l. In Trial 2, there was a difference in response between the collection and the delivery journeys and evidence of a breed × experiment interaction. Least-squares mean plasma cortisol concentrations for the

Table 2
Analysis of covariance of plasma cortisol concentration after transportation

Source	df	SS	MS	F	*p*
(a) Trial 1: Comparison of plasma cortisol response of sheep with 25% and 50% upland character (see text for details)					
Model	4	17 893.6	4473.4	6.6	< 0.001
Error	35	23 753.7	678.7		
Total	39	41 647.3			$r^2 = 0.43$
Covariate		8546.0		12.5	< 0.01
Sheep genotype		7985.7		11.8	< 0.01
Journey		906.9		1.3	0.26
Genotype × journey		545.0		0.8	0.38
		17.893.6			
(b) Trial 2: Comparison of plasma cortisol response of sheep with 0% and 100% upland character (see text for details)					
Model	4	48 037.9	12 009.5	21.7	< 0.0001
Error	35	19 391.2	554.0		
Total	39	67 429.1			$r^2 = 0.71$
Covariate		16 780.5		30.3	< 0.0001
Sheep genotype		24 879.9		44.9	< 0.0001
Journey		4096.7		7.4	0.01
Genotype × journey		2280.8		4.1	0.05
		48 037.9			

collection journey and the delivery journey were, respectively, for the upland sheep 86.3 and 50.7, and for the lowland sheep, 20.8 and 16.8 nmol/l.

Considering Trial 3 (Suffolk and Charollais rams), there was no effect of genotype, experiment or covariate. In none of these three trials was there any consistent pattern of change of PCV.

Finally, considering Trials 4 and 5 in which sheep were transported once only, the Jacob × Texel sheep showed high absolute values of plasma cortisol concentration, 125.5 (10.0) nmol/l before and 137.0 (5.1) nmol/l after transportation; changes in PCV, from 37.6 (0.6) to 36.1 (0.6) were slight. The Manx Loghtan sheep showed a strong cortisol response, means (SEM) before and after transportation being 44.1 (7.8) and 81.8 (7.5) nmol/l respectively. Change in PCV was slight or absent, from 38.0 (0.71) to 36.8 (0.73).

4. Discussion

There is a sizeable body of evidence that sheep breeds differ in their behaviour (Hohenboken, 1986; Le Neindre et al., 1993; Romeyer and Bouissou, 1992) but rigorous demonstrations of such differences in response to husbandry practices are lacking, particularly in relation to the issue of welfare during transportation. This study is preliminary but it does demonstrate that genotypes are highly likely to differ in their responses to the combination of stressors that are likely to operate during and around transportation (Broom et al., 1996). In Trials 1 and 2, sheep were standardised for age and immediate past experience and were transported contemporaneously. A strong effect of genotype was observed, the sheep that were more upland in character showing a heightened cortisol response. The difference between genotypes was stronger in the second paired comparison, where the genotypes were more sharply contrasted too; one was 100% lowland, the other 100% upland. In the supplementary studies, the same contrast was observed. Combined together, these results justify further research on breed differences in response to stressors associated with transportation.

Although in Britain most of the sheep subjected to long distance transportation are meat lambs which may have been reared in relatively intensive conditions and which, genotypically, on average are 50% Suffolk (lowland) breeding (MAFF, 1983), purebred sheep of upland (hill and mountain) breeds are also transported in large consignments. These animals are kept in systems which involve less handling and human contact and they might be expected to respond more markedly to transportation. The significant genotype × journey interaction in the second paired comparison could suggest that genotypes may differ in their degree of habituation to stresses incurred around and during transportation.

It seems at least possible that breeds of livestock that are suited to extensive husbandry systems may differ in their responses to welfare challenges from breeds that have evolved in more intensive conditions. At present our understanding of this subject is very limited (Hall, 1993). Further studies are needed of such breed differences because of growing public concern over animal welfare (Broom and Johnson, 1993), and because the sustainability of livestock systems may depend partly on how well they are seen to meet this concern (Spedding, 1995).

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