MAGNESIUM AND CALCIUM UTILIZATION IN SHEEP TREATED WITH MAGNESIUM ALLOY RUMEN BULLETS OR FED MAGNESIUM SULFATE

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SUMMARY

A metabolism trial was conducted to assess some effects of magnesium alloy rumen bullets and magnesium sulfate on magnesium and calcium utilization in wether lambs fed a basal, semipurified diet (800 g/day) that contained .08% magnesium and .42% calcium. Four sheep were assigned randomly to each of four treatments: basal diet only (BD); basal diet plus two commercial magnesium bullets per animal (AB); basal diet plus two experimental magnesium bullets per animal (EB); basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate ($MgSO_4$). The bullets were administered at the beginning of a 9-day collection period. Both forms of magnesium supplementation increased ($P<.05$) plasma level, fecal excretion and urinary excretion of magnesium. Mean plasma magnesium levels (mg/100 ml) for the respective BD, AB, EB and $MgSO_4$ treatments were 1.9, 1.9, 1.7 and 1.9 initially, and 1.9, 2.6, 2.7 and 2.3 after 9 days of treatment. Fecal excretion of magnesium was greater ($P<.05$) and urinary excretion was lower ($P<.05$) in sheep given magnesium bullets than in sheep fed magnesium sulfate; differences between treatments AB and EB were not significant. Urinary calcium excretion tended to increase with magnesium supplementation, but the treatments had no effect ($P>.05$) on plasma level, fecal excretion, or apparent retention of calcium. These results indicate that magnesium rumen bullets can provide substantial amounts of magnesium to sheep. However, as indicated by weights of bullets recovered from four sheep fed the semipurified diet, or from six sheep fed grass hay in another trial, the rate of decomposition of the bullets in the reticulo-rumen was highly variable.

(Key Words: Magnesium Bullets, Rumen Bullets, Magnesium Metabolism, Calcium Metabolism, Plasma Potassium.)

INTRODUCTION

Results of field trials to determine the efficacy of magnesium alloy rumen bullets in controlling hypomagnesemia have been conflicting. Several investigators (Foot *et al.*, 1969; Kemp and Todd, 1970; Gürtler *et al.*, 1973) reported that magnesium rumen bullets had no significant effect on blood magnesium of dairy cattle. However, other studies with cattle (Ritchie and Hemingway, 1968; Smyth, 1969; Young, 1973), lactating ewes (Davey, 1968; Egan, 1969; Scott, 1973), and suckling calves (Hemingway and Ritchie, 1969) indicated that the bullets prevented development of low blood magnesium concentrations and provided protection against hypomagnesemic tetany.

The study reported here was conducted to determine the effects of magnesium rumen bullets on plasma, urinary and fecal magnesium and calcium levels in wether sheep. Effects of the bullets on potassium concentrations in plasma and excreta were studied also.

MATERIALS AND METHODS

Two types of magnesium alloy rumen bullets developed for sheep by Pfizer Limited were used. One type of bullet, Agrimin[4], has been commercially produced and marketed in the

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[4] Agrimin* Bullets–Sheep, Agricare Products, Pfizer Limited, Sandwich, England. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture, and does not imply its approval to the exclusion of other products that may also be suitable.

United Kingdom; the other type of bullet was available from the same manufacturer for experimental use only. Both bullet types were provided by Pfizer International, Inc. According to information provided by the manufacturer, the two types of bullets were intended to decompose at different rates in the reticulorumen. Individual bullets of each type weighed about 35 g and were 44 mm long and 20 mm in diameter. The bullets consist of a magnesium alloy (86% magnesium, 12% aluminum, 2% copper) weighted with particles of small iron shot dispersed throughout the matrix of the bullet (Davey, 1968). Approximately 50 to 55% of the bullet weight is provided by metallic magnesium.

Experiment 1. Sixteen crossbred wether lambs with an average body weight of 39 kg were used to study the effects of magnesium rumen bullets on plasma, urinary and fecal magnesium and calcium levels. All animals were confined individually in metabolism crates and were fed 400 g of a semipurified diet twice daily (800 g per day) throughout the study. Composition of the diet is shown in table 1. The diet was fed as a wet-mash formed by adding 650 ml of water to 400 g of feed; additional water was available *ad libitum*. All data relative to feed intake and diet composition are on a dry matter basis. The sheep had been used in a 14-day feeding experiment immediately preceding the study reported here, so they were well adjusted to the metabolism crates and to a similar semipurified diet.

Four sheep were assigned randomly to each of four treatments: (1) control, basal diet only (BD); (2) basal diet plus an initial administration of two commercial (Agrimin) bullets to each animal (AB); (3) basal diet plus an initial administration of two experimental magnesium bullets to each animal (EB); and (4) basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate ($MgSO_4$). The supplementary magnesium sulfate was mixed with each lamb's daily portion of feed. According to information provided by the manufacturer, each magnesium bullet was intended to provide about .5 g of magnesium daily. The bullets were administered with an esophageal balling gun.

Urine and feces were collected daily for 9 days after beginning the treatments. Feces collected from each animal were dried, weighed, ground and stored in air-tight containers until analysis. Urine volume was determined and approximately 100 ml of each sample were saved for analysis. Feed was collected daily and composited to obtain samples for analysis.

Samples of venous blood were obtained by jugular puncture about 3 hr after the morning feeding. Blood was collected the day before the treatments were started and on days 2, 6 and 9 of the collection period. Each 5-ml sample of blood was collected into a dry, heparinized tube, chilled in ice and centrifuged; the plasma was removed and frozen prior to analysis.

TABLE 1. COMPOSITION OF BASAL DIET

Ingredient	IRN No.	%
Timothy, hay, s-c, over ripe, ground	1-04-889	40.0
Corn starch	4-02-889	13.4
Corn oil	4-07-882	4.0
Sugarcane, molasses, mn 48% invert sugar	4-04-696	4.0
Urea	5-05-070	4.0
Citric acid	8-01-233	1.0
Cellulose[a]	...	15.4
Soy protein[b]	...	13.0
Mineral mix[c,d]	...	5.2
Vitamins[e]	...	+

[a]Solka Floc, Brown Co., Berlin, NH.

[b]Assay Protein C-1, Skidmore Enterprises, Cincinnati, OH.

[c]Composition: $CaCO_3$, 5.3 g; $NaHCO_3$, 2.6 g; KCl, 8.6 g; $KHCO_3$, 11.5 g; K_2HPO_4, 23.0 g; $FeSO_4 \cdot 7H_2O$, .5 g; $ZnCO_3$, 115 mg; $MnSO_4 \cdot H_2O$, 160 mg; $CuSO_4 \cdot 5H_2O$, 36 mg; KI, 20 mg; $CoCl_2 \cdot 6H_2O$, 1 milligram.

[d]By analysis, diet contained per kilogram: magnesium, 810 mg; calcium, 4.18 g; potassium, 25.52 grams.

[e]Added per kilogram diet: retinyl palmitate, 1,350 IU; cholecalciferol, 350 IU; DL-α-tocopheryl acetate, 50 IU.

Two sheep from each of the "bulleted" groups were slaughtered 2 days after completion of the trial. The alimentary tracts were examined and remaining portions of the magnesium bullets were removed. The bullet fragments were washed, dried and weighed.

Magnesium, calcium and potassium levels in feed, feces, urine and plasma were determined by atomic absorption spectrophotometry in the presence of lanthanum chloride (Anonymous, 1973). Feed and fecal samples were wet-ashed in nitric and perchloric acids prior to analysis. Plasma and urine were appropriately diluted and aspirated directly into the atomic absorption spectrophotometer.

The data were evaluated satistically by an analysis of variance. Individual means were compared using a multiple range test (Duncan, 1955).

Experiment 2. Six crossbred wethers selected at random from the herd maintained at Cornell University were allotted to two groups of three animals each. Two commercial bullets were administered to each of the sheep in one group, and each sheep in the other group was given two experimental magnesium bullets. The sheep were allowed to remain with the herd after the bullets were administered. The sheep were fed a late cutting grass hay (IRN No. 1-02-250) *ad libitum*, plus daily supplements of about 340 g of commercially prepared pellets[5] in the morning and about 340 g of corn grain (IRN No. 4-02-879) in the afternoon. Eighteen days after administering the magnesium bullets, the animals were slaughtered and their alimentary tracts were examined for bullet fragments. Bullets recovered from the alimentary tract were washed, dried and weighed.

[5]Early Market Lamb Pellets, Agway Inc., Syracuse, NY.

RESULTS

In the first trial, sheep treated with commercial bullets refused some feed; two animals refused some feed on 3 days and two animals refused a portion of their feed on 1 day. Overall feed consumption by individual sheep in the AB group averaged 777 g dry matter per day during the trial. No animals in the other groups refused feed.

The weights of magnesium bullets recovered from sheep used in trial 1 are shown in table 2. Following administration of the bullets, the sheep were fed a semipurified diet for 9 days and then were fed a mixed grass hay for 2 days before they were slaughtered. The dietary change was unavoidable, since the sheep were previously committed to be used in another study by different investigators.

Table 3 shows the weights of magnesium bullets recovered from sheep used in the second trial. In sheep fed the dry, high-roughage diet, the bullets dissolved at highly variable rates. In

TABLE 2. MAGNESIUM BULLETS RECOVERED FROM SHEEP FED A SEMIPURIFIED DIET[a]

Sheep	Bullet type[b]	Bullet weight[c]	Location
C293	Commercial	. . .	None located[d]
C566	Commercial	23.0	Reticulum, one fragment[e]
C541	Experimental	14.0	Reticulum, two fragments[e]
C319	Experimental	28.5	Reticulum, two fragments[e]

[a]Sheep were fed a semipurified diet for 9 days and then were fed grass hay for 2 days before they were slaughtered.

[b]Bullets produced by Pfizer, Ltd. for commercial use (Agrimin* Bullets-Sheep) or for experimental use only; two bullets per animal.

[c]Values represent weights of bullets recovered from sheep; weights of individual bullets administered to the sheep were not recorded. Commercial and experimental bullets supplied by manufacturer weighed (mean ± SD) 34.8 ± 1.1 and 35.0 ± 2.3 g each, respectively.

[d]Iron shot included by manufacturer in the matrix of each bullet to provide additional weight was found in rumen, reticulum and small intestine.

[e]Bullets severely eroded.

TABLE 3. MAGNESIUM BULLETS RECOVERED FROM SHEEP FED GRASS HAY AND SUPPLEMENTS[a]

Sheep	Bullet type[b]	Bullet weight, g		Location
		Administered[c]	Recovered[d]	
C419	Commercial	68.4	54.7	Reticulum, two bullets[e]
C512	Commercial	72.3	...	None located[f]
HFF	Commercial	70.2	69.0	Reticulum, two bullets[g]
D886	Experimental	74.0	33.0	Reticulum, two bullets[h]
NNT	Experimental	71.9	33.0	Reticulum and rumen[h]
C532	Experimental	73.0	68.0	Reticulum, two bullets[e]

[a]Sheep fed diet for 18 days after the bullets were administered.

[b]Bullets produced by Pfizer, Ltd. for commercial use (Agrimin* Bullets-Sheep) or for experimental use only.

[c]Combined weights of two bullets administered to each sheep.

[d]Combined weights of bullets recovered from sheep 18 days after the bullets were administered.

[e]Small pieces missing from both bullets.

[f]Iron shot included by the manufacturer in the matrix of each bullet to provide additional weight was found in the reticulum.

[g]Bullets showed little sign of decomposition; small pits on surface of one bullet.

[h]Bullets severely eroded.

one animal, the bullets were nearly intact and weighed only about 1 g less than when administered. In another animal, no bullet fragments were found, but iron shot incorporated in the matrix of the bullets by the manufacturer was observed in the reticulum. This suggests that the bullets had decomposed completely. One animal regurgitated a bullet within 1 min after it was administered. The regurgitated bullet was reimplanted. There was no evidence that any of the bullets were regurgitated later.

Effects of the magnesium bullets and of supplemental magnesium sulfate on plasma magnesium, calcium and potassium concentrations of sheep fed a semipurified diet are shown in table 4. Plasma magnesium levels of control sheep (basal diet only) initially tended to increase, but did not differ significantly during the trial. In sheep provided magnesium bullets and in sheep fed supplemental magnesium sulfate, plasma magnesium concentrations increased ($P<.05$) with time. Although the average concentration of plasma magnesium was higher in each of the magnesium-treated groups than in the control group at each of the sampling times after initiating the treatments, the differences were not always significant. After 6 days of treatment, plasma magnesium tended to be higher in animals given magnesium bullets than in animals fed supplemental magnesium sulfate; both types of bullets appeared to be equally effective in increasing plasma magnesium levels. Plasma calcium and potassium concentrations were not affected by the treatments.

Results of the treatments on daily fecal magnesium excretion are shown in figure 1. Changes in daily fecal magnesium output by sheep in both groups treated with magnesium bullets suggest that the bullets do not dissolve at a constant rate. By the second day of the trial, fecal magnesium was higher ($P<.05$) in the magnesium-treated animals than in sheep fed the basal diet only. After 6 days of treatment, sheep given magnesium bullets had higher levels of fecal magnesium than did animals fed magnesium sulfate. Total fecal magnesium excretion for the 9-day period was greater ($P<.05$) in sheep given magnesium bullets than in animals fed supplemental magnesium sulfate (table 5). Magnesium retention was not calculated, since the amount of magnesium released from the bullets could not be determined accurately.

Effects of the treatments on the daily output of magnesium in urine are shown in figure 2. Urinary magnesium excretion increased ($P<.05$) markedly in sheep fed supplemental magnesium sulfate compared to the control group. Sheep given the commercial bullets generally excreted more magnesium in urine than did animals given the experimental bullets (table 5).

TABLE 4. PLASMA MAGNESIUM, CALCIUM AND POTASSIUM LEVELS OF SHEEP EITHER TREATED WITH MAGNESIUM RUMEN BULLETS OR FED SUPPLEMENTAL MAGNESIUM SULFATE[a]

Item	Treatment			
	BD[b]	AB[c]	EB[d]	$MgSO_4$[e]
Plasma Mg, mg/100 ml				
Pretreatment	1.87 ± .30^{f}	1.89 ± .16^{f}	1.70 ± .18^{f}	1.93 ± .26^{f}
Day 2	2.06 ± .48^{fi}	2.28 ± .18^{gi}	2.29 ± .18^{gi}	2.57 ± .24^{g}
Day 6	2.09 ± .32^{fi}	2.67 ± .26^{g}	2.44 ± .08^{ghi}	2.34 ± .16^{gi}
Day 9	1.91 ± .24^{f}	2.62 ± .36^{gj}	2.70 ± .14^{hj}	2.32 ± .08^{g}
Plasma Ca, mg/100 ml[k]				
Pretreatment	10.18 ± .32	10.27 ± .46	10.09 ± .38	10.16 ± 1.40
Day 2	9.88 ± .50	10.06 ± .46	9.76 ± .62	10.09 ± .46
Day 6	10.34 ± .52	10.25 ± .94	9.61 ± .32	9.94 ± .58
Day 9	9.93 ± .68	10.19 ± .54	9.91 ± .62	10.00 ± .46
Plasma K, mg/100 ml[k]				
Pretreatment	20.09 ± 1.48	20.26 ± 2.62	20.78 ± 2.16	20.84 ± .84
Day 2	19.88 ± 1.46	20.13 ± .78	20.27 ± 1.54	19.83 ± 1.96
Day 6	18.08 ± 1.24	19.87 ± 1.30	19.86 ± .40	19.89 ± 1.60
Day 9	19.42 ± 2.40	20.54 ± 1.42	20.66 ± 1.40	20.10 ± 1.20

[a]Values are means ± SD; four sheep per treatment.

[b]Basal diet only; diet provided about .65, 3.34 and 19.62 g of magnesium, calcium and potassium, respectively, daily.

[c]Basal diet plus two commercial magnesium bullets per animal.

[d]Basal diet plus two experimental magnesium bullets per animal.

[e]Basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate.

[f,g,h,i,j]Mean values in either a horizontal row or a vertical column not followed by a common superscript letter differ significantly ($P<.05$).

[k]Mean values are not significantly different ($P>.05$).

TABLE 5. FECAL AND URINARY EXCRETION OF MAGNESIUM IN WETHER LAMBS EITHER TREATED WITH MAGNESIUM RUMEN BULLETS OR FED SUPPLEMENTAL MAGNESIUM SULFATE[a]

	Treatment			
Item	BD[b]	AB[c]	EB[d]	$MgSO_4$[e]
Fecal Mg, g/9 days	5.20 ± .32[f]	13.97 ± 5.26[g]	13.44 ± 1.70[g]	10.53 ± .36[h]
Urinary Mg, g/9 days	.18 ± .10[f]	1.03 ± .34[g]	.52 ± .20[fg]	1.77 ± .84[h]

[a,b,c,d,e]See table 4 for explanation.

[f,g,h]Mean values in the same horizontal row not followed by a common superscript letter differ significantly ($P<.05$).

Figure 3 shows the effects of the treatments on fecal potassium excretion. Daily fecal potassium excretion by sheep provided magnesium supplements decreased throughout the trial. In contrast, fecal potassium excretion by the control animals tended to increase during the trial. The treatments had no significant effect on the apparent retention of potassium. The retention of potassium averaged (mean ± SD) 1.22 ± .32, 1.37 ± .68, .65 ± .44 and .99 ± .80 g per day for lambs in the BD, AB, EB and $MgSO_4$ groups, respectively.

Within treatment groups, the average daily excretion of urinary potassium did not differ significantly through the trial. The daily output of urinary potassium (mean ± SD) was higher

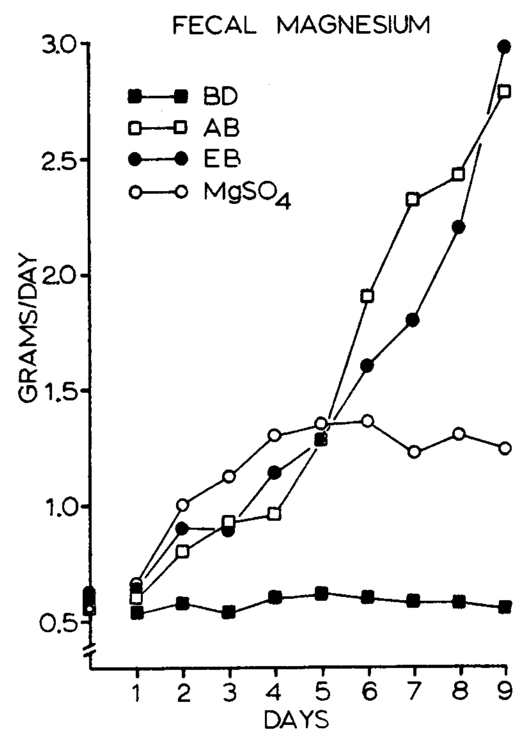

Figure 1. Mean daily fecal magnesium excretion by sheep. Treatments were: basal diet only (BD); basal diet plus two commercial magnesium bullets per animal (AB); basal diet plus two experimental magnesium bullets per animal (EB); basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate ($MgSO_4$).

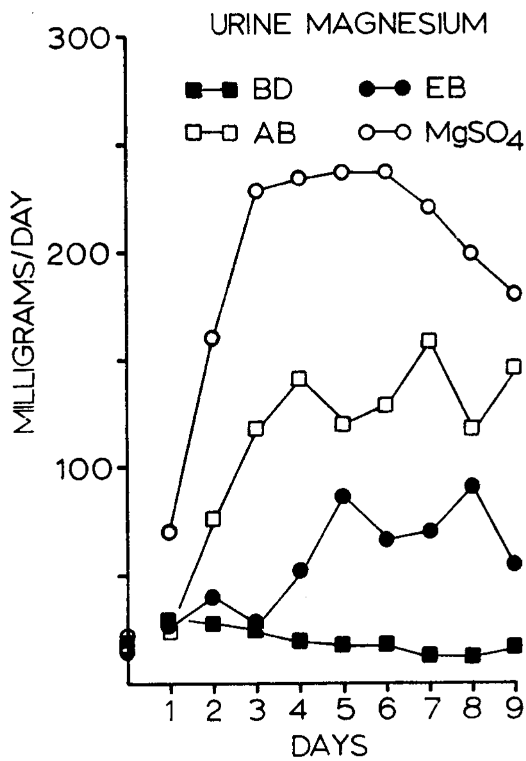

Figure 2. Mean daily urinary magnesium excretion by sheep. Treatments were: basal diet only (BD); basal diet plus two commercial magnesium bullets per animal (AB); basal diet plus two experimental magnesium bullets per animal (EB); basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate ($MgSO_4$).

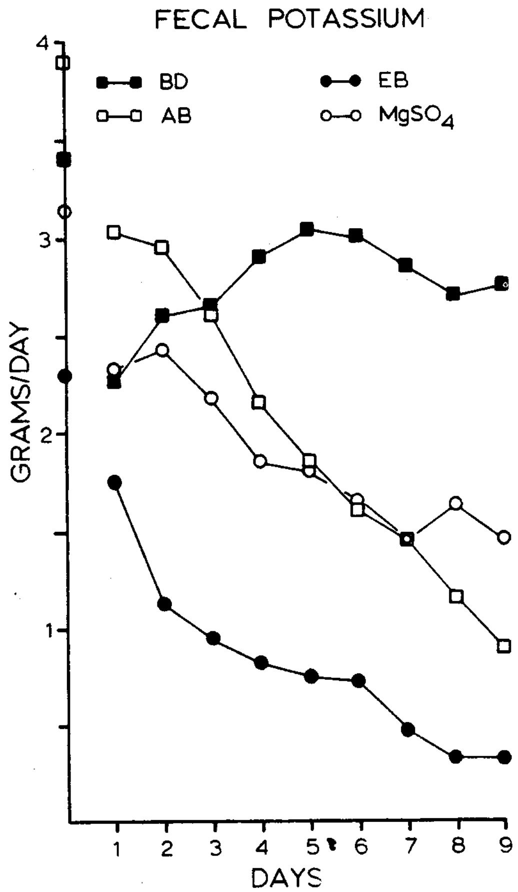

Figure 3. Mean daily fecal potassium excretion by sheep. Treatments were: basal diet only (BD); basal diet plus two commercial magnesium bullets per animal (AB); basal diet plus two experimental magnesium bullets per animal (EB); basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate ($MgSO_4$).

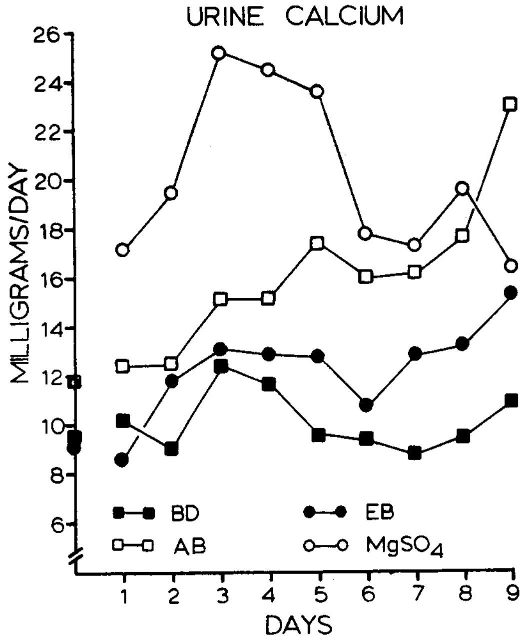

Figure 4. Mean daily urinary calcium excretion by sheep. Treatments were: basal diet only (BD); basal diet plus two commercial magnesium bullets per animal (AB); basal diet plus two experimental magnesium bullets per animal (EB); basal diet plus supplementary magnesium (1 g/day) as magnesium sulfate ($MgSO_4$).

($P<.05$) in sheep given the experimental magnesium bullets (18.16 ± .34 g) than in animals fed supplemental magnesium sulfate (16.78 ± .50 g), and both of these values were greater ($P<.05$) than that for either the control animals (15.64 ± .40 g) or sheep given Agrimin bullets (15.76 ± .72 g). For 2 days before starting the treatments, urinary potassium excretion averaged 15.66 ± 1.28, 15.28 ± 1.26, 17.89 ± .88 and 16.68 ± 1.50 g per day for sheep in the BD, AB, EB and $MgSO_4$ groups, respectively. Although there were significant differences in urinary potassium excretion between groups, covariance analyses between mean initial (last 2 days of pretreatment) and mean final (9-day trial period) urinary potassium values indicated that the treatments *per se* did not affect urinary potassium excretion.

Urinary calcium excretion by the magnesium-treated animals tended to increase during the trial (figure 4). Total urinary calcium excretion for the 9-day collection period (mean ± SD) was higher ($P<.05$) in lambs fed supplemental magnesium sulfate (186 ± 68 mg) than in control animals (91 ± 14 mg), but did not differ significantly from lambs treated with either commercial (146 ± 70 mg) or experimental (116 ± 54 mg) magnesium bullets.

Neither fecal calcium excretion nor apparent retention of calcium was affected ($P>.05$) by the treatments. During the trial, fecal calcium excretion (mean ± SD) by sheep in the BD, AB, EB and $MgSO_4$ groups was 2.53 ± .36, 2.43 ± .36, 2.52 ± .36 and 2.57 ± .54 g per day, respectively. Apparent retention of calcium averaged about .8 g daily for sheep in all groups.

Discussion

The intestinal tracts of the sheep were searched extensively, so failure to find magnesium bullets in several of the slaughtered animals (tables 2 and 3) suggests that the bullets had either broken into very small fragments or had dissolved completely. Iron shot, included by the manufacturer in the matrix of each bullet to provide additional weight, was observed in either the rumen, reticulum or small intestine of the two animals in which no magnesium bullets were found. There was no evidence that sheep confined to metabolism crates either regurgitated magnesium bullets or passed large fragments of the bullets in the feces. Several investigators (Foot *et al.*, 1969; Kemp and Todd, 1970) reported that they found bullets that apparently had been regurgitated or passed in the feces by cattle used in their studies.

Although the experiment reported here was not designed to determine the rate of decomposition of the bullets in the reticulo-rumen, some inferences can be made. With the diet used in the first trial, the magnesium bullets seemed to be effective for a shorter time than the 5-week interval suggested by the manufacturer for sheep grazing spring grass. Hemingway and Ritchie (1969) observed that "sheep-size" magnesium bullets dissolved over a 20-day period in milk-fed calves. Young (1973) reported that the disintegration of magnesium bullets in beef cattle was erratic and that the bullets had an average life between 25 and 28 days.

The data were insufficient to determine if the two types of magnesium bullets decomposed at different rates. Disintegration of both types of bullets appeared to be less erratic in sheep initially fed a semipurified ration than in sheep fed only a dry, high-roughage diet. Although the dietary change at the conclusion of the first trial could have affected the disintegration of the bullets, the bullets probably had decomposed substantially before the change. This is indicated by the changes in plasma magnesium (table 4) and in the patterns of fecal magnesium output (figure 1) during the trial.

In ruminants, magnesium absorbed in excess of requirements is excreted mainly in the urine (Rook *et al.*, 1958). Moreover, Halse (1970) indicated that urinary excretion of magnesium was a better indicator of the magnesium status of an animal than plasma magnesium concentration when plasma levels were within the normal range. In the study reported here, urinary magnesium excretion was greater in lambs fed supplemental magnesium sulfate than in lambs treated with magnesium bullets (table 5). This may indicate greater availability of magnesium from magnesium sulfate than from magnesium bullets.

In the study reported here, two magnesium bullets per animal were as effective as supplemental magnesium sulfate in increasing plasma magnesium concentration (table 4) of sheep fed a semipurified diet that contained a relatively low level of magnesium (.081%). This finding is in general agreement with results obtained with sheep in field trials. Under grazing conditions, administration of magnesium bullets to sheep has prevented development of low plasma magnesium concentrations and provided protection from grass tetany (Davey, 1968; Egan, 1969; Scott, 1973). Moreover, treatment of milk-fed calves with two "sheep-size" magnesium bullets significantly increased plasma magnesium concentration compared to untreated control animals (Hemingway and Ritchie, 1969). However, results of field trials with cattle are conflicting. According to S. R. Wilkinson[6] (*personal communication*), magnesium bullets release insufficient magnesium to increase serum magnesium levels of cattle. Several investigators (Ritchie and Hemingway, 1968; Smyth, 1969; Young 1973) reported that magnesium bullets administered to cattle reduced the incidence of hypomagnesemic tetany without affecting blood magnesium. Other investigators (Kemp and Todd, 1970; Foot *et al.*, 1969; Gürtler *et al.*, 1973) observed that magnesium bullets had no significant effect on plasma magnesium concentration of cattle and did not protect them from grass tetany.

Plasma calcium concentrations of wethers used in the study reported here were not affected significantly by treatment with magnesium bullets or by feeding supplemental magnesium sulfate (table 4). Similarly, administration of magnesium bullets to cows had no effect on plasma calcium levels (Foot *et al.*, 1969; Smyth, 1969). Supplemental magnesium has been observed to decrease plasma calcium in sheep by some investigators (Chicco *et al.*, 1973) but not by others (Dutton and Fontenot, 1967).

The relationship between dietary magnesium and urinary calcium excretion in sheep is not clear. Chicco *et al.* (1973) reported that supple-

[6] S. R. Wilkinson, Southern Piedmont Conservation Research Center, Agricultural Research Service, U.S.D.A., Watkinsville, GA.

mental magnesium as magnesium carbonate reduced calcium excretion. Dutton and Fontenot (1967) found that increased dietary magnesium as magnesium oxide had no effect on urinary calcium excretion. In the study reported here, magnesium supplementation as either magnesium bullets or magnesium sulfate tended to increase urinary calcium excretion (figure 4). The response in urinary calcium excretion to magnesium supplementation may have differed between studies because of the different forms and levels of magnesium fed to the sheep. However, Moore *et al.* (1971) reported that urinary calcium excretion was similar in steers fed the same level of magnesium as either magnesium carbonate or magnesium oxide.

The complex etiology of hypomagnesemic tetany has been related to environmental factors, chemical composition of herbage, and physiological status of the animals involved. Current evidence indicates that clinical hypomagnesemic tetany can be prevented by maintaining an adequate study of magnesium to the animal. Magnesium alloy rumen bullets have been developed to provide supplemental magnesium, but their effectiveness is equivocal. The results of our study indicate that magnesium rumen bullets can provide substantial amounts of magnesium to sheep if the bullets decompose. However, use of magnesium bullets for controlling hypomagnesemia in sheep must be dictated by value of the animals, incidence of the disease, cost of the bullets, and the time involved in administering the bullets.

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