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The effects of injectable trace minerals on growth performance and mineral status of Angus beef steers raised in a natural feedlot program

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ABSTRACT

To evaluate the effects of an injectable trace mineral (TM) on TM status and growth of feedlot steers raised in a Certified Angus Beef Natural system, 168 certified natural Angus steers (359 ± 36.6 kg), blocked by initial BW into pens of 6 head, received a sterilized saline (SAL, n = 84) or Multimin90 (ITM, n = 84) injection (1.47 mL/100 kg of BW). Steers were grown on a corn silage–based diet for 56 d and transitioned, and on d 84 they began a dry-rolled corn–based finishing diet. On d 84 steers were assigned equally within treatment, SAL or ITM, to receive a second injection, making 4 total treatments: (1) d 0 SAL, d 84 SAL (SAL/SAL, n = 42); (2) d 0 SAL, d 84 ITM (SAL/ITM, n = 40); (3) d 0 ITM, d 84 SAL (ITM/SAL, n = 40); and (4) d 0 ITM, d 84 ITM (ITM/ITM, n = 42). Liver Cu and Se concentrations were greater ($P \leq 0.01$), and liver Zn concentrations tended ($P = 0.07$) to be greater in ITM versus SAL steers on d 14. Liver Zn and Mn were not different on d 98 ($P \geq 0.64$). Liver Cu ($P = 0.02$) and Se ($P < 0.001$) concentrations were greater in SAL/ITM and ITM/ITM on d 98. Injectable TM had no effect on growing or finishing BW or G:F ($P \geq 0.14$). Steers had adequate TM status throughout the trial, likely explaining the lack of performance differences due to TM treatment.

Key words: natural, beef cattle, trace mineral, mineral status

INTRODUCTION

An increasing number of consumers are buying naturally raised animal products, including beef raised without the aid of growth promoting technologies or antibiotics. One difficulty in raising natural cattle is the tendency to have lesser growth rates, demonstrated by a 0.454-kg ADG disadvantage for natural cattle compared with conventionally raised cattle (Cooprider et al., 2011). Premiums often associated with natural beef programs are unable to surpass the increased input costs caused by the slower growth rates of natural cattle compared with conventionally raised cattle. It is well known that trace minerals (**TM**) are extremely important for numerous biological processes. For example, Cu and Zn are essential for the activity and structure of numerous enzymes needed for growth and immune system function, Mn is a cofactor for metalloenzymes needed for skeletal structure, and Se is crucial for the antioxidant function of glutathione peroxidase (Suttle, 2010). Trace minerals can improve finishing cattle growth (Genther and Hansen, 2014a) and could help producers minimize the large growth rate and efficiency disadvantages of natural cattle.

Injectable TM are a unique opportunity to rapidly improve the TM status of ruminant animals (Pogge et al., 2012; Genther and Hansen, 2014b) at times when dietary intake may be decreased. Trace mineral supplementation could alleviate some negative effects of stressful events because TM may have beneficial effects on immune status, disease resistance, and feed intake (Paterson and Engle, 2005). Genther and Hansen (2014a) found that after a shipping event, nonimplanted, mildly TM deficient steers that were given an injectable TM had greater ADG throughout the finishing period compared with cattle that did not receive TM injection after shipping. The investigators also found that mildly mineral deficient cattle lost more weight after shipping, possibly because they had decreased DMI after shipping (Genther and Hansen, 2014a). Using a TM injection could help producers rapidly improve the TM status of natural cattle and avoid decreases in performance due to poor TM status and shipping stress when calves enter the feedlot. Therefore, the objective of this study was to determine the effects of an injectable TM product on growth performance and TM status of Certified Angus Beef Natural feedlot steers.

MATERIALS AND METHODS

Animals and Experimental Design

Procedures and protocols for this experiment were approved by the Iowa State University Institutional Animal Care and Use Committee (# 11–14–7889–13). A total of

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168 certified natural high percentage Angus, black hided beef steers (359 ± 36.6 kg) were used in an experiment conducted at the Iowa State University Beef Nutrition Research Center in Ames, Iowa. All diets given to the cattle were completely antibiotic, hormone, animal by-product, and β-adrenergic agonist free. Diet compositions are displayed in Table 1 and were formulated to meet or exceed NRC (2000) recommendations. On day −7 steers were dewormed and vaccinated with Eprinex (Merial Limited, Duluth, GA) and Bovishield Gold 5 (Zoetis Inc., Kalamazoo, MI), respectively, and given unique visual and electronic identification tags; all ears were palpated for evidence of hormone implants and none were noted. Steers were weighed on d −1 and 0 and blocked by initial BW into 28 pens with 6 head per pen, and pens were assigned to receive an initial s.c. injection of either sterilized physiological saline (**SAL**, n = 84 steers, 14 pens) or an injectable TM (Multimin90; Multimin USA, Fort Collins, CO; **ITM**, n = 84 steers, 14 pens) at a rate of 1.47 mL/100 kg of BW on d 0. The Multimin90 product contained 15 mg of Cu/mL (as Cu disodium EDTA), 60 mg of Zn/mL (as Zn disodium EDTA), 10 mg of Mn/mL (as Mn disodium EDTA), and 5 mg of Se/mL (as sodium selenite). Steers received a corn silage–based TMR through a 56-d growing phase. Steers were weighed on day −1, 0, and 28 during the growing period. On d 56 and 57 steers were weighed and on d 57 began a series of 3 transition diets for 7 d each until d 84 when cattle began receiving the final corn-based finishing diet.

Body weights were taken on d 83 and 84 to determine initial weights for the finishing period. On d 84, pens of steers were split equally within initial injection treatments to receive a s.c. injection of either SAL or ITM, resulting in 4 total treatments with 7 pens per treatment: (1) d 0 SAL, d 84 SAL (**SAL/SAL**, n = 42 steers); (2) d 0 SAL, d 84 ITM (**SAL/ITM**, n = 40 steers); (3) d 0 ITM, d 84 SAL (**ITM/SAL**, n = 40 steers); and (4) d 0 ITM, d 84 ITM (**ITM/ITM**, n = 42 steers). Steers were weighed on 28-d intervals for the duration of the trial, and consecutive weights were taken on d 161 and 162 to determine final BW. A 4% pencil shrink was applied to all live BW measures, including those used in the calculation of ADG and G:F. Average daily gains were calculated for each individual steer. Steers were fed a probiotic (Bovamine Defend; Nutrition Physiology Company LLC, Hoersholm, Denmark) at a rate of 1 g/steer per d delivered in a dried distillers grains carrier by top dress starting on d 113 until the end of the finishing period.

On d 162, steers were shipped to a commercial abattoir in Lexington, Nebraska (Tyson Fresh Meats), where steers were harvested and marketed under a Certified Angus Beef Natural Program. The USDA QG distribution of the steers was 10% prime, 84% choice, and 6% select. The electronic identification reader at the abattoir malfunctioned, failing to record individual animal identification on all animals, and thus, carcass data were untraceable back to the individual animal.

Table 1. Composition of growing and finishing diets fed to beef steers raised in a natural feedlot program

	Experimental period[1]	
Item	**Growing**	**Finishing**[2]
Ingredient, % DM		
Corn silage	50	—
Cracked corn	15	60
DDGS	33.09	3.09
MDGS[3]	—	25
Bromegrass hay	—	10
Limestone	1.47	1.47
Salt	0.31	0.31
Vitamin A premix[4]	0.11	0.11
Trace mineral premix[5]	0.024	0.024
Calculated composition		
CP, %	14.79	15.20
NDF, %	32.33	20.36
Ether extract, %	5.47	5.46
Se, mg/kg of DM	0.15	0.15
Analyzed,[6] mg/kg of DM		
Cu	12.1	11.1
Fe	89.3	75.2
Mn	33.6	31.9
Zn	53.0	58.0

[1]The growing period diet was fed d −9 through 56, 3 step-up diets were fed from d 57 through 83, and the finishing diet was fed d 84 through 162.

[2]Bovamine Defend (Nutrition Physiology Company LLC, Hoersholm, Denmark) was top dressed during d 113 through 162 at a rate of 1 g/steer per d, along with 0.08 kg of dried distillers grains with solubles (DDGS) as a carrier.

[3]MDGS = modified distillers grains with solubles.

[4]Vitamin A premix contained 4,400,000 IU of vitamin A/kg.

[5]Provided per kilogram of diet DM: 10 mg of Cu (copper sulfate), 30 mg of Zn (zinc sulfate), 20 mg of Mn (manganese sulfate), 0.10 mg of Se (sodium selenite), 0.1 mg of Co (cobalt carbonate), and 0.5 mg of I (calcium iodate).

[6]Analyzed mineral values reflect diet total, including supplemental mineral.

Sample Collection and Analytical Procedures

Cattle were delivered feed daily at approximately 0700 h with ad libitum access to both feed and water. Daily measurements of total feed offered and bunk scores were recorded, and steers were fed using a modified slick bunk procedure as described by Drewnoski et al. (2014). Ingredient and TMR samples were taken weekly to determine DM content. These samples were dried in a forced-air oven at 70°C for 48 h. Dried feed samples were ground through a 2-mm screen (Retsch Zm100 grinder; Glen Mills Inc., Clifton, NJ) and stored in Fisherbrand Sterile Sampling Bags (Fisher Scientific, Pittsburgh, PA). As-fed feed disappearance values were adjusted for sample DM content