Impacts of Inclusion of either 25 or 50% Modified Distillers Grains (DM Basis) in Feedlot Rations on Ruminal Hydrogen Sulfide Concentration and Blood Oxygen Concentration in Steers

Bryan Neville, Rebecca Moore, Cierrah Kassetas, and Leslie Lekatz

Introduction

Sulfur induced polioencephalomalacia (PEM) has been an ongoing issue with the use of greater concentrations of distillers grains in feedlot rations. Research, for the most part, has been unable to understand the correlation between sulfur in distiller's grains and the incidence rate of PEM in feedlots. Research on hydrogen sulfide outside of ruminant nutrition has also led to a better understanding of hydrogen sulfide at a molecular level. Hydrogen sulfide has been reported to interfere with oxygen transport in blood (Guidotti, 2010). This leads us to the research question of what impact does hydrogen sulfide resulting from feeding rations containing distiller's grains have on oxygen transport in the ruminant animal. One way to measure this type of response is through blood gas profiles. The evaluation of blood gas profiles in beef cattle fed high sulfur diets has not previously been evaluated.

The hypothesis of this project was that bunk management will impact hydrogen sulfide gas concentrations and blood gas profiles in steers, with steers fed greater concentration of distiller's grains having a more pronounced effect. Our secondary hypothesis was that feeding greater concentrations of distillers grains will have minimal impacts on animal performance while bunk management strategy will alter feed efficiency. Our objectives were: 1) to evaluate the impacts of feeding either 25 or 50% distillers grains under two bunk management methods on animal performance and carcass characteristics, and 2) evaluate the impacts of feeding either 25 of 50% distillers grains under two bunk management methods on hydrogen sulfide gas concentrations in the rumen.

Materials and Methods

Steers originating from the North Dakota Angus University and Central Grasslands REC were utilized to evaluate the objectives of this study. Beef steers (32 hd) were stratified by weight, assigned to pen with pens randomly assigned to treatment. Treatments were arranged in a 2 x 2 factorial and included either 25% or 50% distillers grains and managed under one of two bunk management systems: 1) Control: bunks managed to be devoid of feed one hour prior to feeding, and 2) Long: bunks managed to still have approximately 1" of feed remaining at the time of new feed delivery. Adaptation was accomplished by making a series of five transition diets changed weekly until reaching the final finishing ration on day 28. All diets were supplemented with 100 mg of thiamin per head per day to assist in the prevention of polioencephalomalacia.

Ruminal hydrogen sulfide gas concentrations were collected on two steers from each of four pens per treatment, with the average score of the pen used for data analysis. Ruminal hydrogen sulfide was collected on days: 0, 7, 14, 21, 28, and 35 with collections occurring four hours after feeding. Procedures for sampling rumen hydrogen sulfide were previously outlined by Gould et al. (1997) and modified by Neville et al. (2010, 2012). Arterial blood samples were used for evaluation of blood gas profile including but not limited to pH, oxygen pressure, carbon dioxide pressure, and bicarbonate levels using an I-STAT machine and appropriate cartridges.

Results and Discussion

The bunk management strategies imposed in this study did not impact hydrogen sulfide concentrations or blood oxygen saturation ($P = 0.82$). Therefore, bunk management was removed from statistical models and only the effects associated with mDGS inclusion are being presented. As anticipated, the concentration of ruminal hydrogen sulfide increased throughout adaptation ($P < 0.001$, Figure 1). Further, including 50% mDGS increased ruminal hydrogen sulfide compared to those fed 25% mDGS. Previous research has shown that level of roughage and source of sulfur in the diet can impact the concentration of hydrogen sulfide in the rumen (Drewnoski et al., 2014). Previous research has also demonstrated that hydrogen sulfide concentrations can be influenced by bunk management during

adaptation (Lekatz and Neville, 2019). However, the inclusion rate of mDGS in the diets utilized by Lekatz and Neville (2019), were relatively low (25% mDGS, DM basis). In the present study, there is not a definite reason why bunk management did not impact ruminal hydrogen sulfide; however, initial evaluations of dry matter intake seem to indicate that the same degree of separation in intake were not achieved when comparing the current project and the data of Lekatz and Neville, 2019. Research in lambs (Neville et al., 2011) and steers (Neville et al., 2012) has utilized greater percentages of distillers grains in feedlot rations, which resulted in increasing concentration of dietary sulfur and hydrogen sulfide.

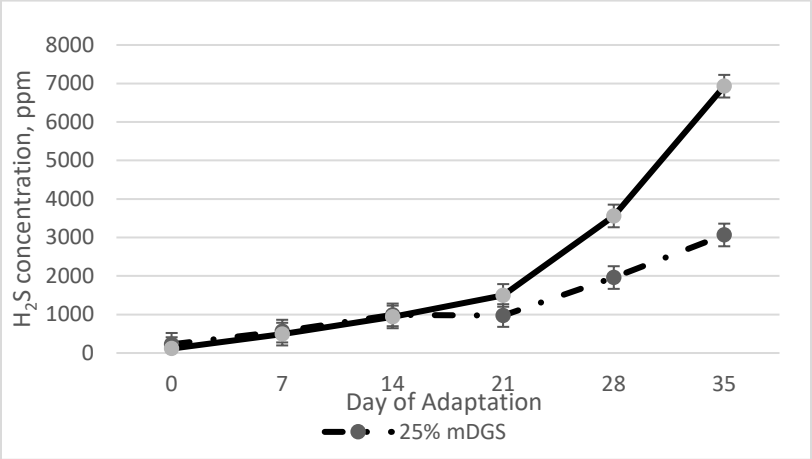

Figure 1. Concentration of ruminal hydrogen sulfide gas in steers fed either 25% or 50% mDGS (DM basis) during adaptation to finishing rations. P-values: Day (P < 0.001), mDGS inclusion (P < 0.001), Day x mDGS (P < 0.001).

Blood oxygen saturation was influenced by day of sampling (P = 0.01, Figure 2). The blood oxygen saturation of steers fed 50% mDGS tended to be greater than that of steers fed 25% mDGS. This is opposite of our hypothesis and is interesting given that hydrogen sulfide exposure has been shown to decrease blood oxygen binding (Guidotti, 2010). Certainly, this fact leads to some questioning the role of hydrogen sulfide in toxicity in ruminants fed high-sulfur diets. However, before any final determinations are made other research needs to be conducted to validate results observed in this study.

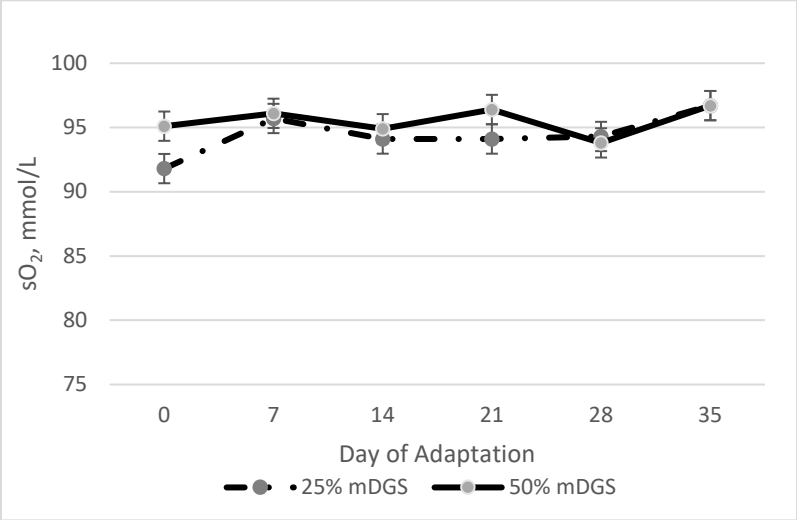

Figure 2. Blood oxygen saturation in steers fed either 25% or 50% mDGS (DM basis) during adaptation to finishing rations. P-values: Day (P = 0.01), mDGS inclusion (P = 0.07), Day x mDGS (P = 0.034).

Conclusions

It is probable that insufficient separation in dry matter intake occurred between the two bunk management systems to result in a difference in rumen fermentation and thus ruminal hydrogen sulfide. The increased ruminal hydrogen sulfide concentrations observed in steers fed 50% mDGS was expected. There appears to be no relationship between ruminal hydrogen sulfide concentration and arterial blood oxygen saturation. Further research evaluating the impacts of hydrogen sulfide concentration, and the mechanism by which ruminal hydrogen sulfide enters the blood are needed. This additional information may allow for more definitive answers which define the relationship between dietary sulfur, ruminal hydrogen sulfide, changes in oxygen saturation, and polioencephalomalacia.

Literature Cited

Drewnoski, M.E., D.J. Pogge, and S.L. Hansen. 2014. High-sulfur in beef cattle diets: a review. J. Anim. Sci. 92:3763-3780.

Gould, D.H. 1998. Polioencephalomalacia. J. Anim. Sci. 76:309-314.

Guidotti, T. 2010. Hydrogen sulfide: advances in understanding human toxicity. Int. J. of Tox. 000:1-13.

Lekatz L.A., and B.W. Neville. 2019. Impact of bunk management strategy on animal performance, carcass, characteristics, and hydrogen sulfide gas concentrations in steers fed modified distillers grains with solubles. Am. Soc. Anim. Sci. Midwest Meetings, Omaha, NE. (accepted)

Neville, B. W., C. S. Schauer, K. Karges, M. L. Gibson, M. M. Thompson, L. A. Kirschten, D. W. Dyer, P. T. Berg, and G. P. Lardy. 2010. Effect of thiamine concentration on animal health, feedlot performance, carcass characteristics, and ruminal hydrogen sulfide concentrations in lambs fed diets based on 60% distillers dried grains plus solubles. J. Anim. Sci. 88:2444-2455.

Neville, B.W., G.P. Lardy, K.K. Karges, S.R. Eckerman, P.T. Berg, and C.S. Schauer. 2012. Interaction of corn processing and distillers dried grains with solubles on health and performance of steers. J. Anim. Sci. 90:560-567.

This research was partially funded by the North Dakota Corn Utilization Council and the North Dakota State Board of Agriculture Research and Education (SBARE).