Effect of Delaying the Feeding of High Sulfur until After Adaptation to a Finishing Diet

A.S. Leaflet R2694

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Summary and Implications

Sulfur (S) intake does not appear to be the only factor contributing to the likelihood of S-induced polioencephalomalacia (PEM). Cattle appear to be more susceptible during the early part of the finishing period. In this study, increasing S inclusion after the first 30 d of finishing resulted in lower peak hydrogen sulfide (H_2S) concentrations compared with feeding the same level of S earlier in the finishing period. Therefore, waiting to include high levels of ethanol co-products until after the first 30 d of finishing may decrease the likelihood of S toxicity.

Introduction

Increased intake of S has been shown to decrease intake, reduce gain, and can lead to the neurological disorder PEM. Sulfate (the most common form of S in the diet) is reduced to sulfide by ruminal bacteria. Sulfide in the rumen can then be converted to the toxic gas H_2S in a pH dependent process. Elevated concentrations of ruminal H_2S have been correlated with S-induced PEM. The incidence of PEM and concentrations of ruminal H_2S in feedlot cattle appear to be greatest during the first 30 days on a full finishing diet. The dramatic increase in rumen H_2S concentrations that occur when cattle are first introduced to a high concentrate, high S ration maybe due a combination of factors such as decreased ruminal pH, changes in bacterial and protozoal populations, or bacterial metabolism. We hypothesized that delaying exposure to high S diets until cattle are fully adapted to a high concentrate diet would reduce ruminal H_2S concentrations and thus reduce potential for toxicity. Additionally, this strategy may reduce the negative feedback of excess ruminal H_2S, thereby potentially improving feed intake and overall performance.

Materials and Methods

Sixty Angus crossbred cattle (850 ± 26 lbs) previously backgrounded on bromegrass pasture and supplemented with soyhulls were blocked by weight and randomly assigned to 1 of 12 pens, and to 1 of 3 dietary treatments, including 1) a control diet (0.3% S) fed throughout the trial (Control), 2) a high S diet (0.6% S) fed throughout the trial (High S), or 3) a control diet fed during the transition period and for the first 28 d of the finishing period then a high S diet for the remainder of the trial (Delayed S). Steers were transitioned from a forage-based diet to a concentrate-based diet through 3 step up diets fed for 7 d each, in which corn was gradually substituted for hay. After three weeks of transition the steers began receiving their finishing diet (Table 1). The level of S in the high S diet was achieved through inclusion of sodium sulfate.

Steers were weighed prior to feeding on two consecutive days prior to the start of the first transition diet and again after finishing diets were fed for 84-85 days. Interim weights were taken 28 and 56 d after the start of feeding final finishing diets. Hydrogen sulfide concentrations of the rumen gas of 2 steers per pen were measured 6 h after feeding on d 1, 7, 14, 28, 35, 42, 56, 70, 77, and 84 of finishing. Hydrogen sulfide concentration in the rumen gas was measured using commercial gas detector tubes (Kitagawa, SM-2).

Data were analyzed as repeated measures using the MIXED Procedure of SAS (SAS Institute Inc., Cary, NC). For all analysis pen was considered the experimental unit, block was considered random, and treatment was a fixed effect. For analysis of intake and ruminal H_2S day was a repeated measure.

Results and Discussion

Peak H_2S concentration of Delayed S (3425 ppm) occurred on d 56 (28 d on high S diet), but was lower ($P < 0.05$) than peak H_2S for High S (5288 ppm), which occurred on d 7 of finishing (Figure 1). Peak H_2S of the Control (2583 ppm) also occurred on d 7 and did not differ ($P = 0.23$) from the peak of Delayed S on d 56, but was less ($P < 0.05$) than High S (on d 7).

Sulfur intake (39.3 g/hd) of the Control steers at peak H_2S was less ($P < 0.01$) than Delayed S (66.8g/hd) and High S (65g/hd) steers. However, the DM intake of the Control steers (13.0 kg/hd) was greater ($P < 0.01$) than Delayed S (12.7 kg/hd) and High S (10.8 kg/hd) steers at peak H_2S. Sulfur and DM intake of Delayed S steers did not differ ($P > 0.60$) from High S steers at peak H_2S.Peak concentration of H_2S was lower for Delayed S steers than High S steers despite the fact that they consumed a similar amount of S, suggests that the Delayed S steers would have a lower risk for toxicity.

Increased S in the diet decreased intake and resulted in decreased gains of both High S and Delayed S steers (Table 2). In terms of gains and intake, there did not appear to be a benefit to delaying S inclusion in the diet as the Delayed S steers had similar gains to High S from d 28 to 84. In our study the control diet had similar energy (91 Mcal/cwt NEg) and protein (13.4% CP) content to the high S diet as the only difference between the high S diet and the control diet was the inclusion of sodium sulfate.

It should be noted, however, that in the Midwest increased S in the diet is often from ethanol co-products which are generally more energy dense than corn. When distiller grains are fed, gains are often increased above that of a corn based diet until distiller's grains are included at levels above 50% of the diet on DM basis.

This study suggests that potential for toxicity was reduced by delaying the inclusion of high S until after steers had received a high concentrate finishing diet for 28 d. Based on the H_2S levels observed in this study, a target S level for the first 30 d of finishing of 0.3% or less would lower the risk of PEM. Once cattle are fully adapted to a high concentrate ration inclusion of ingredients with high levels of S (such as ethanol co-products) can be increased (up to 0.5% total dietary S) with less risk of toxicity.

Acknowledgements

The authors appreciate the work of the farm staff at the Iowa State University Beef Nutrition Research Farm. This research was made possible though funding by the Wise Burroughs Memorial Endowment in Animal Science.

Table 1. Composition of finishing diet.

Ingredients	% of DM
Dry rolled corn	60.00
DDGS[1]	29.84
Bromegrass hay	8.00
Limestone	1.7
Trace minerals and Vitamin A	0.14
Salt	0.31
Rumensin 90	0.02

[1]Sodium sulfate was substituted for DDGS in high S diets at 1.11% of diet DM

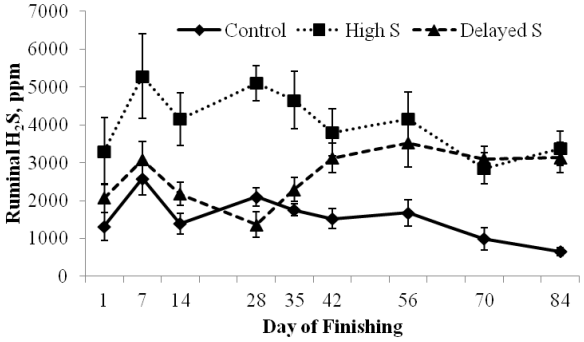

Figure 1. Ruminal H_2S concentrations (ppm) of steers fed a finishing diet containing: 0.3% S throughout the trial (Control), 0.6% S fed throughout the trial (High S), or the control diet fed through week 4 of the finishing period then a high S diet for the rest of the trial (Delayed S).

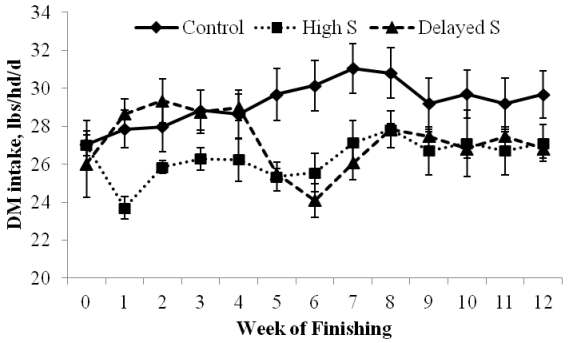

Figure 2. Dry matter intake (lbs/hd/d) of steers fed a finishing diet containing: 0.3% S throughout the trial (Control), 0.6% S fed throughout the trial (High S), or the control diet fed through week 4 of the finishing period then a high S diet for the rest of the trial (Delayed S).

Table 2. Average daily gain of steers during trial.

	ADG, lb/hd/d		
	d -21 to 28	d 28 to 84	Overall
Control	5.75[ab]	4.15[a]	4.84[a]
High S	4.69[b]	3.61[ab]	4.07[b]
Delayed S	6.24[a]	3.01[b]	4.39[ab]
SEM	0.32	0.21	0.18
P-value	0.04	0.02	0.05

Means that lack common superscripts within a column differ ($P \leq 0.05$).