



The Effects of Trace Mineral Inclusion Management on the Performance and Mineral Status of Newly Received Feeder Calves

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Summary

The objective of this study was to determine the effects of trace mineral inclusion management on the performance and mineral status of newly received feeder calves. Steers from 2 pastures at a single ranch in Western South Dakota blocked into non-implanted (**NI**; n = 64; BW = 240 kg), May implanted (**MI**; n = 64; BW 252 kg;) and August implanted (**AI**; n = 66; BW = 248 kg;) groups, then allotted to one of two treatment groups. Treatments consisted of either: a pelleted supplement fed at a fixed amount to meet the gram / daily requirement (**GDR**) of Cu (as CuSO₄) and Zn (as ZnSO₄) of a growing steer or as a percent of the diet (**PER**). Liver biopsy and blood samples were collected at the initiation of the trial and again after 28 d on feed. The ADG and feed conversion (**F/G**) was not affected by diet treatment. Cumulative DMI tended to be greater ($P < 0.10$) in PER diets (7.31 vs. 7.12 kg). Steers receiving PER treatments tended ($P < 0.11$) to have less of a decrease in hepatic Zn than GDR treatments. The change in hepatic K was affected ($P < 0.05$) by implant with AI steers having the greatest increase. These results suggest that if performance and morbidity are enhanced by feeding Cu and Zn to meet the gram daily requirement of the animal, then Cu and Zn may need to be fed at a greater level to see any differences from this practice.

Keywords: Feedlot, Copper, Zinc, Selenium, Mineral Status

Introduction

Stress is manifested in cattle in a variety of ways. Feeder calves are subjected to many stressors in the process of marketing and transit, therefore, calves new to the feedlot environment may experience a decrease in DMI. This decreased feed intake could potentially result in nutrient deficiencies during this time period causing further strains on the immune system of already stressed calves. Trace mineral nutrition

has a potential of being effected during this time period, including those associated with immune function such as Cu and Zn. Therefore, the effects of increasing the diet density of these nutrients on performance and morbidity were selected. The objective of this study was to determine the effects on performance and morbidity of feeding supplemental Cu and Zn either at a fixed amount to meet the gram, daily requirement of growing steers or as a percent of the total diet so that nutrient intake was dependent upon DMI.

Materials and Methods

Single source Angus and Angus-Limousin steers received on November 3 from western South Dakota were used in this trial. Upon arrival, all animals received long stem hay and free access to water. The following day, all calves were weighed, individually identified, vaccinated with a 7-way clostridial vaccine and with a modified live vaccine containing Infectious Bovine Rhinotracheitis Virus (IBR), Parainfluenza 3 (PI₃), Bovine Respiratory Syncytial Virus (BRSV) and Haemophilus Somnus. Calves were treated with doramectin for internal and external parasites.

The 194 steers were blocked into 3 prefeedlot implant treatment groups: non implant (NI), May implanted (MI) at branding, or August implanted (AI). The MI and AI steers were implanted with a Synovex S. The implant treatments were not a part of this study, however, any interaction effects caused by these treatments will be tested for in the statistical analysis. Within the implant treatments, a small percentage of the calves were maintained in a different pasture at the ranch. These calves were stratified across all treatment groups. Within implant groups, animals were assigned to one of two diet treatments. Each diet was replicated by 12 pens (4 pens / implant treatment).

Diet (Table 1) consisted of corn silage, rolled corn, a pelleted ionophore supplement and a

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pelleted mineral supplement (Table 2). Copper (as CuSO_4) and Zn (as ZnSO_4) were included in the mineral supplement (Table 2). The mineral supplement was included in the diet at either a percentage (PER) of the diet (6.5% DMB) or as a total, fixed amount (GDR) of the diet (1 lb. / head / day), which would meet the total daily requirement of the calves. The supplement was included in the GDR diet at 1 lb., until that amount was 6.5% of daily DMI of the pen. The proportion of all other diet constituents were held the same so that the CP and caloric content of the diets would remain equal. Diets were fed once daily in the morning.

Weekly feed samples were analyzed for Cu, Zn, Ca, Fe, Mg, Mn, K, Na, S and P using atomic absorption spectrophotometry and Mo using atomic absorption with graphite furnace during the initial 28 days on feed. These samples were also assayed for Se using the fluorometric method. Subsequent weekly samples were analyzed for the listed minerals as biweekly composites.

Steers were weighed at the time of processing and after 1, 27, 55 and 64 days on feed. Liver biopsy and serum samples were obtained 4 days after arrival and after 27 days on feed from 48 steers (2 steers / pen, 24 steers / diet). Liver samples were analyzed for Cu, Zn, Mo, S, Fe, Na, K, Ca, P, Mg and Mn using the ICP procedure. Serum samples were assayed for Se concentration using the fluorometric method.

Liver biopsy was performed using a JorVet Soft Tissue Biopsy Needle (Jorgensen Laboratories, Inc., Loveland, CO) inserted through a puncture wound at the point where a horizontal line drawn cranial from the middle of the paralumbar fossa crosses the eleventh intercostal space on the right side of the animal. Animals which were biopsied were given a prophylactic dose of long acting penicillin following the procedure. Hepatic tissue was kept at -20°C until shipped to be analyzed. Serum samples were obtained via jugular venipuncture using non-heparinized evacuated tubes. Whole blood was centrifuged for 30 minutes the morning following sampling and serum removed and frozen at -20°C until analysis could be performed.

A morbid steer was identified using criteria based on general appearance of the animal, willingness to eat, as well as other symptoms associated with illness such as coughing, non-

clear discharge from the nasal passage, and lameness. Animals considered morbid were treated as outlined in the South Dakota State University Research Feedlot Health Protocol.

Animal performance and mineral data was analyzed as a factorialized design using the GLM procedure of SAS. Pen was the experimental unit used in the analysis of performance variables and animal was the experimental unit used in the analysis of serum and liver mineral concentrations.

Results and Discussion

It took 14 d before DMI was sufficient that 1 lb. of supplement was 6.5% of the diet. The diets fed during the initial 14 d were analyzed for differences in diet composition. Subsequent inclusion levels of ingredients were equal for both treatment groups. Crude protein, DM, NDF and NEg was not different ($P > 0.10$) between the treatments (Table 3).

The mineral content of the diets during the first 14 days on feed (Table 4) were different ($P < 0.01$) in Ca with PER diets containing a greater concentration. Even though Ca levels were statistically different, the relative difference in the values is quite small, so the importance of this difference I believe to be insignificant.

The ADG (Table 5) was not different ($P > 0.10$) between diet treatments during any feeding period or overall. Due to the energy content being similar during the initial 28 d on feed, any effect on ADG should be due to mineral supplementation. Since mineral levels in both diets were similar during the initial 14 d on feed, an affect on ADG probably would not be expected

Dry matter intake (Table 5) was not effected by diet through d 28 and d 55 ($P > 0.10$) on feed, although, cumulative DMI tended to be greater ($P < 0.10$) in PER. Feed conversion (Table 5) was not affected ($P > 0.10$) by diet during any period of the feeding trial. The absence of an affect on DMI and F/G is probably due to the diets fed being similar in nutrient content. A deficiency of many nutrients can decrease DMI. Since diets were similar in nutrient content, an effect on performance and morbidity rate probably would not be expected.

The change in hepatic and serum mineral levels over the initial 28 d was analyzed to determine any effects. The change in hepatic Zn was the only element on which differences were detected. The PER diets tended to cause less of a decrease ($P < 0.13$) in hepatic Zn concentrations than did steers fed the GDR diets (Table 7). The lack of differences due to diet in the trace minerals examined was probably due to the concentrations being similar in the diets. The change in hepatic K concentration was increased ($P < 0.05$) to a greater extent in

August implanted cattle than any other implant treatment. Estradiol has been demonstrated to affect Cu and Zn status of rats. Other studies have seen an effect of implants on other macrominerals but to my knowledge an effect on K has not been demonstrated prior to this trial. There appears to be an effect of implants on the mineral nutrition of cattle but more research is needed to better define the involvement. Morbidity rate (5.7%) was not affected by diet or implant treatment.

Tables

Table 1. Diet composition^a

Ingredient, % DM basis	Diet	
	PER	TDR
Corn silage	60.0	61.6
Rolled corn	30.0	34.3
Ionophore suppl.	3.5	4.1
Mineral suppl.	6.5	(1 lb/hd/day)

^a Diet contained monensin @ 20 g/ton, 2205 IU Vitamin A/kg, 22 IU Vitamin E/kg.

Table 2. Supplement composition

Ingredient, % DM basis	Supplement	
	Ionophore	Mineral
Soybean meal, 44%	42.8571	81.3846
Ground corn	23.7143	18.5923
Limestone	26.2857	
TM salt ^a	7.1429	
ZnSO ₄		0.0154
CuSO ₄		0.0077

^a Contains not less than 94% NaCl, 37% Na, 0.35% Zn, 0.20% Fe, 0.20% Mn, 0.03% Cu, 0.007% I, 0.005% Co.

Table 3. Composition of diets

Item, DM basis	Diet	
	PER	GDR
d 1 to 14		
DM ^a , %	44.8 ± 0.97	45.1 ± 1.09
CP ^a , %	10.7 ± 0.10	11.0 ± 0.56
NDF ^a , %	31.7 ± 1.25	31.6 ± 0.99
ADF ^a , %	18.1 ± 0.10	18.0 ± 0.01
Ash, %	5.13 ± 0.03	5.15 ± 0.02
NE _m ^b , Mcal/kg	1.85 ± 0.002	1.86 ± 0.003
NE _g ^b , Mcal/kg	1.19 ± 0.10	1.19 ± 0.09
d 15 to 69		
DM ^a , %	45.1 ± 0.42	
CP ^a , %	11.3 ± 0.09	
NDF ^a , %	30.1 ± 0.37	
ADF ^a , %	16.8 ± 0.36	
Ash, %	5.13 ± 0.04	
NE _m ^b , Mcal/kg	1.85 ± 0.002	
NE _g ^b , Mcal/kg	1.18 ± 0.08	

^a Based on assayed values.

^b Values calculated based on NRC (1996) tabular feed values.

Table 4. Mineral concentration of diets

Item, DM basis	Diet	
	PER	GDR
d 1 to 14		
Ca, %	0.54 ± 0.01	0.54 ± 0.01
P, %	0.28 ± 0.00	0.29 ± 0.01
Na, %	0.12 ± 0.01	0.12 ± 0.01
K, %	0.81 ± 0.00	0.83 ± 0.02
Mg, %	0.24 ± 0.00	0.24 ± 0.00
S, %	0.14 ± 0.00	0.15 ± 0.01
Cu, ppm	9.87 ± 0.08	10.29 ± 0.53
Mo, ppm	0.85 ± 0.02	0.88 ± 0.04
Zn, ppm	28.56 ± 0.16	29.02 ± 0.51
Se, ppm	0.27 ± 0.00	0.28 ± 0.01
Fe, ppm	122.5 ± 0.50	123.0 ± 1.00
Mn, ppm	25.3 ± 0.10	25.5 ± 0.20
d 15 to 69		
Ca, %	0.55 ± 0.01	
P, %	0.28 ± 0.01	
Na, %	0.12 ± 0.01	
K, %	0.83 ± 0.01	
Mg, %	0.25 ± 0.01	
S, %	0.14 ± 0.00	
Cu, ppm	10.30 ± 0.08	
Mo, ppm	1.03 ± 0.01	
Zn, ppm	30.42 ± 1.07	
Se, ppm	0.24 ± 0.01	
Fe, ppm	112.3 ± 1.71	
Mn, ppm	27.8 ± 0.68	

^a All values based upon feed assays.

Table 5. Backgrounding phase performance by diet treatment

Item	Diet		SEM	P <
	PER	TDR		
Initial BW, lb	543	544	4.70	NS
Final BW, lb	750	751	7.46	NS
d 1 to 27				
ADG, lb	4.08	4.04	0.14	NS
DMI, lb	12.74	12.41	0.19	NS
F/G	3.13	3.11	0.08	NS
d 28 to 55				
ADG, lb	3.23	3.17	0.10	NS
DMI, lb	16.89	16.51	0.19	NS
F/G	5.31	5.25	0.17	NS
d 56 to 69				
ADG, lb	3.56	3.67	0.24	NS
DMI, lb	18.75	18.14	0.22	NS
F/G	5.54	5.17	0.38	NS
Cumulative				
ADG, lb	3.64	3.61	0.07	NS
DMI, lb	16.12	15.70	0.18	0.10
F/G	4.44	4.36	0.06	NS

Table 6. Backgrounding phase performance by implant treatment

Item	Implant Treatment			SEM
	NI	MI	AI	
Initial BW, lb	529 ^a	556 ^b	547 ^b	5.76
Final BW, lb	739	763	750	9.13
d 1 to 27				
ADG, lb	3.90	4.19	4.10	0.18
DMI, lb	12.41	12.90	12.41	0.24
F/G	3.19	3.13	3.05	0.10
d 28 to 55				
ADG, lb	3.44 ^a	3.22 ^{a, b}	2.93 ^b	0.13
DMI, lb	16.69 ^a	17.24 ^{a, b}	16.16 ^{a, c}	0.11
F/G	4.85 ^d	5.42 ^e	5.58 ^e	0.21
d 56 to 69				
ADG, lb	3.44	3.51	3.88	0.29
DMI, lb	18.24 ^a	19.21 ^b	17.88 ^a	0.26
F/G	5.66	5.63	4.78	0.47
Cumulative				
ADG, lb	3.64	3.66	3.55	0.09
DMI, lb	15.79 ^a	16.45 ^b	15.48 ^a	0.22
F/G	4.34	4.50	4.36	0.07

NI = non-implanted; MI = May implanted; AI = August implanted at the ranch.

^{a, b, c} Within a row, mean with different superscript letters differ (P < 0.05).

^{d, e} Within a row, means with different superscript letters differ (P < 0.10).

Table 7. Initial and change in hepatic and serum mineral concentrations by diet

Item	Diet		SEM
	PER	GDR	
Initial			
Cu	63.28	66.05	8.01
Mo	2.83	2.92	0.08
Zn	185.0	197.3	7.27
Ca	254.5	243.0	6.17
P	10995	10,868	110
Mg	628.8	614.5	6.20
S	7479	7427	76.3
Fe	362.8	339.3	11.4
Na	3755	3562	100
K	8444	8481	137
Mn	6.47	5.97	0.15
Se ^a	0.085	0.084	0.001
Change			
Cu	29.5	32.3	4.55
Mo	0.12	0.18	0.10
Zn	-45.2 ^b	-62.1 ^c	7.57
Ca	-15.3	-12.5	8.48
P	-513	-140	135
Mg	29.9	36.8	10.2
S	-103	-134	123
Fe	-78.8	-80.0	14.4
Na	204.6	213.8	133
K	649.6	551.7	168
Mn	0.66	0.85	0.17
Se ^a	0.001	-0.001	0.002

^a Serum concentration of the element.

^{b, c} Within a row, means tended to be different ($P < 0.11$).

Table 8. Initial and change in hepatic and serum mineral concentrations by implant treatment

Item, ppm	Implant Group			SEM
	NI	MI	AI	
Initial				
Cu	73.77	62.29	57.94	9.81
Mo	2.86	2.97	2.79	0.10
Zn	190.6	184.9	197.9	8.90
Ca	247.4	251.4	247.3	7.56
P	10931	10877	10987	135
Mg	627.6	619.3	618.1	7.59
S	7470	7406	7483	93.5
Fe	361.8	329.1	362.2	14.0
Na	3624	3598	3753	123
K	8567	8213	8608	167
Mn	6.30	6.21	6.14	0.18
Se ^a	0.084	0.082	0.088	0.002
Change				
Cu	28.6	31.9	32.1	5.57
Mo	0.26	0.18	0.03	0.12
Zn	-54.4	-47.4	-59.1	9.27
Ca	-8.00	-22.0	-11.7	10.4
P	-435	-171	-375	166
Mg	22.8	27.4	49.8	12.5
S	-155	33.1	-234	151
Fe	-70.8	-68.3	-99.3	17.6
Na	418	163	45.6	163
K	311 ^b	916 ^c	575 ^{b,c}	206
Mn	0.68	1.01	0.57	0.20
Se ^a	-0.001	0.001	-0.001	0.002

^a Serum concentration of the element.

^{b, c} Within a row, means with different superscript letters tended to differ ($P < 0.13$).