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SULPHUR AND FLAVOMYCIN SUPPLEMENTATION OF LUPIN GRAIN FOR SHEEP

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Summary

Merino ewes, 16 months old, were fed wheat chaff ad libitum every day and the equivalent of 250 g/d of lupin grain twice weekly. Different sulphur sources (2% gypsum or 1.2% methionine) were added to the lupin grain with or without flavomycin (20 mg/ kg lupins). There tended to be an increase in wool growth ($P<0.08$) only in the sheep fed lupin grain with the addition of both methionine and flavomycin. Liveweight gain was increased in the sheep only given gypsum or flavomycin ($P<0.05$). The results of this experiment indicate that the addition of sulphur to lupin grain fed as a supplement to sheep does not increase wool production.

I. INTRODUCTION

The ratio of nitrogen to sulphur in lupins is approximately 20:1, while the ratio required by rumen microbes is around 12:1. It is therefore possible that lupins may require additional sulphur for efficient microbial growth when fed as a supplement. Peter et al. (1987) reported an increase in wool growth (7%) and liveweight (13%) in grazing sheep given lupins with a sulphur supplement. However when penned sheep were fed wheat chaff (600 g/d) and the equivalent of 250 g/d of lupins fed twice per week, with a range of sulphur sources (2% gypsum, 12% fishmeal, 1.2% methionine or 1.2% hydroxymethyl - methionine) only sheep given the fishmeal supplement were found to have significantly increased (7%; $P<0.05$) wool growth (Murray et al. 1990a).

The supply of amino acids available to sheep, particularly the sulphur amino acids, can exert a considerable effect on the rate of wool growth (Wright 1971; Reis 1979). Increases in wool growth of up to 80% have been found in sheep given abomasal supplements of methionine (Reis and Schinkel 1963, 1964; Langlands 1970). However where animals have been supplemented with dietary methionine, responses have been variable (-24% to 53%) depending on the quality of the diet and the quantity of methionine fed (Graceva 1969; Wright 1971; Doyle and Bird 1975) possibly because over 80% is degraded in the rumen (Langar et al. 1973). In circumstances where the diet of sheep is deficient in sulphur additional dietary sulphur should increase microbial protein synthesis and therefore microbial sulphur amino acid supply to the sheep.

Flavomycin is a feed antibiotic which has been shown to promote wool growth (Aitchison et al. 1989; Murray et al. 1990b). The mechanisms by which flavomycin is thought to act is by increasing uptake of amino acids from the small intestines, and/or by reducing the turnover of protein in the gut wall. It is therefore possible that inclusion of flavomycin can increase the efficiency with which additional amino acids are utilised by the animal.

The objective of this experiment was to investigate the potential to improve wool production and liveweight gain in sheep supplemented with lupin grain through provision of additional sulphur or sulphur amino acids, with or without the inclusion of flavomycin.

II. MATERIALS AND METHODS

(a) Animals and Experimental Design

Merino ewes aged 16 months and weighing 43.4 ± 0.4 kg (mean ± s.e.) were used in the experiment. Before the start of the experiment the sheep were drenched with Ivomec (Merck, Sharp and Dohme Australia Pty Ltd). All sheep were housed in individual pens throughout the experiment and water was available at all times. Feed intake was measured daily.

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Animals were allocated to treatments on the basis of liveweight such that treatments started with similar mean liveweights. Animals were fed their experimental diets for two weeks before clipping midside patches. After eight weeks the midside patches were clipped again to measure the effect of the additives on wool growth. There were 30 sheep in the control treatment group supplemented with lupins only and there were 17 animals in all other treatment groups.

In all treatments, chaff (ad libitum) and lupins (equivalent to 250 g/hd.d fed twice/ week) with sulphur and or flavomycin supplements sprinkled on the lupins were given on Mondays and Thursdays. The additives to the lupins were as follows:

Treatment	Sulphur source	Level (g/kg lupins)	Flavomycin	Level (g/kg lupins)
1	Nil		Nil	
2	Nil			20 mg
3	Gypsum	20 g	Nil	
4	Gypsum	20 g		20 mg
5	Methionine	12 g	Nil	
6	Methionine	12 g		20 mg

The wheat chaff had a mineral vitamin premix added which supplied the following minerals (g/tonne of complete diet): Fe 30, Zn 30, S 24, Mn 10, Cu 4, Mo 1, I 0.5, Co 0.1, Se 0.1 and vitamins (MIU/tonne) A 1.65, D 0.28, E 0.015. In addition it supplied 5 kg NaCl and approximately 5 kg ground wheat carrier for each tonne of complete diet.

(b) Experimental measurements

Live weight: Animals were weighed every thursday prior to feeding of the lupin supplement for the duration of the experiment.
Wool production: Clean wool growth was determined by clipping and measuring mid-side patches (10 x 10 cm). Mid-side patches were removed by small animal clippers (Oster, Milwaukee USA, blade size 40) at the end of the two week introduction period (and the wool discarded) and cut again after the sheep had been on their respective diets for a further eight weeks (this wool was kept for production measurements). The wool grown during the eight week period was used to assess the effect of the sulphur and or flavomycin supplements.
Rumen samples: During the last week of the experiment, samples of rumen fluid (20 ml) were taken by stomach tube from all animals, 24 h after the Monday lupin supplement containing sulphur additives and or flavomycin were fed. The pH of the rumen fluid was measured before the samples were acidified with concentrated sulphuric acid and stored at -20 °C for subsequent analysis for volatile fatty acids (VFA) and ammonia concentration.

III. RESULTS

There was no significant difference in intake of lupins or chaff between the treatments (mean ± s.e. across treatments of 247.1 ± 0.9 g lupins/d and 1082.9 ± 14.1 g chaff/d). The lupins were consumed within 24 hours of being offered. The wheat chaff had a dry matter digestibility of 58% and contained 11.7 g N/kg DM and 1.4 g S/kg DM. For the lupins the corresponding values for N and S were 48.0 and 2.8. Liveweight gain and wool growth measured during the final seven weeks of the experimental period are summarised in Table 1. The average clean wool growth rate for all the sheep in the experiment was 8.96 $g/m^2.d$.

Liveweight gain was increased through the addition of only flavomycin (22.6%; $P<0.05$), gypsum (34.8%; $P<0.05$) or methionine (19.0%; $P<0.06$) to the lupin supplement. There tended to be an increase ($P<0.08$) in wool growth (9.4%) only in sheep supplemented with lupins and both methionine and flavomycin.

Table 1. Effect of addition of sulphur and flavomycin to a lupin supplement on live weight change and wool growth of sheep fed wheat chaff (mean ± se)

Sulphur source	Antibiotic	Liveweight gain (g/d)	Clean wool growth ($g/m^2.d$)
Nil	Nil	81.5 ± 4.8^{a}	8.82 ± 0.26
Nil	Flavomycin	99.9 ± 6.3^{bc}	8.98 ± 0.35
Gypsum	Nil	109.9 ± 6.2^{b}	8.62 ± 0.36
Gypsum	Flavomycin	91.0 ± 6.1^{ca}	8.85 ± 0.35
Methionine	Nil	97.0 ± 6.1^{cba}	9.09 ± 0.35
Methionine	Flavomycin	91.5 ± 6.1^{ca}	9.65 ± 0.35

Values in the same column with different superscripts are significantly different ($P<0.05$)

The measurements made on samples of rumen fluid are summarised in Table 2. The sheep fed gypsum as a sulphur additive to their lupin supplement had significantly lower ($P<0.05$) ammonia concentrations than the treatment groups given methionine. The concentration of total VFA was significantly higher ($P<0.05$) for the sheep given both methionine and flavomycin on their lupin supplement.

Table 2. Effect of addition of sulphur to a lupin supplement on rumen pH, total volatile fatty acid (VFA) concentration and ammonia concentration (NH_3) of sheep fed wheat chaff (mean ± se)

Sulphur source	Antibiotic	pH	Total VFA (mmol/l)	NH_3 (mgN/l)
Nil	Nil	6.47 ± 0.02	76 ± 2^{a}	178 ± 8^{ab}
Nil	Flavomycin	6.39 ± 0.05	78 ± 4^{a}	177 ± 11^{ab}
Gypsum	Nil	6.50 ± 0.04	75 ± 2^{a}	155 ± 11^{a}
Gypsum	Flavomycin	6.58 ± 0.05	78 ± 3^{a}	154 ± 12^{a}
Methionine	Nil	6.46 ± 0.03	81 ± 3^{a}	202 ± 16^{b}
Methionine	Flavomycin	6.37 ± 0.04	85 ± 2^{b}	197 ± 13^{b}

Values in the same column with different superscripts are significantly different ($P<0.05$).

IV. DISCUSSION

The increases in liveweight gain in response to sulphur supplementation indicate an animal requirement for additional sulphur with lupin supplementation. Inorganic sulphur (gypsum) increased liveweight gain in this experiment in a similar magnitude to that reported by Peter et al. (1987) and Murray et al. (1990a). However the lack of an increase in wool production with sheep supplemented with gypsum in this experiment appears to contradict the findings of Peter et al. (1987) and Wheeler et al. (1980) who reported a small non significant 7% increase in wool growth. The results of the current experiment support the findings of Murray et al. (1990a) which demonstrated a trend towards a decrease in wool growth in response to gypsum. A major difference was that sheep in our experiments were housed and sulphur was added to the lupins. In the studies of Peter et al. (1987) and Wheeler et al. (1980) the sulphur was included in a mineral mix/lick with animals grazing pasture. Purser (1981) and Doyle et al. (1990) indicate that pasture levels of nitrogen and sulphur may drop as low as 12 gN/kg DM and 1.5 gS/kg DM over the summer-autumn period. The N and S levels of the wheat chaff used in this experiment were probably very similar to that of the pasture levels in the study by Peter et al.(1987) and Wheeler et al. (1980) which would have had to have been much lower to explain the difference in the results of these experiments.

The absence of any significant response in liveweight gain to methionine suggests that either no additional methionine reached the small intestine or that this amino acid was not limiting growth. The increased wool growth in sheep receiving both methionine and flavomycin suggests that some additional methionine may have reached the small intestine and that the presence of flavomycin improved the efficiency with which it was utilised by the animal.

It is interesting that there were increases in liveweight in response to supplementation with gypsum but that these changes were not reflected in wool growth. Since feed intake was similar for all treatment groups an increase in liveweight gain indicates an improved efficiency of nutrient utilization presumably associated with an increased supply of microbial protein due to an improvement in the ratio of N to S. With the well established sensitivity of wool growth to the supply of sulphur amino acids it is difficult to explain why an increase in liveweight was not associated with an increase in wool growth. The fact that rumen pH, total VFA concentration and ammonia concentration was not significantly different raises the question as to whether the addition of gypsum had any effect on rumen microbial (sulphur) metabolism and in fact the combination of lupins and a poor quality feed will supply sufficient N and S for normal growth with the limiting factor being the quality of the basal diet.

Additional experiments are required in grazing animals to confirm the results of this experiment with respect to wool growth. However it appears that increases in wool may not be achieved in response to sulphur supplementation of lupin grain.

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