Effects of Dietary Sulfur Concentration on Carcass Quality, Performance and Mineral Status of Beef Cattle

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Summary and Implications

Sulfur (S) is an essential element in ruminant diets, but it can be toxic at high levels. Sulfur also interacts with other minerals in the diet such as copper (Cu), impacting the status of the animal. This study utilized 96 crossbred yearling steers fed a low sulfur diet (LS, 0.3% S) or the LS diet with additional S from sodium sulfate creating a high S diet (0.6% S, HS) to determine the effects of S concentration on performance, carcass quality, and mineral status. High S decreased gains and Cu and magnesium (Mg) status. Decreased gains may result in more days on feed to finish cattle when feeds high in S are used. Dietary S impacts on mineral status may also further impact animal health.

Introduction

The ethanol industry in Iowa has grown in recent years; as a result co-products from this industry have become more available and economically advantageous to producers when feeding cattle. Sulfuric acid is utilized in the process of ethanol production, resulting in potentially high, and often varied, concentrations of S in co-products such as distiller's grains (DDGS). High S in cattle diets may result in polioencephalomalacia (PEM), decreased animal gains, and altered mineral metabolism.

Materials and Methods

To determine the effects of high dietary S on finishing cattle 96 crossbred yearling steers were blocked by weight (724 ± 64 lbs initial bodyweight) and assigned to treatment. For the first 35 d on study steers were stripgrazed on bromegrass pastures while receiving a DDGS-based supplement with either LS (0.3% S) or HS (0.6% S). On d 36 steers were moved to feedlot pens (n = 4 per pen) and began a transitioning process to the final feedlot diet. Upon moving from the pasture to the feedlot half of the steers continued to receive their experimental S treatment while half were switched to the other S treatment.

Blood samples were collected on d 0, 35, 125 and 155 for plasma mineral analysis. Liver biopsies were also performed on d 0, 35 and 155 for analysis of mineral concentration.

At the conclusion of the trial steers were shipped 94 miles to a commercial abattoir in Denison, IA for harvest. Trained personnel collected data for hot carcass weight (HCW), ribeye area (REA), kidney pelvic and heart fat (KPH), marbling score and backfat thickness.

Results were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). The interaction of pasture S treatment and feedlot S treatment was not significant and as a result all means presented in this paper are representative of 12 replicate pens per treatment (LS and HS).

Results and Discussion

Steer ADG was lower in HS steers vs. LS steers (P = 0.002; Table 1). Intakes were not different due to dietary S (P = 0.15), and gain:feed was not affected by dietary S (P = 0.39). Reduced gains translated to smaller carcasses (P = 0.06; Table 2) in cattle fed high dietary S. Other measures of carcass quality were not affected by high S in the feedlot. The smaller carcasses in high S calves may be due to the weak tendency for decreased intake. This decreased intake is possibly due to a feed aversion created by the high S in the diet and the increased ruminal hydrogen sulfide production

In the rumen S interacts with Cu and molybdenum forming thiomolybdates which irreversibly bind Cu, decreasing Cu available to the animal for processes requiring Cu. In the present study Cu status was negatively affected ($P < 0.05$) by high S as evidenced by decreases in plasma (0.81 ± 0.03 and 0.74 ± 0.03 ppm, LS and HS, respectively) and liver (278.5±30.3 and 195.16±30.3 ppm ; P=0.02). Decreased liver Cu indicates that Cu stores were negatively affected over time by the high intake of S, although the levels seen in this study were not deficient. Thiomolybdate production and the subsequent binding and excretion of Cu from within the body is the probable cause of decreased Cu. Other minerals (iron, S, potassium, calcium, sodium, and zinc) were also analyzed but did not show differences. Plasma magnesium (Mg) was also decreased due to high S at the end of the trial (19.4±0.3, and 19.0±0.3 ppm LS and HS respectively, P=0.06). It is interesting to note that PEM is a neurological dysfunction and that Mg plays a key role in nerve impulse conduction. Further research is required to determine the significance of the decrease in Mg caused by S toxicity.

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Table 1. Effects of high dietary sulfur on gain and efficiency.

Item	Feedlot[a]			
	Low Sulfur	High Sulfur	SEM	*P*-values
DMI (lbs DM/d)	23.6	22.1	0.8	0.15
ADG (lbs/d)	3.6	3.2	0.1	0.002
Gain : Feed	0.150	0.145	0.008	0.39

[a] n = 48 steers per treatment

Table 2. Effects of dietary sulfur on carcass characteristics

Item	Feedlot[a]			
	Low Sulfur	High Sulfur	SEM	*P*-values
HCW (lbs)	788	752	14	0.06
Fat cover (in)	0.42	0.39	0.07	0.39
REA (in^2)	12.9	12.4	0.2	0.25
YG	2.85	2.77	0.12	0.54
KPH (%)	1.94	2.00	0.08	0.58
Marbling Score[b]	429	436	15	0.75

[a] n = 48 steers per treatment

[b] marbling score: 400=small, 500=modest