Effect of Clinoptilolite Zeolite on Cattle Performance and Nitrogen Volatilization Loss

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Summary

A winter feeding experiment evaluated effects of adding clinoptilolite zeolite clay at 1.2% of the diet on steer performance and nitrogen (N) volatilization loss. No differences were found in steer performance, removed manure composition or N balance; however, small numeric improvements were observed in ADG and F:G for steers fed zeolite. Adding zeolite clay to feedlot diets did not affect N loss in open feedlots using mass balance techniques.

Introduction

With increasing environmental regulations, producers will need to incorporate efficient, cost effective methods to reduce N losses from feedlots without negatively affecting cattle performance. Numerous options have been researched which include decreasing diet digestibility by adding corn bran (*2004 Nebraska Beef Report*, pp. 69-71, *2003 Nebraska Beef Report*, pp. 54-58, *2002 Nebraska Beef Report*, pp. 54-57), feeding less total protein (*1999 Nebraska Beef Report*, pp. 60-63) and cleaning pens more frequently (*2004 Nebraska Beef Report*, pp. 72-73).

Zeolite clay, a proposed new treatment to reduce N volatilization, is capable of ion exchange and may be effective in adsorbing ammonia. Most zeolite clays are mined from volcanic ash deposits which form alkaline lakes. One hypothesis for this research is that adding zeolite clay to cattle feedlot diets will bind the ammonia (NH_3), reducing the amount of N lost into the air. The second hypothesis is that steer ADG, feed efficiency and intake will not be negatively impacted by adding zeolite clay to the diet.

Procedure

Ninety-six crossbred steer calves (741 + 26 lb) were fed for 168 days from November to April. Steers were stratified by weight and assigned randomly to twelve pens and one of two treatments (eight head per pen, six pens per treatment). Treatments were 1) control diet with 0% zeolite clay or 2) treatment diet with 1.2% zeolite clay. Clinoptilolite zeolite clay was used in this experiment.

Steers were weighed initially on two consecutive days following a five-day limit-feeding period. Steers were weighed again on days 28, 84 and 168. The cattle were implanted on day 1 and day 84 with Synovex-Choice®. Diets were formulated to meet the steers' metabolizable protein requirement according to the 1996 Beef NRC. Steers were fed on a four-week step-up program to the finishing diet shown in Table 1. The supplement used a ground corn carrier and for the treatment diet, 1.2% of the ground corn carrier was replaced with zeolite clay.

At slaughter, hot carcass weights and liver scores were recorded. Following a 24-hour chill, fat thickness at the 12th rib, quality grades, yield grades and rib-eye areas were recorded. Final weights were calculated as hot carcass weight divided by the dressing percentage of 63.

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

Ingredient	Control	Zeolite
High moisture corn	62.5	62.5
Wet corn gluten feed	25	25
Alfalfa hay	7.5	7.5
Supplement[a]	5	5

[a]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.

The N balance experiments were conducted in 12 open feedlot pens with retention ponds to collect run-off. Run-off amounts were measured using an ISCO 4230 flow meter (Lincoln, Nebraska). Samples were collected during draining of the retention ponds and analyzed for dry matter, organic matter and total N.

Prior to the steers entering the pens, 16 core samples (top 6 inches) were taken at equally spaced intervals throughout the pen. Following removal of the steers at slaughter, pens were cleaned and 16 cores were taken once again at similar locations. Six cores per pond were taken at the same time as the pen cores. All cores were analyzed for dry matter, organic matter and N.

On day 168, following the removal of the steers, pens were cleaned. Total pounds of manure removed were recorded. As manure was loaded, samples were obtained for analysis of dry matter and N.

Table 2. Growth performance and carcass characteristics.[a]

Item	Control	Zeolite	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
Feed/gain [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 thick, 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]12th rib fat thickness.

Table 3. Nitrogen mass balance in the feedlot for steer calves fed from November to April (values expressed as lb/steer over entire feeding period unless noted).

Item	Control	Zeolite	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 [c]	43.9	42.7	2.4	0.64
N lost [d]	29.2	30.6	4.0	0.82
% N lost [e]	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]Manure N includes soil core balance before the experiment and after cleaning.
[d]Calculated as N excretion - manure N - core N.
[e]N lost expressed as % of N excreted.

Table 4. Manure composition.

Item	Control	Zeolite	SEM	*P*-value
DM weight removed	3573	3637	213	0.84
% DM	68.1	69.2	0.9	0.40
OM weight removed	692	657	42	0.57
% OM	19.7	18.0	0.9	0.19
N weight removed	37.0	35.3	2.4	0.64
% N	1.04	0.97	0.03	0.16

Nitrogen intake was calculated using analyzed dietary N concentration for each feedstuff and total DMI. Individual steer N retention was calculated using the NRC (1996) net protein and net energy equations. Nitrogen excretion was determined by the difference between N intake and N retention. Manure N was calculated from weight of manure hauled and N composition. Manure N was corrected for inherent cleaning differences by adjusting for soil core N before and after the feeding period. Total N lost was calculated by subtracting soil corrected manure N from excreted N. All N values are reported on a per steer basis fed for 168 days. All data were analyzed by variance using the Mixed Procedure of SAS.

Results

There were no statistical differences in steer performance between control and zeolite treatments (Table 2). Numerically, the zeolite steers had a 3.4% increase in ADG over the control group. The zeolite group had a 2.9% decrease in feed:gain.

Nitrogen mass balance was not affected by adding zeolite clay. No statistical differences were found in manure composition removed or N balance (Tables 3 and 4).

Previous research suggests zeolite clay is able to adsorb N, thus having the ability to reduce N volatilization loss. In this trial, however, no differences in volatilization were seen. The percent of N lost during this trial (Table 3) was consistent and within the 38-74% N lost during winter months as reported in previous studies. Over the 168-day feeding period, 73.2 lb of N was excreted and about 45 lb of zeolite clay was consumed per steer. The steers were excreting 162% more N than zeolite consumed. About 30 lb of N was lost, so the amount potentially retained by the zeolite clay did not have a significant impact. The amount of N supplied by feedlot diets may be greater than the potential for zeolite clay to adsorb and therefore N balance and losses may not be impacted.

Based on previous estimates of NH_3 binding in soils by Kithome et al. (*1998 Soil Science Society of America Journal*), zeolite clay retained 1 g per lb of zeolite. Using that estimate, only 0.1 lb of N would be trapped in manure from the 45 lb of zeolite fed to each steer over the 168 days.

In this experiment, mass balance techniques were used in open outdoor pens which is different than previous research. Manure is being composted to determine if any differences would be observed between treatments.

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