THE EFFECTS OF DIETARY SUPPLEMENTS OF OIL ON RUMINAL FERMENTATION LIVEWEIGHT GAIN AND WOOL GROWTH IN MERINO SHEEP

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Summary

Twelve sheep given a ration of 800g lucerne chaff were divided into groups of three and the following supplement added to their diet: nil; 50 ml linseed oil; 50 ml safflower oil; 50 ml cottonseed oil. The quantities of oil were increased to 100 ml after 9 weeks. The addition of oils had no effect on either the pattern of volatile fatty acid production in the rumen or on wool growth, but liveweight was significantly increased. The observed fermentation patterns were in contrast to published results of the effects of short term infusions of oils into the rumen of sheep. The study however, demonstrates clearly that extra energy in a particular diet has no effect on wool growth rate.

I. INTRODUCTION

The addition of either saturated or unsaturated long chain fatty acids to the diet of sheep has been found to lower methane production (Czerkawski, Blaxter and Wainman 1966), and to stimulate propionate production in the rumen (Demeyer, Van Nevel, Henderickx and Martin 1969).

Suppression of methane production may reduce energy losses to the animal in fermentation, while an increase in the propionate/acetate ratio may considerably increase the net energy content of the ration.

Hydrogen gas appears to be the precursor of methane in ruminants (Hungate, 1967). This arises from oxidation of pyruvate to acetyl co-enzyme A or acetyl phosphate (Leng, 1970), and also through the oxidation of reduced co-enzymes generated in the fermentative pathways. Since exogenous fatty acids are known to depress methane production, it is possible that they may do so by inducing a change in the microbial community in which propionate forming bacteria develop at the expense of those forming acetate. An interesting property of propionate forming organisms in the rumen is that they appear to have a relatively high requirement for sulphur (Whanger and Matrone 1967).

It occurred to us that feeding oil may have beneficial effects on sheep because (i) it provides directly metabolisable energy for maintenance and growth; (ii) if it changes the pattern of fermentation to a higher propionate producing system, the availability of glucose precursors will increase (a feature of importance in pregnancy and lactation); (iii) promotion of propionate producing organisms may increase wool growth rate if the high sulphur requirement of these organisms results in an increase in the sulphur amino acid content of their cells and (iv) high propionate production may be associated with an increased flow of protein out of the rumen as reported by Ishaque, Thomas and Rook (1971).

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In the studies presented here, the effects on wool growth and bodyweight gain of adding oils to a basal ration of lucerne chaff are reported.

II. MATERIALS AND METHODS

(a) Experimental animals and feeding regime

Commencing on December 9, 1969, 12 medium-wooled Merino ewes (aged 3-5 yr) selected for uniformity of liveweight and fleece type and fitted with permanent rumen cannulae, were given a ration of 800 g lucerne chaff for a period of 20 weeks. During the final 14 weeks of this preliminary period, wool growth rate was measured in each animal by clipping a tattooed area 9 x 9 cm square at approximately monthly intervals. On April 27, 1970 the animals were randomised into four groups on the basis of wool growth rate, and at 0900 hours each day thereafter they were given a ration of 800 g lucerne chaff plus one of the following supplements:

- Group I nil;
- Group 2 50 ml linseed oil;
- Group 3 50 ml safflower oil;
- Group 4 50 ml cottonseed oil.

The quantities of oil were increased to 100 ml after 9 weeks. The sheep consumed their daily ration within about 2 h. The oil feeding continued for 18 weeks. Wool growth rate was measured as above during the final 10 weeks of this period. At approximately monthly intervals the animals were weighed. A sample of rumen fluid was taken at 1100 hours and 1500 hours on each of these occasions.

(b) Chemical methods

Wool samples were processed as described by Hill, Watson and McClymont (1968). The concentrations and proportions of volatile fatty acids (VFA) in ruminal fluid were determined by steam distillation and gas liquid chromatography (Leng and Leonard 1965).

III. RESULTS

(a) Liveweight change

All animals increased in weight during the experimental period, but those given oil exhibited significantly greater liveweight gains than the controls. (Table 1.)

(b) Wool growth rate

Wool growth during the oil feeding period was higher than during the preliminary period, but there was no differential change among the four treatment groups (Table 1.)

(c) Ruminal fluid VFA

Total VFA concentrations and the proportions of each acid present were unaffected by the oil feeding treatment (Table 1.)

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TABLE I

The effects of oil supplementation on the concentrations and proportions of volatile fatty acids (VFA) in the rumen, bodyweight change, and relative wool growth rate.

<table>
<thead>
<tr>
<th>Weight gain during supplementation period (kg)</th>
<th>Control</th>
<th>Supplementation Cottonseed</th>
<th>Supplementation Linseed</th>
<th>Supplementation Safflower</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7 ± 1.7(b)**</td>
<td>12.0 ± 3.5(a)</td>
<td>8.3 ± 2.4(ab)</td>
<td>13.3 ± 1.7(a)</td>
<td></td>
</tr>
<tr>
<td>Wool growth rate as a percentage of that before oil feeding</td>
<td>107 ± 2.2(a)</td>
<td>117 ± 0.5(a)</td>
<td>106 ± 2.2(a)</td>
<td>114 ± 2.5(a)</td>
</tr>
</tbody>
</table>

*Total VFA conc. (m-mole/1)
123  111  118  132

Molar percentage of VFA as
- acetate: 68  69  66  68
- propionate: 17  19  21  19
- butyrate: 8  7  8  8
- others: 6  5  5  5

**values with a common letter do not differ significantly (P < 0.05).
*mean of all samples taken over a period of ten weeks, towards the end of the oil feeding period.

The total VFA concentration and molar percentages were not significantly different between groups of animals (P < 0.05).

IV. DISCUSSION

Unlike the studies of Demeyer et al. (1969) the addition of oils to the feed of sheep in the present study had little or no effect on the fermentation pattern in the rumen. This is surprising in view of the magnitude of the effects of oil supplements on VFA proportions in the ruminal fluid observed by other workers. The present study, however, occupied many months, while the other studies referred to have been of the short-term infusion type. A possible explanation appears to be that the usual community of organisms in the rumen of our sheep had become adapted to the oil supplements.

Since the proportion of propionate in the ruminal fluid was not altered by the inclusion of any of the oils in the ration, it appeared unlikely that the quality or quantity of bacterial protein available to the animal was altered. However, the increase in liveweight indicated that the net energy value of the ration was increased on the diets containing oil, even though wool growth rates were unaffected. This result indicates that increased availability of energy with constant intake of protein had no effect on wool growth. Other studies that have attempted to demonstrate this point have usually depended on addition of dietary carbohydrate (Fraser 1934), but this could also be expected to increase protein availability as a result of enhanced bacterial proliferation in the rumen.

Following intra-abomasal infusions of cystine, methionine or proteins rich in
sulphur amino acids, substantial increases in wool growth rate have occurred in sheep on roughage diets (Reis and Schinckel 1964). However, in the same studies, intra-abomasal infusion of gelatin, a protein deficient in a number of essential amino acids including the sulphur-amino acids, increased wool growth rate only marginally. The effects of the added gelatin on amino acid metabolism are unknown, and therefore the gelatin cannot be merely regarded as an energy source. A process highly sensitive to sulphur-amino acid availability may not be entirely insensitive to increments in energy supply.

However the study now reported supports the principle that wool growth at any protein intake is independent of energy intake above maintenance, provided this does not increase protein availability to the animal through ruminal fermentation.

The present study is in marked contrast to previous reports of oil supplements in the diet of sheep. It can be suggested that in this field; short term studies are unsatisfactory since they may not allow sufficient time for microbial adaptation to a change in the composition of a diet.

V. ACKNOWLEDGMENTS

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VI. REFERENCES