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Effect of Humic/Fulvic Acid in Beef Cattle Finishing Diets on Animal Performance, Ruminal Ammonia and Serum Urea Nitrogen Concentration

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Abstract

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This study was designed to investigate the effects of a humate supplement on rumen ammonia N (RAN), serum urea N (SUN) and live performance in beef cattle finishing diets. Twenty-four English cross steers (BW 432 ±5 kg) were stratified by weight, randomly assigned to individual pens and fed one of the four diets, containing 0 (control), 0.5, 1.0 or 1.5% humic/fulvic acid, for 56 d. Control diets contained 33.3 mg/kg monensin. Steers were weighed at d 0, 28 and 56. Blood (jugular veni-puncture) samples and rumen (esophageal tube) samples were taken prior to feeding on d 0 and there after prior to and 4 h post feeding on d 28 and 56. Rumen fluid pH was determined immediately, acidified with HCl and stored (-20C) for subsequent RAN analysis. Serum was also stored (-20C) for analysis of SUN. During the 56 d period there was no difference in DMI (P>0.58), ADG (P>0.24) or G:F (P>0.28) between treatments. There were no two or three way interactions for SUN (P>0.95), RAN (P>0.87) or rumen pH (P>0.15). There was a tendency for a cubic response (P<0.10) for RAN and SUN, however, no biological significance could be determined. These results suggest that humic/fulvic acid does not affect DMI, ADG, G:F, SUN, RAN and pH in finishing steers when compared to those fed monensin.

Keywords: Beef cattle, humate, humic/fulvic acid.

Introduction

Natural beef products are increasing in popularity across the United States, due to clinical misnomers such as, but not limited to, children reaching sexual maturity at an earlier age and antibiotic resistance. This is thought to be occurring because of the use of management tools such as steroid implants, rbst (recombinant bovine somatotropin) and antibiotic feed additives. Though unproven, these production methods are definitely a concern to consumers and have been confirmed as such by the recent success of niche markets, advertising natural or hormone-free products (Lusk and Fox, 2000). Even so, there are very

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few producers targeting these markets due to the increased cost of production. A study conducted by Sawyer *et al.* (2003) at New Mexico State University provided data that showed a net profit of $17.20 per head after a 140 d feeding period for those cattle that were implanted compared to a ($27.12) net loss per head for those that were not implanted. Therefore, a substantial premium for natural or organic beef would have to occur to stop use of growth promotants. However, introducing completely organic, humate substances into feedlot diets, may be very beneficial if they are mechanistically similar to ionophores.

Humate substances are naturally occurring, geological deposits in the earth's surface composed mainly of decaying plant and animal matter which is formed through the biological activities of microorganisms. Previous research has indicated that humates have nitrogen-binding characteristics when utilized in soil. These nitrogen-binding qualities could prove to be very beneficial in the retention of rumen ammonia N. Shi *et al.* (2001) evaluated the application of humic acids to minimize ammonia emissions from beef cattle feedlots and concluded that humate was effective in reducing ammonia emissions. *In vivo* research has primarily been conducted in monogastrics, specifically poultry. In broilers fed humate from 22 to 42 d, body weights were 4.28% higher than those not fed humate; however, there were no effect on early feeding or during the finishing phase (Kocabagli *et al.,* 2002). Yoruk *et al.* (2004) found that egg production increased and mortality and feed conversion efficiency (weight of feed/weight of eggs) decreased linearly with increasing levels of supplemental humate. This research examined late laying hens, rather than hens in a growing phase. Therefore, it was speculated that this increase in efficiency could be due to an affect on bacterial populations in the cecum. Minimal research has been conducted on the utilization of humates in beef cattle diets. Chirase *et al.* (2000) showed an increase in serum hemoglobin and bilirubin in a 3.12% humate diet when compared to a control, but there was no difference in DMI, ADG or F:G. These results were determined during a short 56 d period with only one sample period on d 28. Therefore, more research is needed to determine its efficacy. Our objective was to determine if supplementing humic/fulvic acid to finishing beef steers could potentially improve feed efficiency similar to ionophores.

Materials and Methods

All procedures were approved by The University of Arizona Institutional Animal Care and Use Committee #05-028.

A completely randomized design was used to determine the effects of humic acid on rumen ammonia N (RAN), serum urea N (SUN) and live performance in beef cattle finishing diets. Twenty-four crossbred beef steers (BW 432±5 kg) were stratified by weight and divided in 4 groups. A steam-flaked corn based diet with soybean meal and urea as protein sources (13.87% CP) and 10% mid bloom alfalfa hay as the roughage component was supplemented with 0 (control), 0.5, 1.0 or 1.5% humic/fulvic acid (Bovigro; Bio Remedies, San Ysidro, NM). One group of steers was allotted to each diet at random. The control diet contained monensin at 33.3 mg/kg. The steers were given a 14 d adjustment period to acclimate to the pen and the diet. Individual troughs were read daily, feed was weighed according to intakes and then steers were individually fed their respective diets for a 56 d period. They were sampled on d 0, 28 and 56 of the trial. Steers were weighed prior to feeding. Blood and rumen samples were collected immediately prior to and 4 h following feeding, excluding d 0 when only a before feeding sample was collected. However, there was not a d 0 pH due to complications with the pH meter. Blood was collected via jugular veni-puncture and stored (-20C) for later evaluation of SUN concentration using a direct colorimetric determination method (TECO Diagnostics, Anaheim, CA 92807). Rumen fluid was

acidified (1 ml 20% HCl/100 ml rumen fluid) after pH estimation and stored (-20C) for subsequent RAN analysis using a phenol-hypochlorite assay adapted from Broderick and Kang (1980) and modified by Galyean (1997). Feed samples were collected weekly and subjected to the following analysis: DM, CP (% Nx6.25; LECO Corporation, St. Joseph, MI 49085), ash and ADF (Ankom Tech Corp, Fairport, NY).

Statistical analysis was performed using the PROC MIXED procedures of SAS (1988). The response variables rumen pH, SUN and RAN, were analyzed with treatment, time and day in the model with d 0 as a covariate. The covariance structure was heterogeneous and autoregressive. Time was used as the repeated measure and linear, quadratic and cubic contrasts were measured. All treatment x time and treatment x time x day interactions were tested and LS means were reported for each variable with significance considered to be P<0.10. Intake was analyzed with treatment and ID in the model and treatment x ID interaction was tested. Individual BW, ADG and F:G was tested within period and across each period with regards to treatment. The most conservative SEM was reported for each variable.

Results and Discussion

In agreement with the findings of Chirase *et al.* (2000), the results indicated that during the 56 d period there was no difference in DMI (P>0.58), ADG (P>0.24) or G:F (P>0.28) between treatments (Table 1). Further data analysis showed no treatment x time or treatment x time x day interactions. Because there were no interactions, the values reported in Table 1 for SUN, RAN and pH are averaged over time. However, there was a treatment by day response (P<0.10) for RAN and this was demonstrated by a drop in concentration on d 28 and a recovery at d 56 for 1.0% humic/fulvic acid (Fig. 1). This is in accordance with findings of Guan *et al.* (2006) concluding that monensin initially decreases methane production, but the rumen ciliate protozoa restore population by the fourth and sixth week and accordingly resume rumen ammonia production at a level similar to that before supplementation. Accordingly, SUN and RAN did respond cubically, with respect to treatment, when comparing the 1.0% humic acid diet to the

Table 1
Serum urea-N concentration (SUN), rumen ammonia-N concentration, rumen pH and performance

Item	HFA %DM				SEM	Contrasts	
	0	0.5	1.0	1.5		L	Q
[a]BW,kg							
d 0	429	434	433	430	10.78	0.96	0.68
d 56	553	547	559	542	11.97	0.72	0.64
[b]ADG, kg/d	2.21	2.01	2.24	2.00	0.10	0.41	0.83
[c]DMI, kg/d	25.48	24.74	26.38	26.93	1.19	0.27	0.60
[d]G:F	0.229	0.217	0.226	0.195	0.01	0.13	0.49
SUN, mg/dl	14.18	15.36	13.20	14.86	0.83	0.97	0.77
Rumen							
pH	6.55	6.60	6.58	6.77	0.09	0.14	0.41
NH_3-N, mg/dl	10.47	10.12	7.85	9.83	0.82	0.20	0.13

[a]BW = Body weight; [b]ADG = Average daily gain; [c]DMI = Dry matter intake; [d]G:F = Gain to feed.

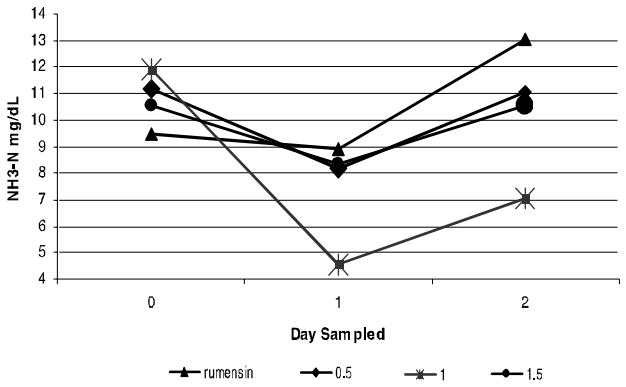

Fig. 1. Least square means of rumen NH_3-N over 56 d period with data collected on d 0, 28 and 56. Day 1 and 2 P<0.10 for monensin and 1.0% humic acid.

other diets. However, there is no mechanistic reasoning for this finding and biological significance is questionable. Accordingly, the data suggests that humate substances have potential to mimic ionophores when fed to beef cattle. However, further research is warranted, utilizing a negative control and a larger more industry equivalent population.

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