The Influence of Supplemental Zinc and Ractopamine Hydrochloride on Mineral and Nitrogen Retention of Beef Steers

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Summary and Implications

The objective of this study was to ascertain how ractopamine hydrochloride supplementation and Zn supplementation affects N retention and Zn absorption in beef steers. No interaction was detected between ractopamine hydrochloride supplementation and Zn supplementation (MIN x BA strategies). There was no effect of ractopamine hydrochloride inclusion on Zn absorption. However, there was an increase of Zn retention with increasing concentrations of supplemental Zn. Additionally, N retention was increased by supranutritional Zn supplementation and also by ractopamine supplementation. Increased N retention may help explain previously noted improvements in cattle performance when fed ractopamine hydrochloride and supranutritional concentrations of Zn.

Introduction

The trace mineral Zn is critical in numerous biological growth processes. The Zn requirement of beef cattle was established over forty years ago; however, ADG from birth to slaughter has increased by 44% in this time period. This increase in growth is made possible by improved genetics, management practices, and growth technologies. Ractopamine hydrochloride (RH), a ß-adrenergic agonist, increases animal growth rates when fed the last month prior to harvest by improving protein deposition. Zn is a critical factor in this process. Therefore, increasing supplemental concentration of Zn in the diet may modulate the response initiated by RH and the increased growth rate induced by RH may be increasing requirements of Zn in the body.

Materials and Methods

Experimental Design. High percentage Angus cattle from two separate sources were acquired. The study was conducted using a 2 x 2 factorial design, with mineral (MIN) supplementation strategies of no supplemental Zn (analyzed 32 mg Zn/kg DM; CON) or supranutritional Zn (formulated 150 mg Zn/kg DM [CON + 60 ppm $ZnSO_4$ + 60 ppm Zn-AA complex], analyzed 145 mg Zn/kg DM; SUPZN). Dietary Zn treatments began on d 0, and beta agonist (BA) strategies of 0 (NON) or 300 mg$\cdot^{-1}$steer$\cdot^{-1}$d (RAC) beginning on d 56. Steers were blocked by BW on d 0 for each group to receive MIN diets for 56 d in pens equipped with GrowSafe bunks (GrowSafe Systems Ltd., Airdrie, Alberta, Canada). Diet composition and analysis is shown in Table 1. Steers were implanted on d 0 of the study with Component TE-IS with Tylan (80 mg trenbolone acetate, 16 mg estradiol USP, and 29 mg tylosin tartrate; Elanco Animal Health, Greenfield, IN). Steers were weighed on d -1, 0, 28, 56, 71, 85 and 86. A 4% pencil shrink was applied to all live weights recorded during the trial. Steers continued to receive respective MIN diets in the metabolism facility from d 56-71 (d 0-15; metabolism period). Steers were randomly assigned to BA strategies (ractopamine hydrochloride; Actogain45, Zoetis) within MIN strategy to be fed the last 30 d (d 56-86 of the study) before harvest.

Metabolism period. Steers were housed in individual stainless-steel crates with rubber fatigue mats from d 56-71 (d 1-10 adaptation, d 11-15 collection). All offered feed and refused feed for each steer was recorded daily, and daily intake was determined by subtracting refused feed from offered feed. All fecal and urine output was collected and aliquoted.

Analytical procedures. Dry matter and organic matter of feed, orts, and fecal matter were determined according to AOAC procedures. Mineral analysis was conducted using inductively coupled plasma optical emission spectrometry (ICP; Optima 7000 DV, Perkin Elmer, Waltham, MA). Nitrogen content of feed, orts, fecal matter, and urine was determined by using the combustion method (TruMac® N, LECO® Corporation, Saint Joseph, MI).

Statistical Analysis

Data collected for the metabolism period were analyzed as a 2 x 2 factorial arrangement utilizing the Mixed procedures of SAS (SAS institute Inc., Cary, NC). The model for the analysis of mineral intake, excretion, absorption and retention included the fixed effects of MIN, BA, group, and the interaction of MIN x BA, with three-way interaction of MIN x BA x group as a random variable. Steer was the experimental unit (n = 8 per treatment combination) for all analyses. Significance was declared at $P \leq 0.05$ and tendencies identified at $P = 0.06$ to 0.10. Values reported are least square means and SEM.

Results and Discussion

After 56 d of Zn supplementation there was no time by treatment interaction. DMI was increased ($P \leq 0.01$; Table 2) in CON vs. SUPZN. No differences in BW, ADG or G:F were detected for the initial 56 d period. Previous research has shown improved performance parameters by feeding increasing concentrations of Zn with a BA. Regardless, there were no interactions between MIN x BA seen on the metabolism parameters measured during this study. No effects of dietary Zn concentration or BA were detected for DMI, DM digestibility, OM digestibility, N intake, fecal output and fecal N during collection. N retention as a percentage of intake was greater in RAC ($P = 0.02$; Figure 1D). Previous research has shown an increase in N retention due to BA supplementation, supporting increased growth rates. Supranutritional Zn retained more N as a percentage of intake than CON ($P = 0.05$; Figure 1D).

BA strategy had no effect on mineral (Cu, Fe, Mn, Zn) fecal excretion, urine excretion, apparent absorption or retention as a percent of intake ($P \geq 0.25$). BA strategy had no effect on fecal excretion, urine excretion, apparent absorption and retention of minerals (mg/d; $P \geq 0.29$). Mineral intake, fecal excretion, urinary excretion, and mineral retention (Figure 1A) of Zn were increased in SUPZN ($P \leq 0.01$). A positive correlation between Zn intake and N retention was detected ($r = .46$, $P < 0.01$). Previous research by others has shown an increase in N retention due to adequate amounts of Zn in the diet compared to Zn deficient diets, as well as an interdependency of Zn and protein on growth. Across the feeding period, RAC increased ADG and G:F relative to NON ($P = 0.03$).

There is opportunity in the industry to refine feeding strategies for livestock when utilizing technologies such as BA. The possibility exists to refine supplemental Zn strategies in conjunction with aspects such as growth rate, growth technologies, and stage of production. Future work is needed to elucidate the mechanism behind increased N retention in beef steers due to SUPZN supplementation, but clearly Zn has a positive role for N retention. The lack of an interaction between SUPZN and RAC in this study supports an independent effect of Zn on protein synthesis. Further research is needed to move the industry towards more strategic supplementation of trace minerals to support optimum livestock production while concurrently lessening environmental impact.

Acknowledgments

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Table 1. Diet ingredient composition and nutrient content

Ingredient (%DM)	**Diet**
Cracked corn	62
Modified distillers grains with solubles	25
Hay	8
Micronutrients and carrier[1, 2]	5
Analyzed components[3,4]	
Crude Protein, %	14.6
NDF, %	19.2
Ether Extract, %	5.19

[1] Basal includes dried distillers grains with solubles as carrier, micronutrients provided as % DM; Limestone (1.5%), Rumensin (0.0135%), and Salt (0.31%). Trace minerals and Vitamins provided per kg of DM: 0.15 mg Co (cobalt carbonate), 20 mg Cu (copper sulfate), 20 mg Mn (manganese sulfate), 0.1 mg Se (sodium selenite), 0.5 mg I (calcium iodate), and Vitamin A 2,200 IU (ROVIMIX A 1000 [1000 kIU/g], DSM, Parsippany, NJ).

[2]Control (CON) diet received no supplemental Zn (32 mg Zn/kg DM); Supranutritional Zn (SUPZN) diet Zn inclusion 60 ppm $ZnSO_4$ and 60 ppm Availa-Zn (Zinpro Corporation, Eden Prairie, MN) which contains (DM basis) 35.5% Zn and AA complex. CON diet analyzed 32 mg Zn/kg DM; SUPZN diet analyzed 145 mg Zn/kg DM.

[3] Analyzed components on DM basis.

[4] Chemical analysis completed by Dairyland Laboratories (Arcadia, WI).

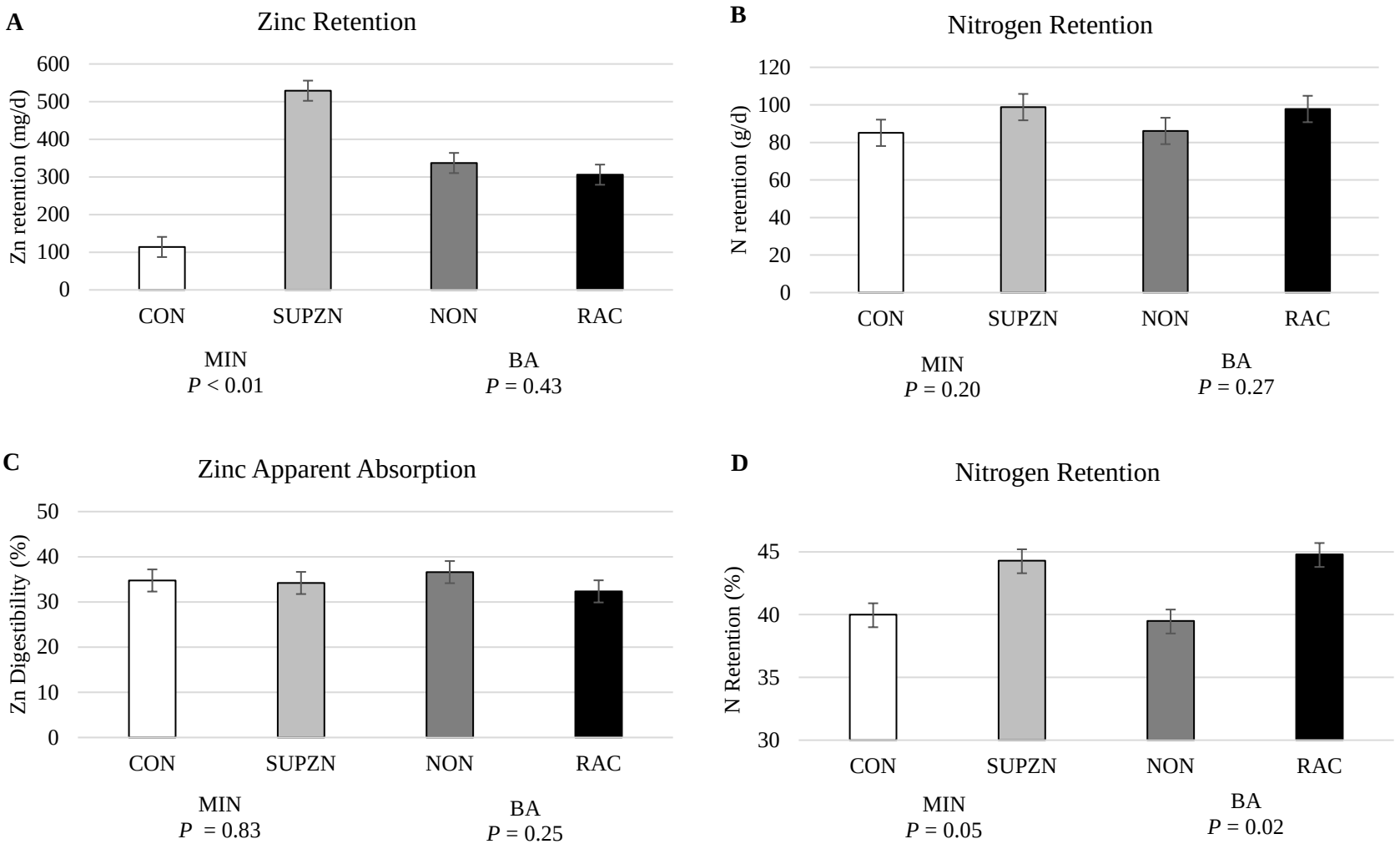

Figure 1. A. Zn retention (mg/d) as affected by MIN and BA strategy (MIN $P < 0.01$; BA $P = 0.43$). **B.** Nitrogen Retention (g/d) as affected by MIN and BA strategy (MIN $P = 0.20$; BA $P = 0.27$). **C.** Zinc Digestibility as affected by MIN and BA strategy (MIN $P = 0.83$; BA $P = 0.25$). **D.** Nitrogen retention as percentage of intake as affected by MIN and BA strategy (MIN $P = 0.05$; $P = 0.02$).