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2015

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Hilscher, E. Henry; Erickson, Galen E.; Laudert, Scott B. Laudert; Cooper, Robert J.; Dicke, Bill D.; Jordon, D. J.; and Scott, Tony L., "Effect of Zinc and Copper Source on Finishing Steer Feedlot Performance and Incidence of Footrot" (2015). *Nebraska Beef Cattle Reports*. 837.
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Summary

A commercial feedlot study compared the effects of the combination of inorganic and organic copper and zinc trace minerals to basic copper chloride and zinc hydroxychloride trace minerals on performance and carcass characteristics and the incidence of footrot in feedlot cattle. There were no differences in DMI, ADG, and F:G. Hot carcass weight and carcass traits were also unaffected by source of trace mineral supplementation. Cattle treated for footrot were not different between treatments. Cattle that received basic copper chloride and zinc hydroxychloride trace mineral supplement performed similar to cattle that received a traditional trace mineral program.

Introduction

The current requirements for copper (Cu) and zinc (Zn) are 10 ppm (mg/kg) Cu and 30 ppm (mg/kg) Zn in beef cattle diets on a DM basis (NRC, 1996, pp. 63-68). However, in a 2007 survey of feedlot nutritionists, the average inclusions of Cu (17.6 mg/kg) and Zn (93.0 mg/kg) were 1.5 and 3 times, respectively, the concentration of current requirements (*Journal of Animal Science,* 2007, 85:2772-2781). Recently a new category of trace minerals, hydroxy trace minerals, has been marketed with basic copper chloride (Intellibond® C) and zinc hydroxychloride (Intellibond Z) available. Limited work has been done comparing these different forms of Cu and Zn in feedlot trials, thus there is little evidence to support one form of trace mineral over the other. The following experiment compared feedlot and carcass performance and footrot incidence in steers receiving either a supplement containing a standard feedlot trace mineral program of copper sulfate, zinc sulfate, and zinc methionine complex (ZINPRO®) or basic copper chloride (IntelliBond C) and zinc hydroxychloride (IntelliBond Z) in a commercial feedlot setting.

Procedure

Crossbred calves (n = 1,471; initial BW = 601 ± 21 lb) from ranches and auction barns in Nebraska, Montana, Colorado, Arizona, Utah, and Missouri were utilized for the trial. This commercial trial was conducted at Herb Albers Feedlots near Wisner,

Table 1. Composition and analyzed nutrient content (DM basis) of basal diets supplemented with copper sulfate, zinc sulfate, and zinc methionine complex (CON) or basic copper chloride and zinc hydroxychloride (IB).

Item	Growing Ration		Finishing Ration 1		Finishing Ration 2[1]	
Ingredient, %						
Dry-rolled corn	—		38.00		58.50	
High-moisture corn	—		20.00		—	
Synergy[2]	32.50		30.00		—	
Modified distillers grains plus solubles	—		—		30	
Corn silage	52.19		2.50		2.50	
Treated cornstalks[3]	10.00		—		—	
Ground cornstalks	—		4.00		3.50	
Supplement (CON or IB)[4,5]	5.31		5.50		5.50	
Targeted Trace Mineral, mg/kg						
Cu	25		19		19	
Zn	136		108		108	
Chemical Composition, %[6]	CON	IB	CON	IB	CON	IB
DM	63.2	66.2	65.1	65.0	65.1	65.0
CP	18.6	15.7	15.2	15.6	15.2	15.6
Ca	0.83	0.81	0.65	0.68	0.65	0.68
P	0.50	0.46	0.49	0.49	0.49	0.49
Zn, mg/kg	146.0	94.0	129.0	138.7	129.0	138.7
Cu, mg/kg	29.0	15.0	20.3	21.7	20.3	21.7

[1]Finishing Ration 1 was fed for the first 96 days of the finishing period and Finishing Ration 2 was fed for the last 45 days.
[2]Synergy = blend of 60% MDGS (Modified Distillers grains plus solubles and 40% WCGF (wet corn gluten feed) (ADM; Columbus, Neb.).
[3]Treated cornstalks = ground cornstalks treated with 5% calcium oxide at 50% moisture.
[4]Supplement (CON) = The supplement was formulated to contain (DM basis): Growing ration — 15.4% CP; 2.62% fat; 3.06% Ca; .96% P; 0.98% K; 465.5 mg/kg Cu from copper sulfate; 2,563 mg/kg Zn from zinc sulfate (65%) and zinc methionine (35%); 33,535 IU of vitamin A/lb; 94 IU of vitamin E/lb. Finishing ration - 11.3% CP; 2.0% fat; 13.32% Ca; 0.70% P; 1.98% K; 349.2 mg/kg Cu from copper sulfate; 1907 mg/kg Zn from zinc sulfate (65%) and zinc methionine (35%); 24,835 IU of vitamin A/lb; 70 IU vitamin E/lb.
[5]Supplement (IB) = The supplement was formulated to contain (DM basis): Growing ration — 15.5% CP; 2.63% Fat; 3.05% Ca; 0.96 % P; 0.99% K; 465.5 mg/kg Cu from basis copper chloride; 2,563 mg/kg Zn from zinc hydroxychloride; 33,535 IU vitamin A/lb; 94 IU vitamin E/lb. Finishing ration - 11.3% CP; 2.01% fat; 13.38% Ca; 0.70% P; 1.98% K; 349.2 mg/kg Cu from basic copper chloride; 1,907 mg/kg Zn from zinc hydroxychloride; 24,835 IU of vitamin A/lb; 70 IU vitamin E/lb.
[6]Chemical composition is based on laboratory analysis (Servi-Tech Labs, Hastings, Neb.) of the growing (single sample) and finishing diet (average of three samples) with either the CON or IB supplement.

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Table 2. Performance of steers supplemented with copper sulfate, zinc sulfate, and zinc methionine complex (CON) or basic copper chloride and zinc hydroxychloride (IB).

	Treatment			
Variable	CON	IB	SEM	*P*-value
Pens	8	8	—	—
Steers	736	735	—	—
Initial BW, lb[1]	606	597	7.5	0.04
Final BW, lb[2]	1396	1401	7.5	0.55
Growing Performance[3]				
DMI, lb/day	17.83	17.77	0.13	0.63
ADG, lb	3.39	3.36	0.09	0.76
F:G	5.32	5.30	—	0.91
Finishing Performance[4]				
DMI, lb/day	25.51	26.02	0.15	0.06
ADG, lb	3.83	3.89	0.07	0.52
F:G	6.69	6.68	—	0.98
Overall Performance[5]				
DMI, lb/day	22.7	23.0	0.1	0.14
ADG, lb	3.68	3.70	0.03	0.56
F:G	6.19	6.23	—	0.44
Carcass Adjusted[6]				
Final BW, lb	1396	1400	6.1	0.55
ADG, lb	3.68	3.69	0.03	0.56
F:G	6.18	6.23	—	0.25

[1]Due to differences in initial body weight ($P = 0.04$), data were analyzed with initial BW as a covariant.
[2]Final BW is the average pen weight shrunk 4%. Subsequent ADG, F:G and G:F are calculated from 4% shrunk final BW.
[3]Growing performance was calculated during the first 75 days on feed.
[4]Finishing performance was calculated from day 75 to the end of the feeding period on day 216.
[5]Overall performance was calculated from day 0 to day 216.
[6]Calculated as HCW divided by the average dressing % of 64.55. Subsequent ADG, F:G and G:F are calculated from carcass adjusted final BW.

Table 3. Carcass characteristics of steers supplemented with copper sulfate, zinc sulfate, and zinc methionine complex (CON) or basic copper chloride and zinc hydroxychloride (IB).

	Treatments			
Carcass Characteristics	CON	IB	SEM	*P*-value
HCW, lb	901	904	4.0	0.55
Dressing %	64.57	64.52	0.21	0.79
Yield Grade[3]	2.83	2.93	0.12	0.17
USDA Yield Grade[1, 2]				
1	15.34[a]	10.85[b]	1.53	0.05
2	41.88	41.41	2.10	0.88
3	34.30	38.52	2.07	0.17
4 and 5	8.48	9.22	1.23	0.67
USDA Quality Grade[1, 2]				
Average Choice and above	16.76	16.64	1.59	0.96
Low Choice	36.76	38.88	2.07	0.48
Select or lower	46.49	44.48	2.12	0.52

[1]All numbers are expressed as percentages. The Yield Grade (YG) and Quality Grade (QG) values represent the proportion of carcasses within each group that received each YG or QG.
[2]For quality and yield grade analysis only, seven replications were analyzed due to missing data for one replication.
[a,b]Means within a row with different superscripts differ ($P < 0.05$).

Neb., from December 2012 to July of 2013. Steers were blocked by location and allocated to pens by sorting every five steers into one of two pens before processing. Steers were weighed (pen basis) in two to three drafts after sorting to determine initial BW. Adjacent pens were assigned randomly to one of two treatments (eight pens/treatment). Treatments consisted of two copper and zinc nutrition strategies: (CON) the feedlot's current copper and zinc trace minerals consisting of copper sulfate, zinc sulfate, and zinc methionine complex, (ZINPRO, Zinpro Corp., Eden Prairie, Minn.) or (IB) basic copper chloride and zinc hydroxychloride trace minerals (IntelliBond C and Z, respectively, Micronutrients, Indianapolis, Ind). Supplemental zinc in CON was provided as 65% zinc sulfate and 35% zinc methionine complex whereas supplemental zinc in IB was provided as IntelliBond Z. ZINPRO, fed at the recommended rate, provided 360 mg Zn daily during the growing and finishing periods in the CON treatment. Supplemental copper in CON was provided as copper sulfate, whereas supplemental IB copper was supplied as IntelliBond C. All steers were given the feedlot's standard processing protocol upon arrival into the feedlot. Upon initiation of the trial, all steers were given a lot tag in each ear, and were implanted with Revalor® IS. Cattle were fed a growing ration for the first 75 days of the trial and a step-up period consisting of four adaptation diets was used to adapt cattle to the finishing ration. The rations with copper and zinc concentrations are presented in Table 1. Cattle were re-implanted with Revalor IS after the growing period and implanted again with Revalor 200 after 154 days on feed. All cattle were fed Zilmax at 7.56 g/ton DM for 20 days followed by a three-day withdrawal prior to harvest. All steers were observed daily and cattle treated for footrot were diagnosed using the feedlot's standard health

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protocol for evaluating and treating animals with footrot. Mean days on feed across all cattle were 216. Final live BW was determined at shipping using the average of the pen weight shrunk by 4% to adjust for fill. Cattle were slaughtered at a commercial harvest facility (Nebraska Beef LLC., Omaha, Neb.) on three consecutive days due to limited number of trucks available. On day 1 of harvest, HCW was recorded, and after a 36-hour chill both USDA quality and yield grades were recorded.

At grading, the quality and yield grade data were not recorded for one replication so yield and quality analysis included only seven replications. Both feedlot and carcass data were analyzed on a pen basis as a randomized complete block design using the Glimmix procedure of SAS (SAS Institute, Inc., Cary, N.C.). The model included the fixed effects of treatment with block as a random effect. There was a 9 lb significant difference ($P = 0.04$) in initial BW, thus initial BW was used as a covariate in the model. Frequency data (Yield, Quality, and Health data) were analyzed using binomial proportions with Glimmix and the ILINK option of SAS was used to determine least square means and SE of the proportions. P values ≤ 0.05 were considered significant.

Table 4. Morbidity and footrot incidence in steers supplemented with copper sulfate, zinc sulfate, and zinc methionine complex (CON) or basic copper chloride and zinc hydroxychloride (IB).

	Treatments			
Variable	CON	IB	SEM	*P*-value
Death/Removal, %[1]	2.58	2.67	0.53	0.89
Morbidity[2]				
Total treatments, %	32.84	31.56	1.76	0.61
1st treatment	22.94	20.67	1.57	0.32
2nd treatment	6.99	7.54	0.99	0.70
3rd treatment	2.38	2.24	0.57	0.86
4th treatment	0.56	1.12	0.39	0.28
Footrot Incidence[3]				
Total treatments,%	5.43	4.49	0.84	0.42
1st treatment	4.89	3.95	0.80	0.39
2nd treatment	0.54	0.54	0.27	1.00

[1]Death/Removal is the average percent of animals that were removed or died. Death in CON trt accounted for .95% of total death and removals and included two bloats, one broken leg, one brainer, and three respiratory deaths. Death in BCHZ trt accounted for .82 % of total death and removals and included six respiratory deaths. Removals in CON trt accounted for 1.63% of total death and removals and Removals in BCHZ trt accounted for 1.85 % of total death and removals. Not all the reasons for removals were recorded.

[2]Morbidity; total treatment = the total percent of the pen that was treated for sickness, 1st treatment = the percent of animals that were treated for sickness once, 2nd treatment = the percent of the animals that received a second treatment for sickness, 3rd treatment = the percent of animals that received a third treatment for sickness, 4th treatment = the percent of animals that received a fourth treatment for sickness. All sick animals were evaluated by trained feedlot employees and were treated using the feedlots treatment protocols.

[3]Footrot incidence; total treatment = the total percent animals that received treatment for footrot, 1st treatment = the percent of animals that were treated once for footrot, 2nd treatment = the percent of animals that received a second treatment for persistent footrot incidence. All animals with footrot were evaluated by trained feedlot employees and were treated using the feedlots treatment protocols. is the average percent of animals that were removed or died. Animals that died or were removed from the study were not due to trace mineral supplementation.

Results

There were no differences ($P \geq 0.14$) in final live BW, DMI, ADG, and F:G in steers supplemented with CON or IB over the entire feeding period (Table 2). There was a tendency ($P = 0.06$) for cattle supplemented with IB to have greater intake during the finishing period; however, there were no differences ($P \geq 0.52$) in ADG and F:G during the finishing period. Similarly there were no differences ($P \geq 0.17$) in HCW, dressing percent, or USDA marbling score in carcasses that were supplemented with CON or IB (Table 3). Steers that received CON trace mineral had an increased ($P = 0.04$) number of yield grade 1 carcasses when compared to cattle that received IB. There was no difference ($P \geq 0.28$) in total morbidity or footrot treatments in terms of total number of pulls or re-treated animals when comparing CON to IB (Table 4).

In conclusion, cattle fed Intelli-Bond trace minerals will perform similar to cattle fed a standard inorganic/organic trace mineral package in regards to feedlot performance, carcass characteristics, and incidence of footrot.

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