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Wool growth responses in Drysdale and high and low staple tenacity Romney sheep to nutrient supplementation in autumn

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ABSTRACT

Maintenance diets containing two levels of energy (9.6 v. 11.5 MJME per kg DM) and two levels of protein (10.7 v. 21.7 g nitrogen per kg DM) were fed to four groups, each of ten Romney (five low and five high staple tenacity) and four Drysdale yearling rams, for six weeks from mid March.

Protein supplementation increased protein intake by 114% ($P<0.001$). It increased clean wool growth in the treatment period (6.2 v. 10.2 $g.\mu m^{-2}.d^{-1}$, $P<0.001$), moreso in Drysdales than Romneys (89 v. 46%; $P<0.001$). It also increased mean fibre diameter (38.1 v. 34.3 µm, $P<0.001$) without changing the proportion of fibre that was medullated. Responses to the nutrient supplements were similar in low and high staple tenacity Romney rams.

It is concluded that during the photoperiod-induced decline in wool growth in autumn, sheep on a maintenance diet responded to the increase in dietary protein with an increase in the volume of fibre and volume of keratin produced with no net change in the proportion of fibre medullated.

Keywords: sheep; wool; diet; fibre diameter; medullation.

INTRODUCTION

The peak force to break staples of greasy wool has been the sole selection criterion used in breeding lines of Romney sheep for high and low staple strength (Bray *et al.*, 1992) or, more correctly, staple tenacity (Scobie *et al.*, 1994a). The selection process has not only produced sheep that differ in staple tenacity but in wool growth, as indicated by staple length, fibre diameter and fleece weight (Bray *et al.*, 1992). The greater wool growth in the High staple tenacity line could be due to greater efficiencies in the ingestion, digestion, or absorption of nutrients, or in their partitioning to wool growth. Any difference could be present all year or only at particular times. Bray *et al.* (1993) reported that, at a common level of intake in winter when wool growth rates of the selection lines (Woods *et al.*, 1995) are at an annual low, the High staple tenacity line grew more wool of greater fibre diameter. Wool growth responses to dietary supplements of energy, protein or methionine at that time were similar in Low and High staple tenacity lines.

The present experiment investigated responses to dietary energy and protein in early autumn when wool growth rates in the staple tenacity selection lines are higher than in winter (Woods *et al.*, 1995). Since the lines differ in the amount of medullated fibres (Scobie *et al.*, 1993), medullation responses to the nutritional treatments were also measured. Drysdale rams were included in the study to provide highly medullated fleeces for comparison with the lesser medullated Romney fleeces.

MATERIALS AND METHODS

Twenty yearling rams were selected from each of the Low and High staple tenacity Romney selection lines (Bray *et al.*, 1992) for extreme values in staple tenacity at hogget shearing. Sixteen Drysdale yearling rams were selected from a commercial flock to provide a range of levels of medullated fibre. Thus the rams were not representative of their genotypes. Within genotypes they were randomly allocated within hogget fleece weight, liveweight and medullation classes to four dietary treatments in a factorial design with two levels of dietary energy (LE, HE) and two of dietary protein (LP, HP). Mean initial liveweight of the rams was 55 kg.

The LELP diet was pellets of meadow hay (67% fresh weight), maize (28%), molasses (3%), lime (1.5%), and minerals (0.5%). The HE diets had tallow incorporated into the LELP pellets at the rate 6% of dry matter (DM), and HP diets had 9% blood meal incorporated. All four diets were fed daily to individual rams at a common rate per unit of metabolic liveweight. The feeding rate was adjusted weekly during the treatment period to maintain the mean liveweight on the LELP diet.

The rams, which had previously grazed grass-clover pastures, were introduced to the treatment diets and individual pens over three weeks, prior to a six week treatment period which lasted from 16 March to 27 April 1993. This was followed by a three week post-treatment period when the rams returned to pasture.

Each week during the treatment period liveweights and intakes of feed dry matter (DM) were measured and samples of the diets were collected. The diets were analysed for nitrogen content by the Kjeldahl method and sulphur content was determined turbidometrically after nitric/perchloric acid digestion. Metabolisble energy (ME) content was estimated from crude protein, crude fibre, ether extract and ash contents (Alderman, 1985). LE diets contained 9.6 and HE diets 11.5

MJME per kg DM. LP diets contained 10.7 g nitrogen and 1.07 g sulphur per kg DM, while HP diets contained 21.7 and 1.4 g respectively.

The relative efficiencies with which nutrients were used for wool growth during the treatment period were estimated by comparing treatment means for wool growth rate at the mean levels of metabolisable energy, nitrogen or sulphur intake.

Wool grown from the previous shearing to the start of treatment and during three periods of three weeks during the treatment and post-treatment periods, was harvested from 10 x 10 cm midside patches. The Romneys had been shorn on 10 November 1992 and the Drysdales on 9 October 1992. To allow previously formed portions of fibres to emerge from follicles, harvesting was delayed five days from the start and end of treatments. Clean wool growth rates were calculated from the weight of clean wool harvested and patch area data for each animal. Mean and variation of fibre diameter was measured by OFDA (Baxter *et al.*, 1992). Medullation was measured by a light refraction method calibrated against projection microscope measurements of the percent of fibre area that was medullated (WRONZ medullameter, Lappage and Bedford, 1983). The medullation data was adjusted for effects of fibre snippet length and sample weight using separate factors calculated for Romney and Drysdale wools (A.R. Bray and N.C. Merrick, unpublished).

The data was analysed by analysis of variance and covariance using GENSTAT5.

RESULTS

When adjusted for differences in initial liveweight, nutrient intakes over the treatment period were similar in low and high staple tenacity and Drysdale rams. Greatest nutrient intakes were achieved on the LEHP diet (Table 1). Dry matter (6%), estimated metabolisable energy (8%), nitrogen (114%), and sulphur (36%) intakes were all increased ($P<0.001$) by the protein supplement. In contrast all except estimated metabolisable energy intake were decreased (-4%, +14%, -9% and -11% respectively, $P<0.001$) by the energy supplement. Interactions between energy and protein supplements had significant ($P<0.01$) effects on the intake of all nutrients except sulphur.

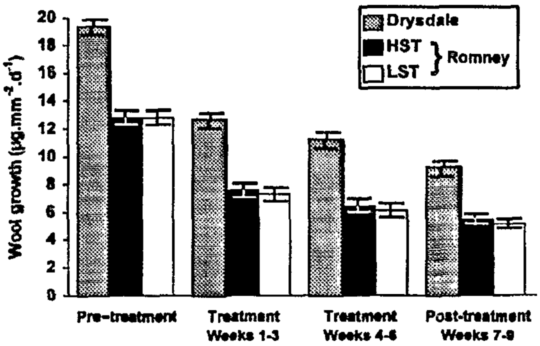
Liveweight gains during treatment averaged 27 $g.d^{-1}$ (Table 1) with no significant difference between ram genotypes, but an increase ($P<0.001$) due to protein supplementation and a decrease ($P<0.001$) due to energy supplementation. Rams in all treatment groups lost weight at an average of 102 $g.d^{-1}$ during the post-treatment period.

TABLE 1: Nutrient intakes and liveweight changes over the treatment period, adjusted for initial liveweight

	Daily intake (g or MJ) Dry matter	Metabolisable energy	Nitrogen	Sulphur	Liveweight change ($g.d^{-1}$)
LELP	1100	10.6	12.6	1.21	17
HELP	1015	11.6	10.1	1.05	-31
LEHP	1125	10.9	24.5	1.61	91
HEHP	1112	12.9	23.9	1.47	31
LSD 5%	31	0.4	0.6	0.04	32

In all three ram genotypes clean wool growth (Figure 1), clean wool yield, fibre diameter mean, and medullation declined during the experiment. Throughout the pre-treatment, treatment and post-treatment periods, Drysdale rams had higher ($P<0.001$) wool growth rates (14.4 v. 7.9$g.\mu m^{-2}.d^{-1}$), fibre diameter means (43.7 v. 32.5 µm), g coefficients of variation in fibre diameter (56.1 v. 26.6 %), and medullation (50.6 v. 9.4%) than Romney rams. Although the differences in wool growth between low and high staple tenacity rams were not significant, high staple tenacity rams had greater fibre diameter means (36.3 v. 31.2 µm, $P<0.001$) and lower coefficients of variation in fibre diameter (22.7 v. 29.9 %) throughout, and less medullation (7.1 v.13.7%, $P<0.01$) in the pre-treatment period.

FIGURE 1: Clean wool production during the experiment



The estimated efficiencies with which dietary metabolisable energy, nitrogen and sulphur were used for wool growth were greater for Drysdales than Romneys ($P<0.001$). They were also greater for high than low staple tenacity rams but the differences were not significant.

Wool growth was increased by protein but not energy supplementation and responses to the supplements differed between breeds (Table 2). These effects were not removed when wool growth data was adjusted for differences in intake of metabolisable energy, nitrogen or sulphur. The wool growth response to the protein supplement ($P<0.001$) was greater in Drysdales than Romneys (61 v. 40% during treatment; breed x protein interaction $P<0.001$). The protein supplement also increased mean fibre diameter by 6% and 14% (NS, Table 3) and the square of mean fibre diameter by 13% and 29% in Drysdales and Romneys respectively. Protein supplementation reduced fibre medullation in Drysdales by 7% and increased it in Romneys by 19% (breed x protein interaction $P<0.05$, Table 4), and it increased the efficiency with which metabolisable energy was utilised for wool growth ($P<0.001$). The depression in wool growth in response to the energy supplement was greater in the Drysdales, particularly in the post-treatment period (post-treatment breed x energy interaction $P<0.001$). Nutritional treatments had no significant effects on the coefficient of variation in fibre diameter nor on % clean wool yield.

DISCUSSION

Nitrogen and sulphur intakes were substantially increased by blood meal in the HP diets. Given that over 60%

TABLE 2: Wool growth rates ($g.mm^{-2}.d^{-1}$) during treatment and post-treatment periods

	Treatment period			Post treatment period		
	Romney		Drysdale	Romney		Drysdale
	LST	HST		LST	HST	
LELP	5.3	5.7	9.9	4.6	4.9	9.9
HELP	5.3	6.5	8.5	4.5	5.5	6.9
LEHP	7.4	8.0	15.2	5.0	6.2	11.2
HEHP	8.7	7.8	14.2	6.5	5.5	8.7
LSD 5%	1.6	1.6	1.8	1.4	1.4	1.5

TABLE 3: Mean fibre diameter (μm) during the treatment and post-treatment periods

	Treatment period			Post treatment period		
	Romney		Drysdale	Romney		Drysdale
	LST	HST		LST	HST	
LELP	28.6	33.7	43.9	26.1	31.2	37.6
HELP	26.7	34.8	41.7	24.3	32.0	37.5
LEHP	33.3	37.3	46.3	29.4	33.8	42.6
HEHP	33.0	37.1	44.7	29.9	33.6	38.8
LSD 5%	3.2	3.2	3.5	2.7	2.7	3.0

TABLE 4: Fibre medullation (%) during the treatment and post-treatment periods

	Treatment period			Post treatment period		
	Romney		Drysdale	Romney		Drysdale
	LST	HST		LST	HST	
LELP	8.0	7.7	57.9	8.5	8.6	48.5
HELP	9.7	7.2	55.4	8.6	7.1	46.5
LEHP	10.1	9.4	54.5	9.0	8.3	49.2
HEHP	9.6	9.9	50.7	9.1	10.3	40.0
LSD 5%	5.2	5.2	5.8	9.7	9.7	10.6

of blood meal escapes degradation in the rumen (National Research Council, 1985) it is likely that the amount of amino acids available to the animal increased more than the nitrogen and sulphur intake figures indicate. The depression of intake by inclusion of tallow in the diet was surprising since it did not occur on similar diets fed in the study of Bray *et al.* (1993). The interactions between effects of energy and protein supplements on food intake indicated that the energy supplement impaired the ability of animals to respond to increased dietary protein and/or that the energy supplement improved the ability of animals to utilise nutrients in the energy supplement. The greater nitrogen and sulphur intakes on the HP diets were associated with greater wool growth during the treatment period which carried over into the post-treatment period. Similarily, a negative impact of energy supplementation on wool growth in Drysdales continued after the end of treatment. This may have been due to abnormal responses in a few of the eight Drysdales rather than a true indication of the ability of Drysdale-type animals to utilise high energy diets.

Compared to Romneys, the Drysdale rams utilised nutrients more efficiently for wool growth and exhibited a greater wool growth increase in response to protein and a greater decrease due to energy supplementation. The magnitude of the wool growth responses to HP diets was impressive, 61% in Drysdales and 40% in Romneys. Rams from the two staple tenacity selection lines exhibited small differences in wool growth efficiency in autumn, supporting the finding of Bray *et al.* (1993) of similar reponses to nutritional treatments in winter.

The declines in wool growth, yield, mean fibre diameter and medullation over the experiment were normal for these type of sheep in autumn (Sumner, 1983; Scobie *et al.*, 1993; Woods *et al.*, 1995). The greater wool growth, fibre diameter and medullation of Drysdale relative to Romney wool were expected although there is limited comparative data available (Sumner *et al.*, 1981; Sumner 1983; Scobie *et al.*, 1994a). Sumner's estimates of the fibre diameter of Drysdale wool are likely to be underestimates because of a bias against broad fibres in the subsample of fibres measured by FDA equipment (Lynch and Michie, 1976). Because the animals in the present study were not necessarily representative of their breed, the findings are not claimed to be true breed effects. In Drysdales there was a relatively small response in fibre diameter and medullation, indicating that a large part of their growth response to protein supplementation must have been due to the increase in fibre length growth. The response of Drysdales to protein was large relative to the response to energy supplementation which is at odds with the finding of Champion and Robards (1994) who compared Tukidales, a highly medullated breed similar to Drysdales, with Australian Romneys. The high staple tenacity Romney rams had greater wool growth rate and mean fibre diameter, less variation in fibre diameter and less medullated fibre than the low staple tenacity rams, supporting the collective findings of Bray *et al.* (1992, 1993) and Scobie *et al.* (1994a and b).

Thicker fibres in a fleece are more likely to be medullated than thinner ones and medullation levels in Romney fleeces are greatest in summer when fibre diameter is greatest (Scobie *et al.*, 1994). Thus the increase in fibre diameter due to protein supplementation could have been expected to increase medullation. However this was not the case, which suggests that the increase in fibre volume was matched by an increase in keratin synthesis.

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