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Supplemental Zinc Sulfate Affects Growth Performance of Finishing Heifers

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Abstract
Zinc is an essential mineral required for normal function of more than 300 enzymes in microorganisms, plants, and animals. Zinc-requiring enzymes participate in metabolism of nucleic acids, proteins, and carbohydrates, all of which are essential for growth of cattle. In addition, zinc is necessary for normal development and function of the immune system. The requirement for zinc in finishing cattle diets has been established at 30 ppm (NRC, Nutrient Requirements of Beef Cattle, 2000), though concentrations recommended by consulting nutritionists and feed manufacturers span a far broader range. The purpose of this study was to evaluate the effects of feeding different levels of zinc on feedlot performance and carcass traits of finishing heifers.

Keywords
zinc, feedlot, carcass

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Introduction

Zinc is an essential mineral required for normal function of more than 300 enzymes in microorganisms, plants, and animals. Zinc-requiring enzymes participate in metabolism of nucleic acids, proteins, and carbohydrates, all of which are essential for growth of cattle. In addition, zinc is necessary for normal development and function of the immune system. The requirement for zinc in finishing cattle diets has been established at 30 ppm (NRC, Nutrient Requirements of Beef Cattle, 2000), though concentrations recommended by consulting nutritionists and feed manufacturers span a far broader range. The purpose of this study was to evaluate the effects of feeding different levels of zinc on feedlot performance and carcass traits of finishing heifers.

Key words: zinc, feedlot, carcass

Experimental Procedures

A total of 480 crossbred heifers (initial body weight=849 lb±29) were blocked by weight and randomly assigned to one of 4 treatments with 6 pens per treatment (24 pens with 20 heifers each). Treatments consisted of heifers receiving 0, 30, 60, or 90 ppm zinc (Table 1). Heifers were implanted with Component TE-200 with Tylan (Elanco Animal Health, Greenfield, IN) at the beginning of the experiment and re-implanted (Component TE-200 with Tylan) 81 days prior to harvest. Heifers were housed in outdoor, dirt-surfaced pens equipped with fence-line feed bunks and automatic water fountains shared between adjacent pens. Heifers were fed a series of three step-up diets fed for seven days each before feeding the final finishing diets. Diets were fed *ad libitum* once daily. Unconsumed feed was removed from the bunk, weighed, and a subsample was dried at 28-day intervals or as needed to determine actual feed intake. Body weights were captured for each pen at 28-day intervals. Final body weights (gross body weight × 0.96) were determined immediately before cattle were shipped on the day of harvest. Heifers were then loaded onto trucks and transported to a commercial abattoir in Lexington, NE. Incidence and severity of liver abscesses and hot carcass weights were recorded the day of harvest. Marbling score, 12th rib fat thickness, ribeye area, USDA Yield grade, USDA Quality grade, and incidence and severity of dark cutting beef were collected after 36 hours of refrigeration. The trial was conducted as a randomized complete block design. Statistical analyses were conducted using the MIXED procedure of SAS (version 9.4; SAS Institute, Cary, NC). The fixed effect included level of zinc supplementation and block constituted the random effect. Pen was the experimental unit. Treatment differences were considered significant at *P*-value less than 0.05 and tendencies at *P*-value less than 0.10.

Results and Discussion

The effects of zinc supplementation on heifer performance are shown in Table 2. Zinc supplementation tended to decrease dry matter intake as zinc concentration of the diet increased (linear effect of treatment; $P=0.07$), without compromising average daily gain ($P \geq 0.29$). As a result, feed efficiency improved with increasing zinc concentration (linear effect of zinc; $P=0.03$) with the greatest improvement observed in cattle fed 60 ppm zinc. When 90 ppm zinc was fed, feed efficiency was not different compared to cattle supplemented with 0, 30, or 60 ppm. Comparing feed efficiency in cattle receiving no supplemental zinc to the average of the zinc supplemented treatments, feed efficiency improved in cattle receiving zinc ($P=0.04$). These results suggest there is an upper limit for zinc supplementation to maximize feed efficiency, and cattle respond favorably to zinc supplementation. Final body weight was not affected by zinc supplementation ($P \geq 0.18$). There were no quadratic effects of zinc for any feedlot performance parameter ($P>0.12$). Effects of zinc supplementation on carcass characteristics are shown in Table 3. Zinc supplementation tended to affect marbling score ($P=0.08$) with carcasses from cattle supplemented 60 ppm zinc tending to have the greatest marbling score. There was a tendency for a quadratic effect of zinc on percentage of carcasses grading Prime and percentages of carcasses classified as Yield Grade 1 ($P=0.07$). Carcasses from cattle supplemented with 60 ppm zinc tended to have the greatest percentage of carcasses grading Prime and the lowest percentage of Yield Grade 1 carcasses. Zinc supplementation did not affect carcass weight, percent liver abscesses, ribeye area, and 12^{th} rib fat, USDA low Choice and high Choice, USDA Select, or carcasses grading Yield Grade 2, 3, 4, or 5 ($P>0.16$). No linear effects of treatment or differences between carcasses from non-supplemented animals compared to zinc supplemented animals were observed ($P \geq 0.22$). These results suggest that zinc supplementation minimally affected carcass traits.

Implications

Zinc supplementation improved feed efficiency in finishing heifers with the greatest improvement observed in cattle supplemented with 60 ppm zinc; however, carcass traits were minimally affected.

Table 1. Diet composition of heifers fed 0, 30, 60, or 90 ppm added zinc as zinc sulfate

	Supplemental zinc, ppm			
Item, % DM basis	0	30	60	90
Steam flaked corn	58.90	58.90	58.90	58.90
Wet corn gluten feed	30.00	30.00	30.00	30.00
Alfalfa hay	7.00	7.00	7.00	7.00
Feed additive premix[1]	2.16	2.16	2.16	2.16
0 ppm Zn vitamin/trace mineral premix[2]	1.94	1.29	0.65	-
90 ppm Zn vitamin/trace mineral premix[2]	-	0.65	1.29	1.94
Calculated nutrient composition[3]				
Neutral detergent fiber, %	19.03	19.03	19.03	19.03
Crude protein, %	14.06	14.06	14.06	14.06
Calcium, %	0.70	0.70	0.70	0.70
Phosphorus, %	0.48	0.48	0.48	0.48
Total zinc (basal diet plus added), ppm	31.89	61.89	91.89	121.89

[1]Formulated to provide 300 mg/day Rumensin and 90 mg/day Tylan (Elanco Animal Health, Greenfield, IN); and 0.4 mg/day Melengesterol acetate (Elanco Animal Health, Greenfield, IN) in a ground corn carrier. Melengesterol acetate was removed from the diet for the final 18 days on feed due to a shortage of the product. Optaflexx (Elanco Animal Health, Greenfield, IN) was included at a rate of 300 mg/day during the final 28 days prior to harvest.
[2]Formulated to provide the following nutrient levels: 1,000 IU/lb vitamin A; 10 IU/lb vitamin E; 0.10 ppm added cobalt; 10 ppm added copper; 0.5 ppm added iodine; 20 ppm added manganese; 0.1 ppm added selenium; 0.3% salt; and 0.7% calcium.
[3]Based on values presented in NRC Nutrient Requirements of Beef Cattle, 2001.

Table 2. Feedlot performance of finishing heifers fed diets containing 0, 30, 60, or 90 ppm supplemental zinc as zinc sulfate

	Supplemental zinc, ppm					*P*-value[1]			
Item	0	30	60	90	SEM	Trt	C1	C2	C3
Number of heifers	117	118	118	120	-	-	-	-	-
Initial body weight, lb	850	847	849	850	28.83	0.64	0.93	0.33	0.40
Final body weight, lb	1329	1329	1345	1327	43.40	0.53	0.79	0.37	0.67
Average daily gain, lb	3.71	3.73	3.83	3.70	0.13	0.52	0.78	0.29	0.56
Dry matter intake, lb	22.60	22.32	21.94	21.78	0.77	0.33	0.07	0.87	0.15
Feed:gain	6.09[b]	5.99[b]	5.71[a]	5.89[ab]	0.09	0.03	0.03	0.12	0.04

[a,b]Within a row, means without a common superscript letter are different ($P \leq 0.03$).
[1]Effect of treatment (Trt); linear effect of zinc (C1); quadratic effect of zinc (C2); zero ppm zinc versus average of treatments with added zinc (C3).

Table 3. Effects of feeding 0, 30, 60, 90 ppm supplemental zinc as zinc sulfate on carcass characteristics of finishing heifers

	Supplemental zinc, ppm					*P*-value[1]			
Item	0	30	60	90	SEM	Trt	C1	C2	C3
Hot carcass weight, lb	837	835	845	836	27.61	0.60	0.82	0.54	0.82
Dressed yield, %	63.01	62.86	62.81	62.99	0.003	0.80	0.89	0.34	0.54
Liver abscesses, %	11.10	5.96	7.63	10.00	3.12	0.55	0.89	0.18	0.32
Ribeye area, in^2	14.68	14.53	14.50	14.56	0.44	0.88	0.60	0.55	0.44
12^{th}-rib fat thickness, in	0.57	0.55	0.58	0.55	0.03	0.53	0.68	0.87	0.55
Marbling score[2]	444	434	454	440	11.28	0.08	0.72	0.66	0.87
USDA Prime, %	1.71	2.54	5.09	0.00	1.53	0.16	0.71	0.07	0.64
Low Choice, %	46.14	48.95	51.71	48.33	4.90	0.86	0.66	0.51	0.52
High Choice, %	18.77	15.18	17.81	20.83	4.57	0.76	0.61	0.39	0.85
USDA Select, %	24.78	24.82	21.14	26.67	4.77	0.80	0.91	0.51	0.90
Sub-Select[3], %	6.88	6.01	2.54	4.17	2.22	0.46	0.22	0.55	0.28
Dark cutter, %	1.71	2.50	1.71	0.00	1.25	0.43	0.23	0.26	0.81
Yield grade 1, %	16.36	12.85	10.26	21.67	5.41	0.21	0.45	0.07	0.75
Yield grade 2, %	35.96	42.32	35.57	35.00	3.37	0.26	0.46	0.24	0.62
Yield grade 3, %	33.20	34.74	42.37	31.67	4.86	0.28	0.87	0.15	0.52
Yield grade 4, %	14.47	9.25	11.80	10.83	3.19	0.70	0.56	0.51	0.32
Yield grade 5, %	0.00	0.83	0.00	0.83	0.64	0.54	0.51	1.00	0.40

[1]Effect of treatment (Trt); linear effect of treatment (C1); quadratic effect of treatment (C2); zero ppm zinc versus average treatments with added zinc (C3).
[2]Marbling scores were determined by camera imaging (VBG 2000, E+V Technology GmbH & Co. KG, Oranienburg, Germany); Small = 400 to 499.
[3]Includes standard and commercial carcasses.