

THE FOOD INTAKE RESPONSE OF SHEEP FED FIVE ROUGHAGE SOURCES
SUPPLEMENTED WITH FORMALDEHYDE TREATED
CASEIN WITH AND WITHOUT UREA

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SUMMARY

Voluntary roughage intake (VRI), rumen ammonia nitrogen and plasma urea nitrogen concentrations were measured in sheep fed five low quality roughages (Pangola hay, sorghum stubble, barley straw, oat straw and native pasture hay) supplemented with molasses (M), M plus formaldehyde treated casein (TC), M plus urea (U) and M + TC + U.

In two diets (Pangola hay and oat straw) supplementation had no effect on VRI. Sheep fed the other three diets had increased intakes when supplemented with TC, U and TC + U. with only one diet (barley straw) was the response to TC superior to U.

Both VRI and plasma urea nitrogen were positively related to rumen ammonia levels up to a concentration of approximately 70 mg/l.

INTRODUCTION

Productivity of animals grazing poor quality roughages is often depressed by low ad libitum intakes. In many such situations non protein nitrogen supplements have been used to promote increases in intake when the level of nitrogen in the roughage has been considered inadequate (Leng, Murray, Nolan and Norton 1973).

It has also been suggested that the protein status of the host animal is an important factor in ensuring optimum intakes on such diets (Egan and Moir 1965). Subsequent studies have reported increased intake by animals supplemented with protein sources which contain a large proportion of rumen undegradable protein, but responses in general have been inconsistent (Kellaway and Leibholz 1982; Lindsay et al. 1982). Most protein sources have both a rumen degradable fraction as well as an undegradable component and it has been argued that any response in intake of animals fed such a supplement could be due to the breakdown of the degradable fractions in the rumen causing an increase in microbial activity (Maeng et al. 1976). Many natural protein supplements also contribute substantially to the energy and mineral supply available to the rumen microbes.

Although a wide variety of diets has been used in different experiments to investigate the effect of protein sources on voluntary food intake, there are few experiments which have compared the intake response to protein supplementation in a range of roughages.

Egan (1977) reported the effects of duodenally infused casein on the intake of sheep fed a range of diets but did not examine changes in rumen ammonia concentrations.

The experiment described here evaluated the effect on voluntary roughage intake (VRI) of a protein source totally undegradable in the rumen (formaldehyde treated casein) either alone or in combination with a NPN source and molasses in intact sheep fed five low quality diets.

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MATERIALS AND METHODS

Sheep

Twenty merino crossbred sheep were allocated by stratified randomisation on the basis of liveweight and sex to five groups of four animals and placed in individual pens. The mean liveweight of the animals was 31.3 ± 0.58 kg.

Diets

The five basal roughage diets were hammermilled Pangola grass hay, sorghum stubble, barley straw, oat straw and a native pasture hay, predominantly *Heteropogon contortus*. Each basal diet was offered at 125% of ad libitum intake with or without supplements to one of the groups of sheep. The supplements were 75 g molasses (M), M plus 50 g formaldehyde treated casein (TC), M plus 10 g urea (U) and M + TC + U. The supplements when fed were mixed together where appropriate and placed on the roughage portion of the ration. The sequence in which each of the diets was fed was basal (B) followed by B + M, B + TC, B + M, B + U, and B + TC + U.

The formaldehyde treated casein was prepared by the method of Ferguson et al. (1967). The extent of protection was determined by measuring the solubility of the treated casein in a phosphate citrate buffer at pH6. In addition the extent of rumen ammonia elevation in four sheep dosed intraruminally with protected and unprotected casein was also measured.

RESULTS

The casein used was shown to be fully protected against degradation in the rumen. During the initial feeding period, when only the basal roughages were offered, sheep given Pangola hay had a significantly higher VRI than did those given the other roughages (Table 1). In the following period when molasses (M) was given, sheep offered Pangola hay, oaten straw and pasture hay had significantly higher intakes than sheep offered sorghum straw and barley straw. In subsequent supplementation periods, there were no significant differences in VRI.

Table 1. The daily voluntary roughage intake (g/kg/day) of sheep fed five roughages.

Treatments	B	B+M	B+M+TC	B+M	B+M+U	B+M+TC	S D of means
Diets:							
Pangola hay	24.0 ^{a*}	20.6 ^a	22.7	19.2	23.6	21.7	1.75
Sorghum stubble	15.1 ^b _{c+}	14.6 ^{bc} _c	24.7 _a	17.2 _b	23.9 _a	24.6 _a	2.37
Barley straw	14.9 _d	12.8 _e	25.3 _a	19.0 _c	19.9 _c	23.8 _b	2.06
Oat straw	17.3 ^b	18.6 ^{ab}	25.3	22.1	20.3	22.5	4.25
Native pasture	16.7 ^b _c	17.3 ^{abc} _c	24.5 _a	18.0 _c	21.6 _b	21.8 _b	3.27
S D of means	3.61	3.52	1.85	2.42	2.58	3.07	

* Values in columns with different superscripts differ significantly ($P < 0.05$)

+ Values in rows with different subscripts differ significantly ($P < 0.05$)

The various supplements did not significantly affect the VRI of sheep offered Pangola hay or oat straw. Supplementation with TC significantly increased the VRI of sheep given sorghum stubble, barley straw and native pasture hay.

Supplementation with urea alone produced a similar response in VRI to TC in animals given sorghum stubble but a significantly lower response in animals given barley straw or native pasture hay.

Supplementation with TC and urea together resulted in no further increases in VRI over that produced by the HCHO casein alone in the animals fed sorghum stubble or native pasture hay. However the addition of TC to urea supplements in animals fed barley straw significantly increased VRI but only to the level achieved with TC supplement alone. The addition of urea to either barley straw or native pasture hay plus TC significantly depressed VRI.

Fig. 1(a) shows the relationship between rumen ammonia concentration (mg N/l) and VRI (g/kg/d) for sheep offered the different forages and supplements. There was a significant linear relationship between rumen ammonia (X) and VRI (Y) over the range 0 to 70 mg $\text{NH}_3\text{N/l}$. The regression equation ($n = 20$) was:

$$Y = 0.179 x + 13.0 \quad r = 0.85$$

The relationship between plasma urea (mg N/l) and rumen ammonia (mg N/l) is shown in Fig. 1(b). Over the same range of $\text{NH}_3 - \text{N}$ concentrations, rumen ammonia (X) was linearly related to plasma urea concentrations (Z). The regression equation ($n = 15$) was:

$$x = 0.431 z + 15.7 \quad r = 0.82$$

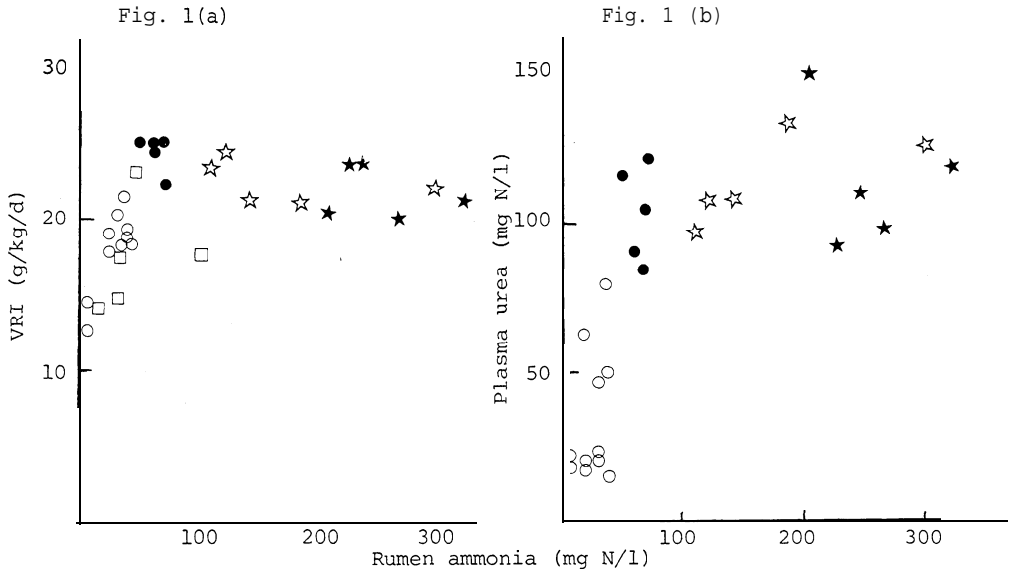


Fig. 1 The relationship between (a) rumen ammonia (mg N/l) and VRI (g/kg/d) and (b) rumen ammonia (mg N/l) and plasma urea (mg N/l) concentration in sheep offered different roughage types and supplemented with nil (\square) M (\circ), M + TC (\bullet), M + U (\star), and M + U + TC (\star).

DISCUSSION

The lack of intake response to supplementary molasses and the significant response to increased rumen ammonia concentrations indicated that the only limitation to intake in three of the five diets was the availability of N in the rumen. It is interesting to note that the Pangola hay and oat straw which did not respond had less than the commonly accepted nitrogen content thought to be required for adequate rumen function. (6.2 and 5.8 % CP respectively.)

Both formaldehyde treated casein and urea supplements elicited intake responses in the sheep fed sorghum stubble, barley straw and native pasture hay. From the data presented in Fig. 1 it is argued that most of the response was due to an increased availability of ammonia to the rumen microbial population. The increased rumen ammonia levels in the animals fed TC can only be explained by recycling of nitrogenous compounds. This conclusion is supported by the elevated plasma urea concentrations observed in these animals (Fig 1(b)). In only one diet, namely barley straw, was there a significant response to TC in addition to the response that we have ascribed to recycled nitrogen.

The intakes of the sheep fed Pangola hay were consistent at around 2.3% of liveweight throughout the experiment. It is relevant to note that when supplementation promoted intake responses in the other diets the intakes attained were similar, indicating that the potential intake of these roughages is around 2.3% of liveweight.

There was a linear response in feed intake to increasing rumen ammonia concentrations up to approximately 70 mg/l. This concentration is similar to the concentration currently accepted as being adequate for optimum rumen microbial activity (Roffler et al. 1974).

In conclusion, VRI in this experiment was positively influenced by increasing rumen ammonia concentrations up to approximately 70 mg/l. With the exception of barley straw there was no indication that formaldehyde treated casein increased VRI above that attainable with urea. The study also indicates that with the currently accepted parameters of nutritive value the potential responsiveness of a low quality forage diet to nitrogen containing supplements is unpredictable. Further studies are in progress.

REFERENCES

- EGAN, A.R. (1977). Aust. J. Agric. Res. 28: 907.
EGAN, A.R. and MOIR, R.J. (1965). Aust. J. Agric. Res. 16: 437.
FERGUSON, K.A., HEMSLEY, J.A. and REIS, P.J. (1967). Aust. J. Sci. 30: 215.
KELLAWAY, R.C. and LEIBHOLZ, J. (1982). Proc. Aust. Soc. Anim. Prod. 14: 61.
LENG, R.A., MURRAY, R.M., NOLAN, J.L. and NORTON, B.W. (1973). Aust. Meat Res. Comm. Rev. 15: 1
LINDSAY, J.A., MASON, G.W.J. and TOLEMAN, M.A. (1982). Proc. Aust. Soc. Anim. Prod. 14: 67.
MAENG, W.J., VAN NEVET, C.J., BALDWIN, R.L. and MORRIS, J.G. (1976). J. Dairy Sci. 59: 68.
ROFFLER, R.E., SCHWAB, C.G. and SATTER, L.D. (1974). J. Dairy Sci. 57: 631.