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MIN-AD

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An Evaluation of MIN-AD® in Feedyard Diets For Yearling Steers

This bulletin is one of a series of technical bulletins that discusses the applications of MIN-AD to feedlot and dairy cattle nutrition.

Previous feeding trials with different grain combinations have shown that MIN-AD increases average daily gain (ADG) and improves feed conversion (F/G) in feedlot steers. Two supervised field trials gave similar results. (See Bulletins B-1 and B-2). Typical increases in ADG were just over 3% and feed conversion was generally improved by about 2%. In addition, a series of four dairy ration fermentation studies suggested that MIN-AD increased microbial efficiency and acted as a ruminal buffer when the 24-hour average ruminal pH dropped below about 5.7.

This Bulletin reports on two new studies, a performance trial and a metabolism trial, that were conducted to help answer the following questions. (1) What is the optimum feeding level of MIN-AD? (2) Are the Ca and Mg available? (3) What is the mode of action? MIN-AD replaced MgO and $CaCO_3$ in both studies to balance the rations in Mg and Ca.

The main conclusions from this work program were as follows.

1. Cattle fed a 0.75% MIN-AD diet achieved greater performance from d1-d56 than cattle fed a control diet with MgO and numerically better performance over the duration of the entire trial.

2a. MIN-AD successfully replaced MgO and $CaCO_3$ as a source of Mg and Ca in finishing diets for yearling steers.
2b. No difference in Mg or Ca digestibility between MIN-AD and MgO or $CaCO_3$ was observed in the metabolism study.

3a. MIN-AD appeared to impact drinking behavior and led to increased frequency and duration of visits to water tanks.
3b. Steers consuming 3.8% roughage with MIN-AD had similar intake as steers consuming 7.5% roughage without MIN-AD.
3c. Microbial N flow to the duodenum was numerically increased by the addition of MIN-AD and microbial efficiency was numerically increased by about 10%.

PERFORMANCE TRIAL

Trial Procedure

One hundred and ninety two crossbred yearling steers were selected from a group of 270 head. Cattle that were beyond plus or minus two standard deviations from the mean weight were culled. The remaining 192 were assigned to twenty-four pens of eight steers. The pens were used in a randomized block design consisting of eight weight replicates and three treatments. The treatments were as follows.

1. Control diets resembling those typically fed in the major cattle producing regions of the United States.
2. MIN-AD fed at a rate of 0.75% of DM
3. MIN-AD fed at a rate of 1.50% of DM

Cattle were treated for parasites, vaccinated, treated for flies, and implanted with Component E-S. Cattle were re-implanted with Revalor–S on day 56.

The trial was conducted at a feedlot research facility and ran for 138 days from April 13 to September 11.

During the initial 48 days of the study, the drinking and eating behaviour of replicates three and four of each treatment was monitored by antennae that detected the presence of an electronic ear tag in each feedbunk or at each water fountain.

Only two cattle exhibited any symptoms of disease during the study. One from the 0.75% MIN-AD treatment showed signs of nasal discharge and depression on May 12 and was removed from the study. A second steer from the control treatment exhibited symptoms of bloat on August 27 and was removed from the trial.

Nutrition

The starting and finishing diets utilized for the study are shown in Tables 1 and 2. The step-1 and step-2 diets are not shown. The starting, step-one, and step-two diets contained 15 g Rumensin per ton of dry matter. Tylan was included in the step-one and step-two rations at 2 and 6 g per ton of dry matter, respectively. The finishing diets contained Rumensin and Tylan at 30 and 10 g per ton of dry matter, respectively. All diets were formulated to contain 13.5% crude protein, 1500 IU per lb dry matter vitamin A, and 15 IU per lb dry matter vitamin E.

All diets were fed two times daily. Starter diets were fed through the morning of May 3. Step-one diets were fed starting the afternoon of May 3 and continuing though the morning of May 10. Step-two diets were fed starting the afternoon of May 10 and continuing through the morning of May 16. Finishing diets were fed from the afternoon of May 16 and continuing through to the end of the trial.

Corn was flaked to a density of 27 lb per bushel the afternoon prior to feeding.

One formulation error was discovered; the supplement for the 0.75% MIN-AD starter diet did not include MgO. Therefore, the Mg content of this diet was about 0.25% of dry matter instead of the intended 0.30%.

Water meters were read daily; total water consumption for each fountain was adjusted to a 24-hr basis. Consumption per head was calculated by dividing total 24-hr consumption for the fountain by head count.

Table 1. Dry matter ingredient and theoretical nutrient composition of starter diets.

	Treatment		
Item (%DM)	Control	0.75% MIN-AD	1.50% MIN-AD
Flaked corn	48.981	48.841	48.450
Alfalfa hay	30.000	30.000	30.000
Corn silage	14.926	14.926	14.926
CCDS	3.000	3.000	3.000
Soybean meal	1.141	1.196	1.271
Supplement	1.952	2.037	2.353
Nutrients			
Dry matter, % as-fed	66.008	66.015	66.053
Crude protein	13.500	13.500	13.500
Non-protein nitrogen	1.000	1.000	1.000
Acid detergent fiber	15.661	15.616	15.567
Calcium	0.890	0.890	0.890
Phosphorus	0.300	0.300	0.300
Potassium	1.239	1.240	1.242
Magnesium	0.300	0.300	0.363

Table 2. Dry matter ingredient and theoretical nutrient composition of finishing diets.

	Treatment		
Item (%DM)	Control	0.75% MIN-AD	1.50% MIN-AD
Flaked corn	76.448	76.256	77.600
Corn silage	11.194	11.194	11.194
CCDS	3.000	3.000	3.000
Yellow grease	3.000	3.000	3.000
Soybean meal	2.600	2.654	2.702
Supplement	3.758	3.896	4.035
Nutrients			
Dry matter, % as-fed	67.661	67.675	67.689
Crude protein	13.500	13.500	13.500
Non-protein nitrogen	3.250	3.250	3.250
Acid detergent fiber	5.553	5.507	5.463
Calcium	0.700	0.700	0.700
Phosphorus	0.300	0.300	0.300
Potassium	0.700	0.700	0.700
Magnesium	0.300	0.300	0.301

The dry matter ingredient composition of supplements used in the starting and finishing diets is shown in Tables 3 and 4.

Drinking water was purchased from a local water association. Nutrient evaluation is shown in Table 5.

Table 3. Dry matter ingredient composition of supplements used in starting diets.

	Treatment		
Ingredient (% DM)	Control	0.75% MIN-AD	1.50% MIN-AD
Limestone	46.260	22.975	1.020
Urea	10.553	10.260	9.052
Salt	12.807	12.273	10.625
Magnesium oxide	12.039		
MIN-AD		36.819	63.748
Dicalcium phosphate	13.422	12.862	11.135
Soy oil	1.998	2.013	1.997
Trace Mineral Premix	1.434	1.375	1.190
Rumensin 80	0.461	0.442	0.382
Vitamin A premix[a]	0.154	0.147	0.127
Vitamin E premix[b]	0.871	0.835	0.722

[a]50,000,000 IU vitamin A per lb. [b]90,000 IU vitamin E per lb.

Table 4. Dry matter ingredient composition of supplements used in finishing diets.

	Treatment		
Ingredient (% DM)	Control	0.75% MIN-AD	1.50% MIN-AD
Limestone	39.037	26.489	14.796
Urea	27.621	26.745	25.898
Salt	6.652	6.417	6.196
Magnesium oxide	9.580	4.594	
MIN-AD		19.251	37.175
Dicalcium phosphate	6.307	6.083	5.849
Potassium chloride	6.945	6.622	6.344
Soy oil	1.996	2.002	2.007
Trace Mineral Premix	0.692	0.667	0.644
Rumensin 80	0.506	0.488	0.471
Tylan 100	0.133	0.128	0.124
Vitamin A premix[a]	0.080	0.077	0.074
Vitamin E premix[b]	0.452	0.436	0.421

[a]50,000,000 IU vitamin A per lb. [b]90,000 IU vitamin E per lb.

Table 5. Composition of drinking water used for the trial.

Item[a]	May 4, 2001	May 25, 2001	Average±SEM
pH, units	7.37	8.04	7.71±0.33
Chloride	25.00	30.00	27.50±2.50
Chloride as salt	41.20	49.40	45.30±4.10
Hardness	350	360	355±7
Sulfate	1080	844	962±118
Nitrate	0.66	0.90	0.78±0.17
Total dissolved solids	2080	2000	2040±40
Calcium	77.00	69.00	73.00±4.00
Magnesium	33.10	37.90	35.50±2.40
Sodium	600	528	564±36
Iron	0.10	None detected	0.05±0.05

[a]mg per Liter unless stated otherwise.

Average nutrient composition and the variation observed in the composition for each feed commodity used in the trial is shown in Table 6. Average nutrient composition and the variation observed for the analysis for each finishing diet is shown in Table 7.

Table 6. Dry matter nutrient analyses for feed commodities.

	Feed commodity				
Nutrient[a]	Flaked corn	SBM[b]	CCDS[c]	Corn silage	Alfalfa hay
Dry matter[d]	78.08±0.40	88.94±0.17	47.91±0.83	36.25±0.77	89.95±0.65
Crude protein	9.05±0.11	51.14±0.42	36.21±0.67	7.94±0.19	18.56±0.32
NPN[e]	0.21±0.04	1.01±0.15	5.34±0.64	0.58±0.02	0.52±0.04
ADF	3.42±0.10	6.75±0.19	0.99±0.15	26.15±0.46	36.43±1.14
Ether extract	3.40±0.20	1.56±0.12	1.92±0.34	2.56±0.07	1.48±0.09
Calcium	0.03±0.01	0.50±0.04	0.08±0.02	0.54±0.06	1.34±0.03
Phosphorus	0.25±0.02	0.75±0.02	1.86±0.04	0.21±0.02	0.24±0.01
Potassium	0.39±0.01	2.47±0.02	3.16±0.07	1.23±0.03	2.40±0.08
Magnesium	0.10±0.01	0.37±0.01	0.72±0.07	0.23±0.01	0.30±0.02

[a]Percentage of dry matter ± standard error of the mean unless stated otherwise.
[b]Soybean meal, 47% crude protein, solvent extracted.
[c]Condensed corn distiller's solubles. [d]Percentage of as-fed.
[e]Non-protein nitrogen, crude protein equivalent.

Table 7. Dry matter nutrient analyses for finishing diets.

	Treatment		
Nutrient[a]	Control	0.75% MIN-AD	1.50% MIN-AD
Dry matter, % of as-fed	69.49±0.60	68.40±0.60	68.89±0.40
Crude protein	12.71±0.19	12.68±0.24	12.90±0.27
Non-protein nitrogen	2.34±0.12	2.44±0.18	2.41±0.21
Acid detergent fiber	6.97±0.24	6.99±0.21	7.13±0.19
Ether extract	6.05±0.17	6.03±0.20	5.91±0.18
Calcium	0.76±0.04	0.70±0.03	0.65±0.06
Phosphorus	0.37±0.01	0.38±0.02	0.36±0.01
Potassium	0.79±0.03	0.82±0.06	0.75±0.02
Magnesium	0.35±0.02	0.33±0.01	0.32±0.02

[a]Percentage of dry matter ± standard error of the mean unless stated otherwise.

Performance

Table 8 displays the effect of treatment on cumulative feedyard performance. At 56 days, steers fed the 0.75% MIN-AD dietary treatment were 13 lb. heavier than control steers and 16 lb. heavier than steers fed the 1.50% MIN-AD treatment (P=0.05). From d1-56 cattle fed the 0.75% MIN-AD diet gained more weight (P=0.08) and converted feed more efficiently (P=0.08) than cattle on the control or 1.50% MIN-AD diets. From d57-finish, treatment did not affect performance. The weight gain advantage seen through 56 days was maintained through finish (P=0.07).

Table 9 illustrates the effects of period and treatment on daily dry matter intake. There was a tendency (quadratic, P=0.18) for cattle on the 0.75% MIN-AD treatment to consume more of the step-two diet as compared with the control and 1.50% MIN-AD treatments (DMI by diet not shown).

Average calcium and magnesium intake from the diet for the Control, 0.75% MIN-AD, and 1.50% MIN-AD treatments were 69.1 and 31.8, 64.1 and 30.2, and 59.6 and 29.3 g per head daily.

Table 8. Effect of dietary MIN-AD® concentration on cumulative feedyard performance.

	Treatment			Prob. > F	
Item[a]	Control	0.75% MIN-AD	1.50% MIN-AD	Linear	Quadratic
Initial weight	703±23	706±21	703±22	0.97	0.38
Weight d56	918±28	931±25	915±24	0.62	0.05
ADG d1-56	3.84±0.11	4.01±0.11	3.77±0.09	0.58	0.08
DMI, d1-56	20.03±0.76	20.22±0.57	20.00±0.42	0.97	0.75
FG, d1-56	5.21±0.13	5.05±0.12	5.30±0.04	0.49	0.08
Finish weight	1162±32	1177±30	1162±23	0.99	0.07
ADG, d57-finish	2.97±0.09	3.00±0.07	3.01±0.05	0.66	0.86
DMI, d57-finish	20.03±0.68	20.16±0.39	20.19±0.19	0.78	0.93
FG, d57-finish	6.78±0.27	6.72±0.12	6.72±0.15	0.84	0.89
ADG, d1-finish	3.32±0.07	3.41±0.07	3.32±0.02	0.97	0.13
DMI, d1-finish	20.03±0.67	20.18±0.45	20.11±0.26	0.89	0.83
FG, d1-finish	6.03±0.18	5.92±0.10	6.06±0.07	0.90	0.42

[a]Treatment means ± standard error of the mean.

Table 9. Least square pen means showing the effect of treatment and period on average daily dry matter intake.

	Treatment[ab]		
Period	Control	0.75% MIN-AD	1.50% MIN-AD
D1-28	18.93	18.63	18.42
D29-56	21.13	21.90	21.57
D57-84	20.43	20.77	20.47
D85-112	18.87	18.67	18.68
D113-138	20.85	21.16	21.51

[a]Treatment linear (P=0.89). Treatment quadratic (P=0.80).
[b]Treatment by period interaction (P=0.16).

Water intake is shown in Table 10. The effect of day of trial on water intake was significant (P<0.001). Cattle consumed more water mid-trial during the hottest days of the summer as compared with the cooler days early or late in the trial. Average water intake was 9.15±0.52, 9.56±0.52, and 9.49±0.52 gal per head daily for the Control, 0.75% MIN-AD, and 1.50% MIN-AD treatments, respectively. Average calcium and magnesium intake from water for the Control, 0.75% MIN-AD, and 1.50% MIN-AD treatments were 2.5 and 1.2, 2.6 and 1.3, and 2.6 and 1.3 g per head daily. Average calcium and magnesium intake from water as a percentage of total calcium and magnesium intake was 3.5 and 3.6, 3.9 and 4.1, and 4.1 and 4.3 for the Control, 0.75% MIN-AD, and 1.50% MIN-AD treatments, respectively.

Least square pen means showing the effect of treatment and period on average daily gain are displayed in Table 15. There was a tendency (P=0.15) for the quadratic effects of treatment to be significant, indicating that cattle fed the 0.75% MIN-AD diet achieved higher gains than control or 1.50% MIN-AD cattle. There was an interaction (P=0.05) between treatment and period suggesting that treatment effects on average daily gain may have been significant early in the feeding period but not significant during later periods.

Table 10. Average daily water intake for each treatment and period.

	Treatment[b]		
Period[a]	Control	0.75% MIN-AD	1.50% MIN-AD
D1-28	6.25	6.23	6.31
D29-56	8.07	8.80	8.60
D57-84	10.98	11.56	11.29
D85-112	10.94	11.53	11.32
D113-138	9.14	9.30	9.22

[a]Period (P<0.001).
[b]Treatment linear (P=0.49). Treatment quadratic (P=0.67).

Table 11. Least square pen means showing the effect of treatment and period on average daily gain.

	Treatment[ab]		
Period	Control	0.75% MIN-AD	1.50% MIN-AD
D1-28	4.15	3.74	3.91
D29-56	3.55	4.29	3.64
D57-84	3.91	3.99	4.11
D85-112	2.73	2.65	2.49
D113-138	2.20	2.33	2.40

[a]Treatment linear (P=0.99). Treatment quadratic (P=0.15).
[b]Treatment by period interaction (P=0.05).

Table 12 shows the effects of period and treatment on feed conversion. More feed was required per unit gain for later periods compared with early periods. Linear and quadratic effects of treatment on feed conversion were not significant.

Table 12. Least square pen means showing the effect of treatment and period on feed conversion.

	Treatment[ab]		
Period	Control	0.75% MIN-AD	1.50% MIN-AD
D1-28	4.59	5.02	4.77
D29-56	5.96	5.14	5.97
D57-84	5.25	5.22	5.02
D85-112	7.00	7.10	7.79
D113-138	10.08	9.40	9.22

[a]Treatment linear (P=0.93). Treatment quadratic (P=0.42).
[b]Treatment by period interaction (P=0.69).

Carcass Characteristics

Least square pen means for carcass measurements are displayed in Table 13. There was a tendency for heavier carcass weights (quadratic effect, P=0.21) and greater fat depth (quadratic effect, P=0.26) from steers fed the 0.75% MIN-AD diet compared with steers fed the control or 1.50% MIN-AD diet. Dressing percentage, ribeye area, and marbling score were not impacted by treatment. The number of Choice and Prime carcasses were not influenced by treatment.

Table 13. Least square pen means for various carcass measurements.

	Treatment				Prob.>F	
Item	Control	0.75% MIN-AD	1.50% MIN-AD	SEM[a]	Linear	Quadratic
HCW[b], lb	747	755	746	19.54	0.93	0.21
Dressing percentage	64.27	64.07	64.21	0.24	0.86	0.55
Fat depth, inches	0.44	0.46	0.42	0.02	0.56	0.26
Ribeye area, $inches^2$	12.73	12.76	12.73	0.21	0.99	0.86
Marbling score, units[c]	4.35	4.32	4.40	0.12	0.75	0.69

[a]Standard error of the mean.
[b]Hot carcass weight.
[c]Marbling score units: 4.00 = $small^{00}$, 5.00 = $modest^{00}$.

Water Tank and Feed Bunk Behavior

Least square means describing frequency and duration of individual cattle visits to the water tanks and feed bunks are shown in Table 14. Some interesting results were found for feeding and drinking behavior. The biological relevance of these findings is not known.

There was a linear (P=0.0006) and quadratic (P=0.01) increase in the number of times steers visited the water tanks with increasing MIN-AD concentration in the diet. Steers fed the 0.75% MIN-AD diet made 1.46 more daily visits to the water tanks than steers fed the control diet. Steers fed the 1.50% MIN-AD diet made 4.69 more daily visits to the water tanks than steers fed the control diet.

Total duration of water tank visits increased linearly (P=0.0008) with increasing MIN-AD concentration in the diet and averaged 26.74, 40.72, and 66.05 minutes per day for the control, 0.75% MIN-AD, and 1.50% MIN-AD treatments, respectively. Increased time at the water tanks did not result in increased consumption of water.

Cattle visited the feed bunk approximately 13 times daily. Although linear and quadratic effects of treatment were statistically significant, interactions between treatment and day and between treatment and day by day complicate the interpretation of treatment differences.

There were linear (P=0.005) and quadratic (P=0.0003) effects on the duration of feed bunk visits of dietary MIN-AD concentration, indicating that steers fed the 0.75% MIN-AD diet spent more time at the feed bunk than steers fed the control or 1.50% MIN-AD diet. This relationship appeared to be most consistent from approximately d30-48. Steers on the 0.75% MIN-AD treatment achieved greater average daily gains from d27-56 as compared with the control or 1.50% MIN-AD steers.

Table 14. Least square means describing frequency and duration of individual cattle visits to the water tank and feed bunk.

	Treatment			Prob. > F	
Item	Control	0.75% MIN-AD	1.50% MIN-AD	Linear	Quadratic
Frequency[a]					
Water tank	10.53±0.60	11.99±0.64	15.22±0.62	0.0006	0.01
Feed bunk	13.17±0.48	12.87±0.51	12.92±0.50	0.0005	0.004
Duration					
Water tank	26.74±4.99	40.72±5.33	66.05±5.16	0.0008	0.98
Feed bunk	122.45±7.20	136.28±7.69	112.50±7.45	0.005	0.0003

[a]Number of visits.

METABOLISM STUDY

A companion metabolism study was carried out simultaneously with the intention of studying the effects of MIN-AD and roughage level on ruminal metabolism and site and extent of digestion by beef steers.

It is generally known that feeding high levels of non-structural carbohydrate to cattle predisposes them to metabolic disorders such as ruminal acidosis. Roughages are included in high-grain finishing diets to avoid or minimize these problems. However, it is one of the most expensive ingredients on an energy basis and increases feedlot operating costs. Typically, it is included at the 3-11% level. Research to decrease the dietary roughage content to near zero generally results in reduced cattle performance. There could be some economic benefit to feedlot operations if roughage use could be reduced with the use of MIN-AD while maintaining or reducing metabolic disorders.

Materials and Methods

The experiment was a 5x5 Latin square design experiment with five ruminally and duodenally cannulated Angus x Hereford steers. The dietary treatments are shown in Table 15; the experiment ran from June to October.

The 7.5% roughage level diets and supplements at 0% MIN-AD and 1.5% MIN-AD were exactly the same as the production study control and MIN-AD 1.5% diets, respectively. That is, MIN-AD fully replaced the MgO and 2/3 of the limestone. The details are shown in Tables 2,4,5,6, and 7. In the other treatments (3.8% and 11.3% roughage), flaked corn replaced or was replaced by corn silage.

Table 15. Metabolism Study Dietary Treatments

Treatment No.	Roughage Level	MIN-AD Level
1	3.8%	0%
2	7.5%	0%
3	11.3%	0%
4	3.8%	1.5%
5	7.5%	1.5%

Cattle were fed *ad libitum* twice daily at 0800 and 1300. Fresh water was always available. Each experimental period lasted 21 days: 2 diet transition days, 14 adaptation days, and 5 sampling days. Fecal, duodenal, ruminal, and rumen bacteria isolation samples were taken.

Digestibility Data

Carryover effects of the treatments were checked and none were detected. It is important to note that the trial was conducted with growing steers, albeit not growing at the rate of the production study steers. Cattle were individually weighed on d 21 of each period. At trial start, the average bodyweight was 578.6 ± 19.8 lbs.; the final bodyweight was 919.6 ± 92.4 lbs. The overall ADG was 2.71 ± 0.84 lbs./day.

Nutrient intakes, duodenal flows, and ruminal digestions are shown in Table 16. As expected, OM, fiber, and N intake generally increased as dietary roughage

Table 16. Site and Extent of Nutrient Digestion

	No MIN-AD			MIN-AD		
Item	3.8	7.6	11.4	3.8	7.6	SEM
Water intake, L/d	31.8	30.3	32.8	33.2	26.2	2.6
Nutrient intake, g/d						
DM	6,156	6,864	7,501	7,004	6,600	563
OM	5,787	6,437	7,026	6,612	6,211	529
NDF	1,090	1,361	1,467	1,174	1,235	122
N	119	131	149	137	136	11.2
Duodenal flow, g/d						
OM	2668	2840	3103	3390	2987	411
NDF	919	1010	901	918	656	235
Total N	120	123	124	135	125	9.6
NH_3-N	2.03	2.33	2.65	2.21	2.01	0.21
Microbial N	67.1	66.1	71.7	75.0	66.2	5.64
Feed N	51.1	52.7	49.5	56.8	53.9	6.83
Ruminal digestion, %						
OM	54.5	56.4	56.5	50.6	54.6	4.41
NDF	16.0	25.5	38.6	23.9	42.9	19.4
Feed N	58.4	60.3	66.9	59.1	62.1	5.14
Microbial Efficiency	21.8	18.6	18.5	24.2	20.2	2.80

increased. Steers consuming 3.8% roughage and MIN-AD had similar intake as steers consuming 7.5% roughage without MIN-AD.

Microbial efficiency was numerically increased by about 10% with the replacement of MgO and $CaCO_3$ by MIN-AD. Microbial N flow to the duodenum was numerically greatest when 3.8% roughage was fed with MIN-AD, although there were no statistical differences among treatments.

Fecal output, post-ruminal digestion, and total tract digestions are shown in Table 17. Total tract digestions were not affected by roughage or MIN-AD.

Table 17. Site and Extent of Nutrient Digestion.

	No MIN-AD			MIN-AD		
Item	3.8	7.6	11.4	3.8	7.6	SEM
Fecal output, g/d						
OM	746	857	1070	700	1058	176
NDF	588	636	682	575	734	103
N	28	30	36	25	35	6.4
Postruminal digestion, %						
OM	32.8	30.4	28.6	39.6	28.9	4.69
NDF	29.5	26.3	15.0	29.9	-3.7	21.3
N	76.7	69.3	60.5	79.0	62.2	7.71
Postruminal digestion, % leaving abomasum						
OM	71.4	69.1	65.0	81.9	61.0	6.38
NDF	22.9	33.2	11.0	39.7	2.7	19.3
N	76.6	75.0	71.6	83.1	69.8	5.05
Total-tract digestion, %						
OM	87.2	86.9	85.2	90.2	83.4	1.97
NDF	45.4	51.8	53.9	54.7	38.7	8.95
N	76.6	77.2	76.6	82.5	73.8	3.77

Mineral digestibilities are shown in Table 18; mineral digestibility ($P > 0.10$) was not altered by dietary treatment. The duodenal flow of Ca was higher than the intake, while the fecal output was lower than the duodenal flow. This is as expected and is consistent with Ca absorption post-rumen and recycling of Ca into the rumen. Total tract Ca digestion was about 25%; approximately 50% of the total Ca intake was from MIN-AD.

The duodenal flow of Mg was lower than the intake which would indicate a net uptake of Mg through the rumen. The numerical average ruminal Mg digestion was approximately 22%. A further 10% (numerical average) of the total dietary Mg intake was digested post-ruminally. About 50% of the total Mg intake was provided by supplemental Mg, either exclusively from MgO (control treatments) or exclusively from MIN-AD (MIN-AD treatments).

Table 18. Mineral Digestibilities.

	No MIN-AD			MIN-AD		
Item	3.8	7.6	11.4	3.8	7.6	SEM
Mineral intake, g/d						
Ca	36.2	44.0	46.5	47.6	41.9	3.82
P	20.7	24.2	25.9	25.4	23.5	2.19
Mg	21.6	24.4	23.7	23.7	21.4	2.11
Duodenal flow, g/d						
Ca	49.5	45.8	46.0	51.6	47.0	7.22
P	29.2	28.6	34.5	32.4	29.2	3.88
Mg	17.9	16.3	18.6	16.5	18.8	2.27
Ruminal digestion, %						
Ca	-38.6	-5.8	-1.2	-3.7	-16.2	17.4
P	-41.8	-21.1	-36.0	-29.6	-23.2	13.8
Mg	17.3	32.2	20.6	28.9	13.2	7.5
Fecal output, g/d						
Ca	31.9	34.8	32.1	30.6	32.9	8.29
P	7.00	7.50	9.03	6.55	7.25	2.40
Mg	13.6	15.4	18.7	14.0	17.4	4.25
Postruminal digestion, %						
Ca	48.0	23.9	33.6	43.9	35.9	17.5
P	108.6	90.7	102.3	102.3	97.5	14.2
Mg	18.5	2.9	5.8	6.0	16.4	16.9
Postruminal digestion, % leaving abomasums						
Ca	33.3	25.0	31.9	43.9	31.7	14.0
P	76.0	75.2	75.1	80.2	78.4	5.25
Mg	22.2	3.1	5.2	11.0	17.5	21.5
Total-tract digestion, %						
Ca	9.4	18.1	32.4	40.2	19.7	20.3
P	66.8	70.5	66.6	74.6	73.3	6.5
Mg	35.7	35.5	24.9	39.0	25.0	16.2

A graph of pH versus time is shown below; time averaged and maximum and minimum values are shown in Table 19. Neither roughage nor MIN-AD had any impact on pH, although there was a tendency for pH to increase with increasing roughage level. It is likely that the pH levels barely approached the sub-acute acidosis threshold because of the relatively low intake of these cannulated steers.

Total VFA production (not shown) was not affected by treatment. Acetate production tended to increase with increasing roughage levels, as expected.

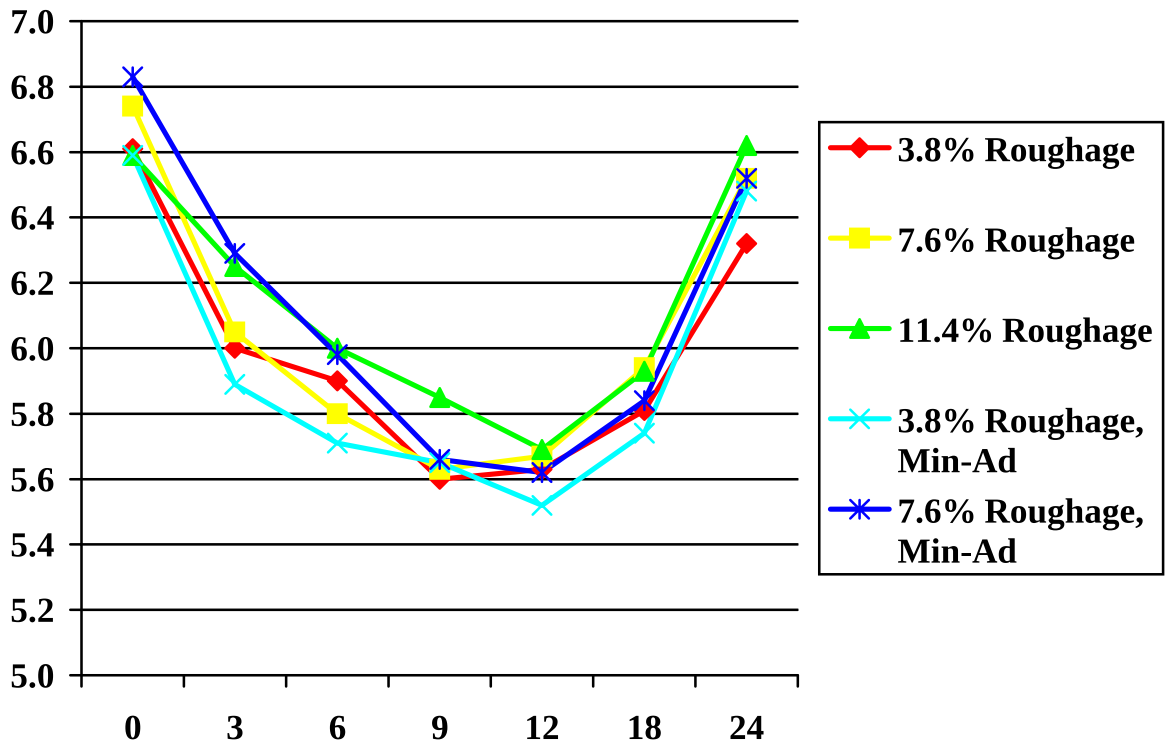

Table 19. Time averaged, minimum, and maximum pH values.

	No MIN-AD			MIN-AD		
Item	3.8	7.6	11.4	3.8	7.6	SEM
pH						
Mean	5.98	6.05	6.13	5.94	6.11	0.11
Minimum	5.50	5.58	5.63	5.54	5.62	0.09
Maximum	6.62	6.81	6.78	6.83	6.89	0.12

Summary and Conclusions

In the performance study, cattle fed diets containing 1.50% MIN-AD achieved similar performance as cattle fed the control diets. Since MIN-AD replaced 100% of the MgO and 62% of the $CaCO_3$ in this diet, this suggests that MIN-AD can successfully replace MgO and $CaCO_3$ as a source of Mg and Ca in finishing diets for yearling steers. The MIN-AD accounted for approximately 50% of the total Mg and the total Ca intake. This conclusion was corroborated by the metabolism study observation that mineral digestibility was not affected by treatment. Furthermore, post-ruminal digestion of Mg was observed.

Cattle fed the 0.75% MIN-AD diet achieved greater performance from d1-d56 than cattle fed the control diet. There was a tendency for these cattle to achieve higher gains than cattle on the control treatment. By trial end, the pen mean weight was numerically 15 lbs heavier than the control pen mean, ADG was numerically increased by 2.7%, and FG was improved by almost 2%.

MIN-AD in the diet of finishing cattle may have impacted feeding and drinking behavior. There was an observed increase in the frequency and duration of visits to the water tanks with increasing MIN-AD concentration in the diet. Total water intake was numerically higher by about 4%. This was not observed in the metabolism study; the MIN-AD 7.6% roughage treatment had lower water intake than the no MIN-AD treatments and the MIN-AD 3.8% roughage treatment. The biological significance of these observations is not completely understood.

Adding 1.5% MIN-AD to high-grain diets with low roughage levels (3.8% DM basis) results in similar intake and duodenal flow of nutrients compared with feeding 7.5% roughage without MIN-AD. Microbial efficiency was about 10% higher with MIN-AD than without MIN-AD. Microbial N flow to the duodenum was numerically greatest when 3.8% roughage was fed with MIN-AD. The metabolism study results suggest that replacing MgO and $CaCO_3$ with MIN-AD in low roughage (3.8%) diets results in similar intake and duodenal flow of nutrients compared to mid-roughage level diets without MIN-AD.