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Relating Hydrogen Sulfide Levels to Polioencephalomalacia

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Summary

Data from a finishing trial and a metabolism study were used to relate incidence of polioencephalomalacia (polio) with ruminal hydrogen sulfide gas concentration. The finishing trial included different inclusion levels of byproducts with differing alfalfa hay levels. Similar diets were used in the metabolism study. The feedlot trial had 12 cases of polio on a 75% byproduct diet with no alfalfa and no cases of polio when alfalfa was included at 7.5%. The metabolism study reported the highest concentration of H₂S with the high byproduct diet with no grass hay, and lower concentrations when grass hay was included. These data would indicate that forage inclusion can reduce the risk of polio and that polio is related to ruminal H₂S concentrations.

Introduction

Sulfur content in byproduct diets of feedlot cattle may increase risk of cattle developing polioencephalomalacia (polio). Our previous research (2009 *Nebraska Beef Report*, pp. 79-80) indicated that the risk of polio is low when the sulfur content of the diet is below 0.46% (four of 3,137 cattle, or 0.13%, developed polio). As the sulfur content increased up to 0.56%, the incidence of polio increased to 0.35%, or 3 in 857. Sulfur content above 0.56% dramatically increased the risk of cattle developing symptoms of polio, with 6.06% or 6 in 99 developing symptoms. One treatment with zero forage inclusion was not included in this summary because diets with no forage would not be fed in usual feedlot production. Therefore, the objective of this research was

to relate incidences of polio to ruminal hydrogen sulfide (H₂S) gas concentrations associated with byproduct inclusion levels.

Some of the sulfur in byproducts comes from the protein in the corn from which the byproduct is made. Additionally, some of the sulfur is in the form of sulfate. Therefore, byproducts are a combination of both organic and sulfate sulfur. Microbes in the rumen reduce sulfate compounds to H₂S. It is believed the H₂S directly or indirectly (thiaminase) causes polio. This concern has led to research measuring H₂S concentration either *in vitro* or in the rumen. Research has shown mixed results on the effect of monensin in the diet of feedlot cattle and the effect on ruminal H₂S. When sulfur levels were high (1.2%), a significant increase in the *in vitro* concentration of H₂S was observed when monensin was added to the substrate material (1998 *J. Dairy Sci.* 81:2251-2256). However, when sulfur levels ranged from 0.2% to 0.6%, there was no observed influence of monensin on the H₂S concentration *in vivo* (2009 *Midwestern Section ASAS Abstract # 272*).

Procedure

The metabolism study used a 2 × 3 factorial treatment arrangement with two byproduct types and three grass hay levels in a 6 × 6 latin square arrangement with 6 fistulated steers (2009 *Nebraska Beef Report*, pp. 81-83). The two byproducts that were tested were 50% wet distillers grains plus solubles (WDGS) and a 50:50 blend of WDGS and wet corn gluten feed (WCGF), each included in the diet at 37.5% DM basis. Grass hay was included in the diets at 0, 7.5 or 15% DM basis. Hydrogen sulfide gas was collected using tubing inserted through the cannula plug. The tube was connected to a foam block that floated on the mat layer in the rumen.

The end of the tube was covered with a filter to reduce the amount of material that entered the tube and allow gas to flow freely. Samples were taken from the tube using a syringe and mixed with water in a serum bottle to solubilize H₂S. The concentration of H₂S was analyzed using a spectrophotometric method developed by Kung et al. (1998 *J. Dairy Sci.* 81:2251-2256). The study was statistically analyzed as a 2 × 3 factorial using the MIXED procedure of SAS. There was a byproduct by grass hay level interaction ($P < 0.01$); therefore, simple means for each treatment are reported.

The feedlot study (2005 *Nebraska Beef Report*, pp. 45-46) tested levels (25, 50, or 75%) of a 50:50 blend of WDGS and WCGF. Level of roughage also was studied, resulting in a treatment with 37.5% WCGF, 37.5% WDGS, and no roughage, similar to the diet used in the metabolism study. The feedlot study involved 288 yearling steers in 35 pens (8 steers/pen) and 40 steers per treatment.

Results

In the metabolism trial, the concentration of ruminal H₂S decreased linearly ($P < 0.01$) with an increase in inclusion of grass hay in the diet (Table 1). Overall there were only small differences between byproducts for H₂S concentration in the rumen. However, for the 50% WDGS diet, H₂S concentrations decreased from 32.7 to 27.6 and 20.7 μmol sulfur per L of rumen gas as grass hay inclusion increased from 0 to 7.5 and 15%, respectively. The results of the combination byproduct diet were similar to the 50% WDGS diet; however, the combination diet with 0% grass hay had a greater concentration of H₂S than the WDGS diet. The concentrations of H₂S were 80.5, 27.7, and 12.4 μmol sulfur per L of ruminal gas as the grass hay level in the diet increased from 0 to 7.5 and 15%,

Table 1. Ruminal hydrogen sulfide concentrations in byproduct diets at 8 hours post feeding¹.

Byproduct	WDGS ²			WDGS/WCGF ³		
	0.0	7.5	15	0	7.5	15
Grass hay						
8 h H ₂ S μ mol/L	32.7 ^b	27.6 ^b	20.7 ^b	80.5 ^c	27.7 ^b	12.4 ^b
Diet S, % ^a	0.43	0.42	0.41	0.47	0.46	0.45

¹2009 *Nebraska Beef Cattle Report*, pp. 81-83. Six steers per treatment mean.

²Wet distillers grains plus solubles, 50% of diet dry matter.

³Wet distillers grains and wet corn gluten feed, each at 37.5% of dry matter.

^aByproduct type \times hay level, $P < 0.01$.

^{b,c}Means with unlike superscripts are different ($P < .05$).

respectively. At zero grass hay inclusion, steers fed the combination diet had a H₂S concentration of 80.5 μ mol sulfur per L of collected rumen gas, while those fed the WDGS diet had a concentration of 32.7 μ mol sulfur per L of rumen gas (Table 1).

The feedlot study reported in the 2005 *Nebraska Beef Report* (pp. 45-46) tested different levels of 50:50 WDGS/WCGF fed to feedlot cattle. When the byproduct combination was fed at 75% of the diet with 0% forage, 12 cases of polio were observed out of 40 steers on the treatment, while no cases of polio were observed in steers on the 75% combination diet with 7.5% alfalfa. Dietary S content observed in the study described in the 2005 *Nebraska Beef Report* was 0.45%. When the combination diet was fed in the metabolism study (2009 *Nebraska Beef Report*, pp. 81-83), the dietary S concentration was 0.47%. The feedlot and metabolism studies differed in grain and roughage sources. Diets from the metabolism study contained dry rolled corn (DRC) and grass hay while diets from the feedlot study contained a 50:50 blend of DRC and high moisture corn (HMC) and alfalfa hay. In the feedlot study, symptoms

of polio were diagnosed visually by the health crew at the research feedlot located near Mead, Neb. When cattle showed visual signs of polio, steers were treated with an IV injection of 2,000 mg of thiamin.

In a feedlot study testing different byproduct inclusion levels and combinations (2009 *Nebraska Beef Report*, pp. 76-78), five steers exhibited signs of polio. Four of the steers that exhibited signs of polio were on a high combination diet consisting of a 50:50 blend of WDGS and WCGF, included in the diet at 87.6%, and 7.5% alfalfa. The fifth steer was on a diet that contained a 50:50 blend of WDGS and WCGF, included at 65.6% of the diet, and 21.9% soy hulls. The dietary sulfur contents of these two diets were 0.587% and 0.476%, respectively. Another diet tested consisted of 65.6% WDGS, 7.5% alfalfa, and 21.9% grass hay (DM basis). This diet had a sulfur content of 0.549% and did not induce polio in any cattle. This is consistent with the results from the metabolism study reported in the 2009 *Nebraska Beef Report* (pp. 81-83) that concluded increased forage levels in the diet decrease the risk of developing polio.

A summary of sulfur level and in-

cidence of polio was reported in 2009 *Nebraska Beef Report*, pp. 79-80. Since that time four new cases of polio have been observed in the University of Nebraska research feedlot. One case of polio developed when a steer was fed a diet containing a 50:50 blend of DRC and HMC at 45% of the diet with 35% WCGF, 15% corn silage, and 5% supplement. The dietary sulfur content of this diet was 0.29% (Huls et al., 2009 *Nebraska Beef Report*, pp. 53-55). One steer developed symptoms of polio when consuming a diet consisting of 85% WDGS, 10% straw, and 5% supplement with a dietary sulfur content of 0.67% (Rich et al., unpublished). The last two steers that showed symptoms of polio were from the same trial; one steer died, and one was treated. These steers consumed a diet consisting of 50% HMC, 40% WCGF, 5% straw, and 5% supplement (Dib et al., unpublished). The dietary sulfur concentration of this diet was 0.26%.

In conclusion, most diets mentioned in this report had S contents higher than 0.30%. Therefore, diets above 0.30% S may be safely fed to feedlot cattle, at least when the source of sulfur is byproducts; however, it is important to maintain roughage levels in these diets. Furthermore, the relationship between dietary S and roughage levels to ruminal H₂S concentration has been demonstrated.

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