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Summary

A winter and a summer nitrogen mass balance experiment were conducted to analyze effects of feeding clinoptilolite zeolite clay to steers. No differences were found in steer ADG, F/G or carcass characteristics. Nitrogen mass balance and volatilization were not affected by a 1.2% addition of clinoptilolite in feedlot diets. These experiments indicate clinoptilolite zeolite clay does not have a large enough cation exchange potential to be effective in reducing N volatilization in open feedlot pens.

Introduction

Clinoptilolite zeolite clay is a proposed new method to reduce N volatilization. Zeolite clay is a naturally occurring hydrated aluminosilicate mined from volcanic ash deposits associated with alkaline lakes. The clay has a high cation exchange capability and permeability rate which may make it effective in adsorbing ammonia. The first hypothesis of this research is the addition of zeolite clay to feedlot cattle diets will bind the ammonia; therefore, reducing the amount of N lost. The second hypothesis is steer performance will not be negatively impacted by the addition of zeolite clay to the diet.

Procedure

Two feeding trials (96 steers/trial) were conducted using 96 crossbred steers. Calves (741 ± 26 lb) were fed for 168 days from November to April (Exp 1) and yearlings (842 ± 15 lb) were fed for 120 days from May to September (Exp 2). For each experiment, steers were stratified by weight and assigned randomly to 12 pens and one of two treatments (eight head/pen, six pens/treatment). Treatments were 1) control diet with 0% zeolite clay (CONTROL) or 2) treatment diet with 1.2% zeolite clay (CLAY). Diets were formulated to meet the steers' metabolizable protein requirements according to the 1996 Beef NRC. Steers were fed a three-week four-step-up program to the finishing diet shown in Table 1. The supplement in both diets used a ground corn carrier which was replaced with zeolite clay.

Steers were weighed initially on two consecutive days following a five-day limit-feeding period. Calves were again weighed on days 28, 84 and 168 (Exp 1). They were implanted with Synovex-Choice® (Fort Dodge Animal Health, Overland Park, Kan.) on day 1 and 84. Yearlings (Exp 2) were also weighed on day 25 and 120 and implanted on day 25 with Revelar-S® (Intervet, Millsboro, Del.). At slaughter, hot carcass weights and liver scores were recorded. Following a 24-hour chill, 12th rib fat thickness, rib-eye area, quality and yield grades were recorded. For data analysis, final weights were calculated as hot carcass weight divided by the common dressing percentage of 63.

Nitrogen mass balance experiments were conducted using 12 open feedlot pens with retention ponds to collect runoff. Total runoff from each pond was quantified using an ISCO 4230 flow meter (Lincoln, Neb.). Samples were collected during draining and analyzed for DM, OM and total N.

Prior to the steers entering the pens, November (Exp 1) and May (Exp 2), 16 core samples of the top 6 inches of lot surface material were taken at equally spaced intervals throughout each pen. Following removal of steers, April (Exp 1) and September (Exp 2), pens were cleaned and 16 core samples were taken at locations similar to the beginning cores. On the same day pen cores were taken, six, 6-inch cores of settled solids were removed from each retention pond. All cores were analyzed for DM, OM and N.

On the day steers were removed from the pens and sent to slaughter, the pens were thoroughly cleaned and total pounds of manure removed were recorded. As manure was loaded for transport to the compost yard, 30 random samples per pen were collected for analysis of DM and N.

For both experiments, N intake was calculated using analyzed dietary N content of each feedstuff and multiplied by total DMI. Individual steer N retention was calculated using the NRC (1996) net protein and net energy equations. N excretion was determined by the difference between N intake and N retention. Manure N was calculated using the total weight hauled and its N composition. Exp 1 manure N was corrected for inherent cleaning differences by adjusting for soil core N before and after the feeding period. Total N in Exp 1 lost was calculated by subtracting N levels of the soil corrected manure and runoff from excreted N. All Exp 1 values are reported on a per steer basis for 168 days. Total Exp 2 N lost was calculated by subtracting manure N from excreted N. All Exp 2 values

Table 1. Composition of finishing diets (% DM basis).

Ingredient	CONTROL	CLAY
High moisture/dry rolled corn[a]	62.5	62.5
Wet corn gluten feed	25	25
Alfalfa hay	7.5	7.5
Supplement[b]	5	5

[a]Exp 1 trial used high moisture corn, Exp 2 trial used dry rolled corn.
[b]Control supplement: ground corn (3.14%), Rumensin® (320 mg/head/day), Tylan® (90 mg/head/day), limestone, salt, tallow, vitamins and minerals. Treatment supplement: ground corn (1.94%), zeolite clay (1.2%), Rumensin® (320 mg/head/day), Tylan® (90 mg/head/day), limestone, salt, tallow, vitamins and minerals.

Table 2. Growth performance and carcass characteristics for Exp 1 steers.[a]

Item	CONTROL	CLAY	SEM	*P*-value
Initial BW, lb	742	742	1	0.87
Final BW, lb	1378	1400	14	0.30
DMI, lb	22.2	22.3	0.3	0.95
ADG, lb	3.79	3.92	0.08	0.30
F/G [b]	5.85	5.68	0.01	0.37
Hot carcass weight	868	882	9	0.30
Marbling score[c]	548	531	8	0.15
Fat thickness, in[d]	0.63	0.60	0.03	0.56

[a]Adjusted using hot carcass weight.
[b]Analyzed as gain:feed.
[c]Marbling score: 500 = $Small^{0}$, 550 = $Small^{50}$.
[d]12^{th} rib fat thickness.

Table 3. Growth performance and carcass characteristics for the Exp 2 steers.[a]

Item	CONTROL	CLAY	SEM	*P*-value
Initial BW, lb	842	842	1	0.69
Final BW, lb	1323	1314	5	0.56
DMI, lb	27.1	27.1	0.1	0.65
ADG, lb	4.01	3.95	0.04	0.61
F/G[b]	6.90	7.30	0.01	0.33
Hot carcass weight	833	829	3	0.59
Marbling score[c]	535	530	12	0.79
Fat thick, in[d]	0.50	0.45	0.02	0.15

[a]Adjusted using hot carcass weight.
[b]Analyzed as gain:feed.
[c]Marbling score: 500 = $Small^{0}$, 550 = $Small^{50}$.
[d]12^{th} rib fat thickness.

Table 4. Nitrogen mass balance in the feedlot for Exp 1 (values expressed as lb/steer over entire feeding period unless noted).

Item	CONTROL	CLAY	SEM	*P*-value
N intake	85.8	86.3	1.3	0.77
N retention [a]	12.6	13.1	0.3	0.30
N excretion [b]	73.2	73.2	1.1	0.95
Manure N	43.9	42.7	2.4	0.64
Runoff N	0.51	0.97	0.15	0.06
N lost [c]	29.2	30.6	4.0	0.82
% N lost[d]	40.1	41.8	5.7	0.84

[a]Calculated using NRC (1996) net protein and net energy equations.
[b]Calculated as N intake - N retention.
[c]Calculated as N excretion - manure N - core N - runoff N.
[d]N lost expressed as % of N excreted.

Table 5. Nitrogen mass balance in the feedlot for Exp 2 (values expressed as lb/steer over entire feeding period unless noted).

Item	CONTROL	CLAY	SEM	*P*-value
N intake	74.8	73.7	0.7	0.18
N retention [a]	9.0	8.9	0.3	0.69
N excretion [b]	65.8	64.8	0.5	0.11
Manure N	12.0	11.1	0.9	0.55
Runoff N	0.06	0.10	0.01	0.10
N lost[c]	53.8	53.6	0.9	0.90
% N lost[d]	81.7	82.7	1.4	0.64

[a]Calculated using NRC (1996) net protein and net energy equations.
[b]Calculated as N intake - N retention.
[c]Calculated as N excretion - manure N - runoff N.
[d]N lost expressed as % of N excreted.

are reported on a per steer basis for 120 days. All data were analyzed by analysis of variance using the Mixed Procedure of SAS.

Results

For both experiments there were no statistical differences in steer performance between the control and clay treatments. In Exp 1, CLAY steers had a 3.4% increase in ADG over CONTROL. The CLAY steers also had a 2.9% decrease in F/G (Table 2). Whereas, during Exp 2, CONTROL had a 1.5% increase in ADG over the CLAY steers and were more efficient with a 5.8% decrease in F/G over the CLAY steers (Table 3). However, these changes in performance were not statistically significant and we conclude the addition of 1.2% clinoptilolite zeolite has no impact on cattle ADG or F/G.

Nitrogen mass balance was not affected by the addition of zeolite clay for either experiment (Tables 4 and 5). No statistical treatment differences were present for manure N or N lost. The % N lost during Exp 2 was higher than other reported amounts by Erickson (*2002 Nebraska Beef Report*, pp. 54-57) and Adams (*2003 Nebraska Beef Report,* pp. 54-58). However, the N losses observed in this study were similar to observations by Wilson et al. (*2004 Nebraska Beef Report,* pp. 72-73). The higher levels of N lost during the summer, compared to previous research, could be due to environmental factors such as warm, humid conditions, rainfall, temperature, or diet differences.

Research with other species has shown zeolite clay to be effective in adsorbing N, thus having the ability to reduce N volatilization losses. The lack of a response to zeolite in the current study could be due to variations in clays used and methodology for assessing N losses. Also, zeolite clay may not have the cation exchange potential needed for the conditions in open pens versus confinement conditions.

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