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In recent years, there has been evidence indicating that limestone in excess of normal requirement levels for calcium has beneficial effects for ruminants. Research at this station has shown that limestone supplementation is effective in preventing phosphatic urinary calculi formation in ruminants when fed at higher levels than normally recommended. Work at other stations has shown positive effects on weight gain from limestone added to high-concentrate diets, which was attributed to buffering action within the digestive tract.

In short-term finishing periods, buffer supplementation may help ruminants adapt to high-grain diets if roughage has been their major feedstuff in the past. Graded levels of limestone were fed in this experiment to determine beneficial effects in protecting lambs from the effects of rumen acidosis during an extremely short adaptation period and to determine the optimum level of supplementation needed to improve performance during the longer term finishing period.

Experimental Procedure

This experiment involved four dietary treatments including a control, 1% limestone, 2% limestone and 4% limestone. There were four pens in each treatment group. The lambs were randomly allotted on the basis of weight with five wethers and five ewes per pen (160 lambs total). All lambs received baled alfalfa-brome hay free-choice for 3 weeks prior to the beginning of the 121-day experiment. The lambs were vaccinated for the prevention of enterotoxemia and drenched for the control of internal parasites. An experiment on the effects of implants on performance was superimposed across the four treatments and these data are presented in another report.

The basal diet consisted of ground corn, 84.4%; ground alfalfa-brome hay, 8%; and soybean meal (44% protein), 6%, with supplemental minerals and vitamins A and E making up the remaining part. The limestone treatments were added at the expense of the complete mix. Residual hay was removed from the feed bunks on the first day of the experiment and the lambs were fed 3 lb per head of their respective diets and had free access thereafter. Individual weights were taken approximately every 21 days and feed consumption was recorded daily for each pen. Feed efficiency and feed consumption were calculated on a pen basis after correction for the limestone content of the diets.

The average weight at the time of slaughter was 120 pounds. Kidneys and urinary bladders were collected at the time of slaughter. These were examined at a later time for evidence of urinary calculi. Carcass data were collected 24 hours after slaughter.

Prepared for Sheep Field Day, June 10, 1977.

Results and Discussion

Pronounced signs of apparent rumen acidosis resulted from the abrupt switch in diets. The lambs exhibited varying degrees of the condition along with diarrhea and were consuming little, if any, feed by the third day. Lambs that died during the first 21 days were examined by the South Dakota Animal Disease Research and Diagnostic Laboratory. The pH in the rumens of the dead lambs ranged from 4 to 5 and there were severe gastric ulcers and bleeding. Death was attributed to rumen acidosis in all cases.

Death losses attributed to rumen acidosis from each treatment are presented in table 1. There was a 25, 35, 22.5 and 10% loss in the 0, 1, 2 and 4% supplemental limestone groups, respectively. Even the 10% loss suffered in the 4% limestone group would be unacceptable for commercial lamb producers. However, this degree of apparent reduction ($P<.10$) would indicate that higher levels of supplementation may be necessary for limestone to be of practical importance in helping prevent the adverse effects of rumen acidosis during adaptation to high-concentrate diets.

Survivors in the control group did not recover quickly. This was reflected in their feedlot performance during period 1 as shown in table 2. All three limestone treatments improved ($P<.01$) average daily feed intake (ADR) and increased ($P<.01$) average daily gain when compared to lambs in the control group. Although death loss was high in the treated groups, performance was very acceptable in the surviving lambs. These levels of limestone seemed to help lambs recover from acidosis quickly and make normal gains during the adaptation period.

The improvement in weight gain during the adaptation period for the lambs receiving the 1% limestone supplementation was maintained for the remainder of the experiment. Over the 121-day experiment, 1% limestone supplemetation improved ($P<.01$) ADG by 17% when compared to that for lambs receiving the basal diet. The differences between limestone treatment groups were not statistically significant. This would indicate that 1% may be the optimum level of limestone supplementation in terms of feedlot performance following adaptation.

There were no significant differences between treatment groups for the carcass characteristics measured. Examination of kidneys and urinary bladders showed no differences in the incidence of urinary calculi between treatment groups.

Conclusions

At the levels fed, limestone did not offer acceptable protection from the harmful effects of rumen acidosis. Results with the 4% level in comparison to lower levels are indicative that higher levels might be beneficial in preventing death loss. Limestone supplementation did improve feed consumption and weight gain during a very abrupt adaptation period. The 17% improvement in average daily gain attributed to 1% added limestone over the entire trial could be of major economic importance when feeding high-concentrate diets.

Further areas of study will be the use of combinations of limestone for its apparent growth-promoting effects and sodium bentonite or sodium bicarbonate for the protection they offer from the harmful effects of rumen acidosis.

Table 1. Death Losses From Rumen Acidosis During Adaptation to High-Concentrate Diets

Treatment	No. of deaths[a]
Basal	10
1% limestone	14
2% limestone	9
4% limestone	4[b]

[a] Forty lambs per treatment group initially.
[b] Lower than control (P<.10).

Table 2. Limestone Supplementation With High-Concentrate Diets (August 20 to December 19,1975--121 Days)

	Control	Added limestone 1%	2%	4%
No. animals	29	22	31	35
Initial wt., lb.	60.1	61.4	60.7	61.0
Final wt., lb	115.2	126.8	117.7	121.0
Avg daily gain, lb				
1-22 days	.131	.366**	.407**	.444**
23-121 days	.512	.580	.484	.508
1-121 days	.443	.541**	.470	.496
Avg daily ration, lb				
1-22 days	1.48	1.75**	1.96**	1.99**
23-121 days	2.90	3.14	2.93	2.93
1-121 days	2.64	2.89	2.75	2.76
Feed/100 lb gain, lb				
1-22 days	1130	478	482	448
23-121 days	566	541	605	577
1-121 days	596	534	585	556
Carcass wt., lb.	61.6	66.4	63.1	63.5
Grade[a]	12.4	12.1	12.4	12.6

[a] Choice = 11, Prime = 14. Graded to one-third grade.
** Differs significantly from control (P<.01).