K-STATE Research and Extension

2017 SEARC Agricultural Research

Comparison of Two Organic Trace Mineral Supplements for Cows Grazing Tall Fescue

J.K. Farney

Summary

The purpose of this study was to determine the effects of two sources of organic trace mineral and two sources of magnesium supplementation on cow performance of spring-calving cows on K31 endophyte-infected fescue. The two treatments were organic trace minerals (zinc (Zn), copper (Cu), and manganese (Mn)) offered free choice as an amino-acid chelate with magnesium (Mg) as an amino acid chelate (CHEL) or organic trace mineral supplement with amino-acid complex with magnesium supplied as magnesium oxide (COMP). Mineral was offered free-choice beginning 30 days before breeding season on 4 ranches with 6 pastures per treatment (cows n = 203). Blood samples were collected prior to mineral supplementation and at pregnancy evaluation and serum was analyzed for Mg, Zn, Cu, and Mn. One ranch had an anaplasmosis event, therefore analysis was completed with and without this ranch. Pregnancy rate was not different ($P = 0.46$) when all 4 ranches were analyzed even though pregnancy rates were 89.3 and 92.9% for COMP and CHEL, respectively. Cows on the COMP mineral calved 6 days earlier ($P = 0.04$). When removing the anaplasmosis ranch, pregnancy rate was closer to approaching a tendency for a difference ($P = 0.15$) with pregnancy rates of 95.5 and 87.2% for CHEL and COMP, respectively, with a tendency ($P = 0.12$) for COMP cows to calve 5 days earlier. All serum mineral levels were lower at pregnancy detection than initial blood draw primarily due to reduction in mineral levels in fescue late in summer and a reduction in intake at the end of the project. Serum Mg tended ($P = 0.11$) to stay more stable with the CHEL mineral such that the difference in final and initial Mg were similar. Serum Zn, Cu, and Mn were not different ($P > 0.10$) with the exception of some ranch-to-ranch variations. Additionally, CHEL intake was 6% lower than COMP. Even with the lower intake of the CHEL mineral, serum mineral levels were similar between both treatments; this indicates that CHEL minerals are more bioavailable. Overall, chelated minerals appear to provide an advantage to spring-calving cows on K31 fescue especially from a chelated magnesium source.

Introduction

Failure to breed is the number one culling criteria for beef cattle operations. One of the most difficult management systems to breed cows is spring-calving operations on endophyte-infected fescue. One issue with endophyte-infected fescue is that it can raise the body temperature of the cow, which negatively impacts cow breeding success. Conception issues automatically arise due to the effect of hot weather while breeding,

and the increase in body temperature associated with cattle grazing endophyte-infected K-31 fescue. Incorporating management practices to improve reproductive success should lead to increased revenue and sustainability for cattle producers.

Organic forms of mineral have already been established to improve reproductive success, versus non-organic forms. This study will look at the ability of metal amino acid complex versus chelates to offset some of the production issues associated with high-endophyte fescue. Therefore, the objective of this study is to determine the performance effects of supplementing cows on K-31 fescue with metal amino acid chelates (CHEL) versus a metal amino acid complex (COMP).

Experimental Procedures

This experiment was approved by Kansas State University Institutional Animal Care and Use Committee prior to project being completed. Four ranches with a total of 203 spring-calving cows in southeast Kansas and southwest Missouri were used in a completely randomized block design where cows were offered one of two different organic mineral supplements beginning 30 days prior to breeding season and ending at pregnancy exam. The two treatments were free-choice mineral supplied where the copper (Cu), zinc (Zn), and manganese (Mn) are offered in the complex form (Availa-4, Zinpro Corp, Eden Prairie, MN; COMP) or mineral supplied where the Cu, Zn, and Mn are offered in the chelate form (Mineralate-3ChelateBlend, Nutech Biosciences, Inc, Oneida, NY; CHEL). Additionally, magnesium source was different for the two minerals: magnesium (Mg) offered in COMP was magnesium oxide while magnesium in CHEL was amino acid chelated magnesium (Mineralate-Mg 10, Nutech Biosciences, Inc, Oneida, NY). Mineral supplements were balanced to provide equal amounts of all required macro and trace minerals and vitamins with the addition of chlortetracycline (CTC; 0.5 mg/head/day) for anaplasmosis control (Table 1) and formulated for a 4 ounce/head/day intake. Pregnancy evaluation was completed in the fall of 2015 where three of the four ranches' pregnancy determination was completed by manual palpation and one of the ranches utilized an initial screening blood pregnancy test, then followed that test with manual palpation by a veterinarian.

All mineral was offered to cows using ground mineral feeders (Dura-Bull Mineral Feeder, Pride of Farm, Houghton, IA). Mineral feeders were placed near a water source at all locations. Mineral intake was calculated for each ranch based on amount offered through the project period. Fescue samples were collected (n = 10) in each pasture in June then evaluated for endophyte presence using aniline blue staining of the epidermal strip under a microscope.

Calving dates were recorded for spring-calving cows in 2016 to determine calving distribution.

Results and Discussion

Pasture endophyte infection levels were low in 2015 for all pastures tested. The endophyte levels ranged from 10-25% infection rate with very little variation between pastures within ranches. Mineral intake was higher with the COMP mineral (5% greater)

than CHEL mineral (3.2 oz/hd/d vs. 3.0 oz/hd/d, respectively). Water quality was similar between pastures and did not impact overall mineral intake.

Pregnancy Evaluations

Overall pregnancy rate was not different ($P = 0.46$) for COMP or CHEL, with 89.3% and 92.9% pregnancy rates, respectively (Table 2). Biologically and economically, a 4% difference in pregnancy rate is significant. In two of the four ranches, pregnancy rate was numerically higher for CHEL mineral (Ranch B had a significantly higher pregnancy rate, ~23% - $P < 0.05$), and at one ranch the pregnancy rates were the same (100% for both minerals). For the Ranch D, there was an anaplasmosis event in the cows receiving the CHEL mineral and subsequently that herd was the only one where pregnancy rates were higher in the COMP treatment (95 vs. 84% for COMP vs. CHEL). There was no significant ranch ($P = 0.81$) nor ranch by treatment interaction ($P = 0.14$). Interestingly, cows on the COMP mineral calved 6 days earlier than cows receiving the CHEL mineral ($P = 0.04$) when evaluating all four ranches (Table 3). The lack of significance in pregnancy rate might be explained by still not having enough cows in the study.

When removing the anaplasmosis ranch, treatments are still not statistically significant, but are closer to approaching significance ($P = 0.15$) with an even larger difference in pregnancy rates; 95.5% versus 87.2% for CHEL and COMP respectively (Table 2). When Ranch D was removed from the analysis because of anaplasmosis, there was no difference ($P = 0.12$) in calving distribution even though numerically the cows on COMP mineral calved 5 days earlier (Table 3).

Blood Mineral

Serum blood mineral levels were lower in the second collection period for all minerals measured, which also corresponded to lower mineral intakes later in the season and a reduction in forage Mg concentrations. Typically, when testing lush growing fescue for Mg the value indicated should meet cow requirements, however, it has been reported that only ~30% of that Mg can be utilized. The recommendation for gestating cows is 7 to 9 g/d of Mg to maintain a blood level of 20 ppm which is the ideal serum concentration. Serum Mg tended to be more stable with the CHEL mineral ($P = 0.11$) than the COMP mineral as evidenced by the difference in final and initial Mg levels which were -0.21 ppm in CHEL and -2.60 ppm for cows on the COMP mineral. The greater conception rates suggest CHEL allowed cows to maintain a serum Mg at pregnancy check similar to initial levels, despite the decrease of Mg in forage. Additionally, CHEL cows consumed less mineral while maintaining serum Mg concentration, suggesting that CHEL was more bioavailable (Figure 1).

At the initiation of the study, cows on the COMP treatment group tended to have higher serum Mg concentrations ($P = 0.14$). This might be the explanation for why COMP cows calved earlier in the calving season than cows on CHEL. Additionally, final serum Mg was impacted by ranch and mineral supplementation ($P = 0.03$; Figure 2) where Ranch B COMP cows had the lowest final Mg.

Serum Zn, Cu, and Mn were not different ($P > 0.10$) for any treatments (Figure 1). Manganese was not different by treatment, ranch, or the interaction for serum Mn for initial, final, or the difference ($P > 0.10$) with all levels ~0.04 ppm (~40 ng/mL), which is nutritionally adequate. There was a tendency for a treatment by ranch interaction ($P = 0.09$) for final Zn where Ranches A and B had lower Zn than Ranches C and D (Figure 3). Ranches C and D had adequate (> 0.80 ppm) levels of Zn while Ranches A and B were considered marginal (between 0.50 and 0.79 ppm). There was a treatment by ranch interaction ($P = 0.02$) for final Cu concentration where Ranch C cows on both minerals had greater Cu levels than both minerals for Ranch A and CHEL mineral for Ranches B and D (Figure 4).

At the initiation of the study the average Cu levels would be considered marginal, Zn was adequate, and Mn was adequate. Final Cu levels remained marginal for Ranches A, B, and D while Ranch C had an adequate level according to recommendations. All ranches had adequate final Mn concentrations. Ranch C has the highest levels of Zn and Cu, adequate for both minerals at the end of the study, which might explain the 100% pregnancy rate for cows in all treatments at this ranch. Ranch B had the lowest pregnancy rate for cows on the COMP mineral. The Zn levels were considered marginal for Ranch B COMP cows, and in combination with the lowest Mg levels might potentially explain the reduction in pregnancy rate.

Implications

The amino acid chelated organic trace mineral supplement showed promise to aid in reproductive success for spring-calving producers on K31 endophyte infected fescue. Even though significance was not achieved in this study, economically there was a greater pregnancy rate for cows on chelated trace minerals. Specifically, the amino acid chelated Mg has the potential to be an improved source of Mg in mineral supplements. Magnesium plays a significant role in reproductive success as evidenced by this study. Cattle with higher circulating concentrations of Mg breed earlier; however, a static concentration appears to improve herd-level pregnancy rates, which was observed with the amino acid chelated mineral. Additionally, this study demonstrated that the chelated form of trace minerals were more bioavailable as intake was lower while maintaining serum levels that were equal to or greater than the complex form which had a greater consumption.

Acknowledgments

This study was funded by Nutech Biosciences, Inc, Oneida, NY, with the cooperation of Chris Schuetze. The author appreciates the use of the cattle by the four producers in this study as well as the local extension agents who helped to develop these relationships and helped with sample collection.

Table 1. Calculated nutrient analysis (dry matter basis)

Item	Chelates	Complex
Crude protein (%)	5.36	5.81
NEg (Mcal/cwt)[1]	11.64	12.07
NEm (Mcal/cwt)[2]	16.98	17.62
Fat (%)	1.50	1.56
Acid detergent fiber (%)	2.82	2.80
Calcium (%)	13.41	13.45
Phosphorus (%)	5.83	5.84
Salt (%)	21.66	21.72
Potassium (%)	1.37	1.38
Magnesium (%)	2.79	2.79
Sulfur (%)	0.58	0.65
Cobalt (ppm)	105.84	104.06
Copper (ppm)	932.14	957.01
Zinc (ppm)	3517.64	3527.46
Manganese (ppm)	1722.72	1727.53
Selenium (ppm)	20.63	20.69
Iodine (ppm)	104.19	104.48
Iron (ppm)	5114.03	5144.90
Vitamin A (IU/lb)	190,840	191,373
Vitamin D (IU/lb)	30,946	31,033
Vitamin E (IU/lb)	217	218

[1] NEm = Net energy for maintenance.
[2] NEg = Net energy for gain.

Table 2. Pregnancy rates by treatment and ranch

Treatment	Ranch A	Ranch B	Ranch C	Ranch D	Total
Chelate % (n)	93.1 (49)	93.3[a] (15)	100 (14)	85.0 (20)	92.9 (98)
Complex % (n)	91.2 (50)	70.6[b] (17)	100 (16)	95.5 (22)	89.3 (105)
Ranch pregnancy rate % (n)	88.9 (99)	84.4 (32)	100 (30)	90.4 (42)	90.1 (203)

Pregnancy rates with Ranch D removed due to anaplasmosis event

Treatment	Ranch A	Ranch B	Ranch C	Ranch D	Total
Chelate % (n)	93.1 (49)	93.3[a] (15)	100 (14)	--	95.5 (78)
Complex % (n)	91.1 (50)	70.6[b] (17)	100 (16)	--	87.2 (83)
Ranch pregnancy rate (%)	92.1 (99)	82.0 (32)	100 (30)	--	91.6 (161)

[ab] Superscripts with different letters differ within column with $P < 0.05$.

Table 3. Average calving date within calving season

Treatment	Ranch A	Ranch B	Ranch C	Ranch D	Average[1]
Chelate	27.8	31.9	27.9[b]	50.4	34.5[b]
Complex	27.7	30.2	13.8[a]	41.5	28.3[a]

Average calving date with Ranch D removed due to anaplasmosis event

Treatment	Ranch A	Ranch B	Ranch C	Ranch D	Average[1]
Chelate	27.9	31.9	27.9[b]	--	29.2
Complex	27.9	30.2	13.9[a]	--	24.0

[ab] Superscripts are treatment differences within column with $P < 0.05$.

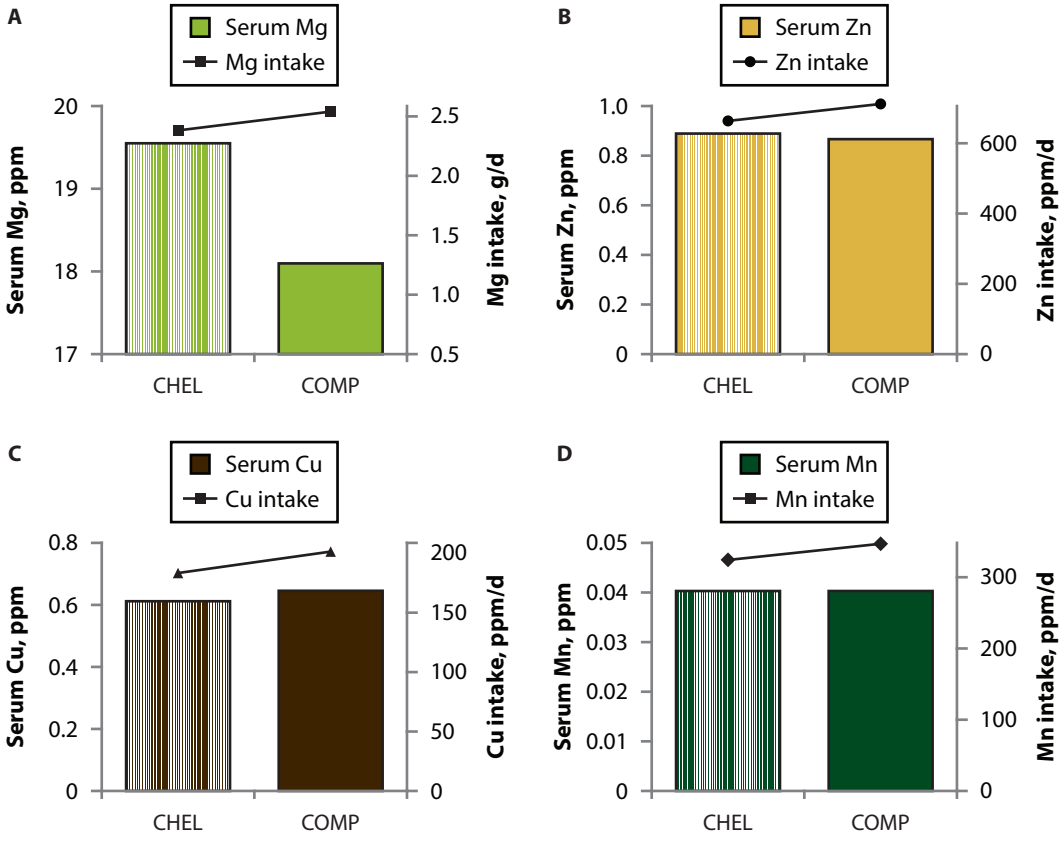

Figure 1. Final serum mineral concentration along with daily mineral intake

There is no difference ($P > 0.10$) in serum minerals by treatment. Daily mineral intakes were lower on CHEL minerals than COMP minerals. The combination of reduced intake and equal to or higher serum levels indicate that CHEL mineral is more bioavailable than COMP mineral for all four minerals measured in serum analysis (Mg, Cu, Zn, and Mn).

* CHEL minerals are recognized by vertical lines within bar and COMP in solid bars

Panel A: Serum magnesium (Mg) is represented by light green bars and daily Mg intake in g/d is illustrated by the black line with squares.

Panel B: Serum zinc (Zn) is represented by yellow bars and daily Zn intake in ppm/d is illustrated by the black line with circles.

Panel C: Serum copper (Cu) is represented by brown bars and daily Cu intake in ppm/d is illustrated by the black line with triangles.

Panel D: Serum manganese (Mn) is represented by green bars and daily Mn intake in ppm/d is illustrated by the black line with diamonds.

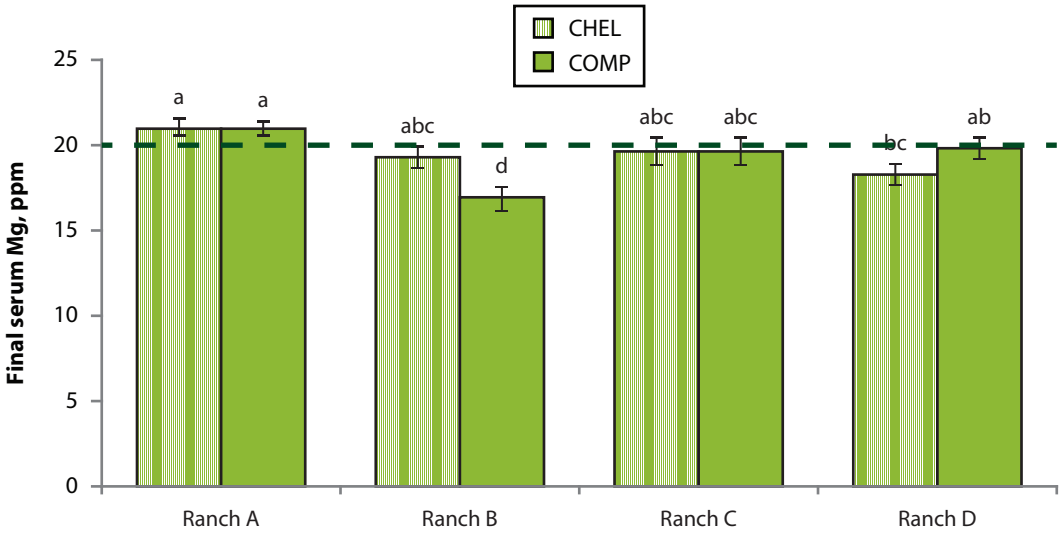

Figure 2. Final magnesium (Mg) concentration by ranch and treatment.
[abcd] Values with different letters differ with $P < 0.05$.
Vertical lines represent chelated (CHEL) mineral. Bars that are solid represent complex (COMP) mineral. The dashed line indicates blood magnesium levels that meet requirements for gestating cows.

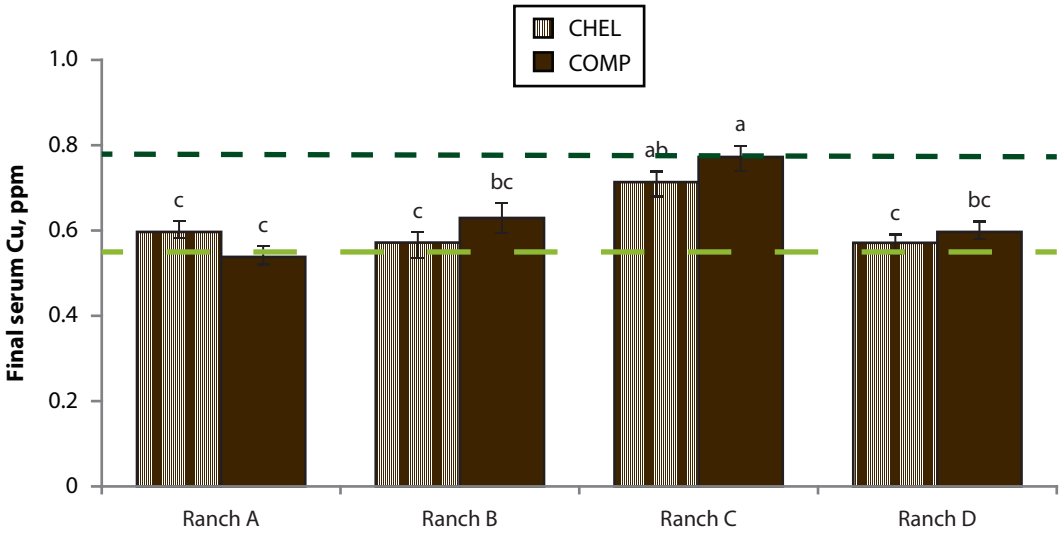

Figure 3. Final serum copper (Cu) concentration by ranch and treatment.
[abc] Values with different letters differ with $P < 0.05$.
Vertical lines represent chelated (CHEL) mineral. Bars that are solid represent complex (COMP) mineral. The short dashed line indicates blood copper levels that meet requirements for gestating cows. Long dashed lines indicate minimal serum levels for "marginal" serum copper status.

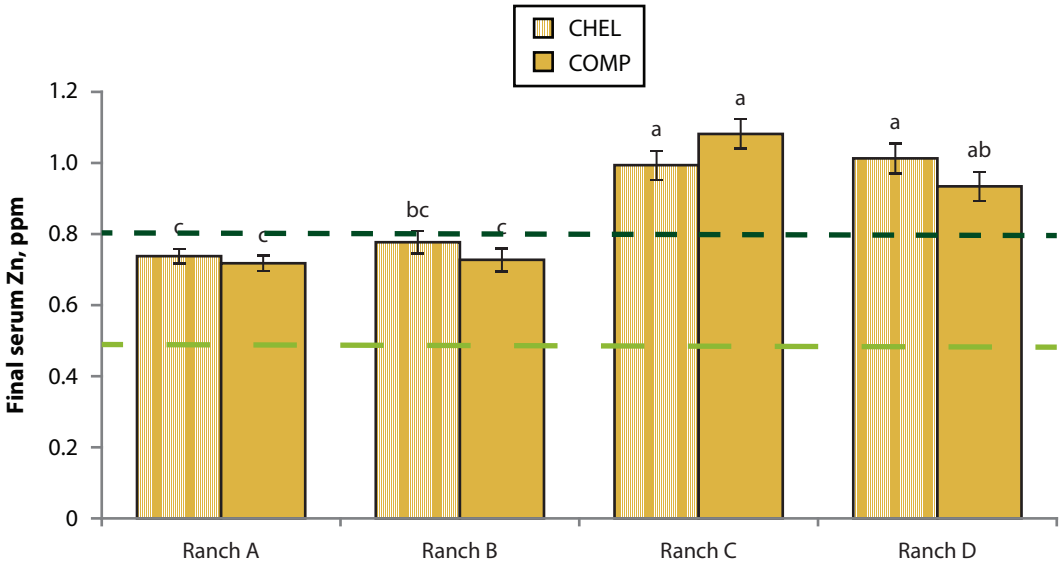

Figure 4. Final serum zinc(Zn) concentration by ranch and treatment.
[abc] Values with different letters differ with $P < 0.05$.
Vertical lines represent chelated (CHEL) mineral. Bars that are solid represent complex (COMP) mineral. The short dashed line indicates blood zinc levels that meet requirements for gestating cows. Long dashed lines indicate minimal serum levels for "marginal" serum zinc status.