EFFECT OF MONENSIN ON CILIATE PROTOZOA IN RUMEN OF SHEEP FED AN OATEN CHAFF DIET

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SUMMARY

A study was made of the effects of including 0, 50 or 75 ppm monensin in a diet based on oaten chaff on protozoa1 populations in the rumen of sheep. Protozoa1 numbers were significantly ($P<0.05$) reduced by monensin throughout the 28 weeks of the experiment. Giving the diets once a day ad libitum or at hourly intervals did not affect the protozoa1 response to monensin.

Half times of protozoa labelled with ^{14}C-choline in the rumen were significantly lower when monensin was fed. This together with low uptake of ^{14}C-choline by protozoa in vitro suggests a toxic effect of monensin on protozoa in the rumen. (Keywords: monensin, protozoa, rumen, sheep, oaten chaff.)

INTRODUCTION

Field studies of grazing lambs without protozoa in the rumen indicated that live weight gains were 15% higher than in faunated lambs (Bird and Leng 1985). Poos et al. (1979) reported that monensin decreased protozoa1 populations in the rumen but Leng et al. (1984) found no effect of monensin on half life or growth rate of protozoa. However in previous studies (Habib, G. & Preston, T.R. 1984 unpublished) with cattle on molasses-based diets, monensin effectively reduced protozoa1 populations and, as Bergen and Bates (1984) concluded, the effect of monensin is variable, further studies were undertaken to study the effects of continuous or ad libitum feeding of high and medium levels of monensin, on protozoa1 numbers and their half life in the rumen of sheep.

MATERIAL AND METHODS

Twelve mature rumen cannulated wethers given a diet of oaten chaff, urea and mineral mixture were divided into three equal groups, A, B and C. Mean protozoa1 numbers in the three groups were 3.9 (A), 4.2 (B) and 4.4 (C) x 10^5/ml rumen fluid. The animals were housed in individual pens and were fed the experimental diets for 28 weeks. The basal diet of oaten chaff was supplemented with 0 (A), 50 (B) or 75 (C) mg monensin per kg feed (Elanco Product) mixed in the mineral mixture. The animals were gradually adapted to increasing doses of monensin over a period of two weeks. They were fed ad libitum once a day for 16 weeks and then fed by continuous belt feeder at one hour intervals (800 gm oaten chaff each) for five weeks. Protozoa1 numbers were estimated by the method of Bird et al. (1979) in samples of rumen fluid taken immediately before (0 hour) and 3 hours after feeding at intervals of 3 to 4 days during the first eight weeks. With continuous feeding, samples were taken daily for the first two weeks and thereafter every third day for another 3 weeks at 10.00 hours each day. The experimental procedure for estimation of the half life of protozoa labelled with ^{14}C-choline in rumen fluid was similar to that described by Leng (1982).

The viability of protozoa in rumen fluid in vitro was estimated from the uptake of ^{14}C-choline according to Campbell et al. (1982). Data were analysed statistically using analysis of variance with a repeated measures model.

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RESULTS

The effect of feeding different levels of monensin on protozoa1 numbers in rumen fluid is summarised in Table 1. Samples of rumen fluid taken at different times throughout the experiment show significant ($P<0.05$)-depressions in protozoa1 populations due to inclusion of monensin in the diet as compared to control, and this effect was consistent at sampling times 0 and three hours after feeding. There was no difference in protozoa1 numbers in the rumen of sheep fed either 50 or 75 ppm monensin. Protozoa1 populations in all animals was dominated by small entodinia (30-50μ). The number of protozoa in the rumen of sheep receiving monensin increased (about 3 fold) towards the end of the experiment, but the difference between control and monensin groups remained significant.

Table 1 Influence of monensin feeding on numbers and half-life of rumen protozoa

Observations	Levels of monensin (mg/kg feed) 0 (A)	50 (B)	75 (C)	Significance
1. Protozoal numbers (x10^5/ml rumen fluid)				
(i) Week 1 to week 8 (once daily feeding)				
(a) immediately before feeding	13.3^a	2.2^b	1.9^b	*
(b) 3 hours after feeding	6.7^a	1.6^b	1.5^b	*
(ii) Week 28 (once daily feeding) 3 hours after feeding	15.9^a	6.3^b	6.1^b	*
(iii) Continuous feeding	18.8^a	7.5^b	6.5^b	**
2. Protozoa $t_{\frac{1}{2}}$ (minutes)	1210^a	630^b	600^b	*

Means with different superscripts in same line are significantly different.
* $P<0.05$ ** $P<0.01$

Changing the feeding pattern from once a day to hourly did not affect the magnitude of difference in protozoa1 numbers between control and monensin groups. Protozoa1 numbers in the rumen of sheep receiving monensin were only about 30% of those in sheep given the control diet ($P<0.01$).

Figure 1 shows the number of protozoa in rumen fluid with time after feeding. The numbers of protozoa were consistently low in sheep receiving monensin ($P<0.05$).

Half life of protozoa labelled with ^{14}C-choline in the rumen was significantly ($P<0.05$) reduced from 1210 minutes to 630 and 600 minutes in the sheep fed monensin (Table 1). Protozoa1 viability (as estimated by uptake of ^{14}C-choline by protozoa in the rumen fluid incubated with different concentrations of monensin in vitro), decreased in response to 6, 8 and 10 mg monensin per liter (Fig. 2).

DISCUSSION

Results of the present study clearly show that feeding moderate to high levels of monensin caused decreases of 60 to 86 percent in rumen protozoa1 numbers. Increases in number of ruminal protozoa during the course of the experiment as compared to pre-experimental period (13.3 vs 3.9 x 10^5/ml rumen fluid) was possibly due to more favourable conditions in the rumen, such as the maintenance of a slightly higher rumen fluid pH and the presence of small amounts of dried molasses in the diets.

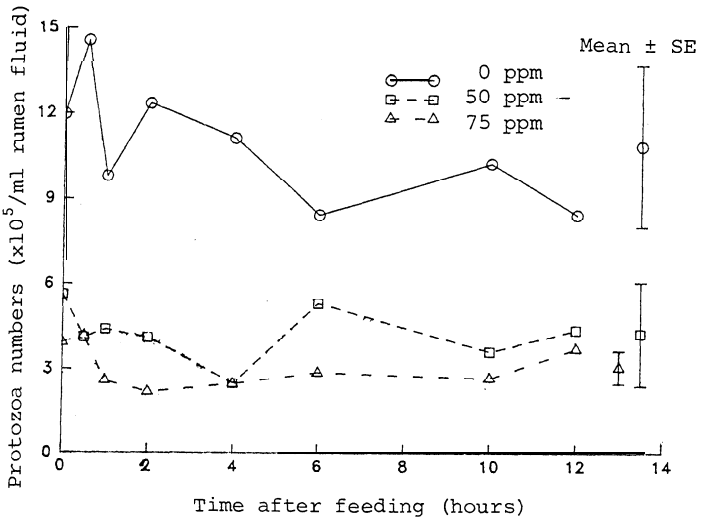

Fig. 1. Protozoa1 response to monensin levels (post-feeding pattern)

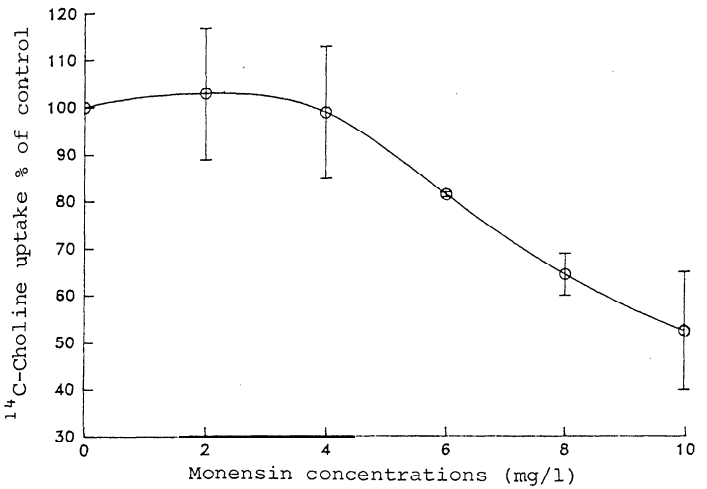

Fig. 2. In vitro ^{14}C-choline uptake by protozoa in rumen fluid (mean of 2 experiments)

The maintenance of low protozoa1 numbers in the rumen during continuous or intermittent feeding of monensin suggests an absence of adaptation by protozoa to monensin. Differences in the results of the present study and those reported by Leng et al. (1984), who also fed 50 ppm monensin in an oaten chaff diet to sheep, are difficult to explain. It is possible that variations in monensin activity for different batches of the product may account for different responses reported in the literature (see Bergan and Bates 1984).

The effect of increasing doses of monensin on the viability of protozoa in vitro (as indicated by the uptake of ^{14}C-choline) suggests that there may be a

toxic effect of monensin on protozoa. The similarity of the half life of protozoa when they are exposed to monensin and the half life of liquid pool in the rumen (Leng et al. 1984) may indicate that preferential retention of protozoa in the rumen due to sequestration (Weller and Pilgrim 1974) may be reduced by monensin, and suggest that selective retention of protozoa in the rumen may depend on their metabolic activity, which appears to be reduced by monensin.

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REFERENCES

BERGEN, W.G. and BATES, D.B. (1984). J. Anim. Sci. 58: 1465.

BIRD, S.H., HILL, M.K. and LENG, R.A. (1979). Proc. Aust. Soc. Anim. Prod. 12: 137.

BIRD, S.H. and LENG, R.A. (1985). In "Reviews in Rural Science 6", editors R.A. Leng, J.S.F. Barker, D.B. Adams and K.J. Hutchinson. (University of New England: Armidale, N.S.W. (in press))

CAMPBELL, A.J., CUMMING, G.J., GRAHAM, C.A. and LENG, R.A. (1982). N.Z. J. Agric. Res. 25: 535.

LENG, R.A. (1982). Br. J. Nutr. 48: 399.

LENG, R.A., NOLAN, J.V., CUMMING, G., EDWARDS, S.R. and GRAHAM, C.A. (1984). J. Agric. Sci. Camb. 102:

POOS, M.I., HANSON, T.L. and KLOPFENSTEIN, T.J. (1979). J. Anim. Sci. 48: 1516.

WELLER, R.A. and PILGRIM, A.F. (1974). Br. J. Nutr. 32: 341.