

Trace Mineral Clearance from Plasma and Liver Following Injection is Affected by Cattle Breed

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Summary and Implications

Trace mineral supplementation during times of stress and critical production periods may prove beneficial to overall animal health and performance. A decrease in trace mineral status may negatively impact reproduction, immunity, and general performance of the animal. Little research is available inquiring into breed differences on trace mineral status and clearance. This study concluded that Multimin[®]90 appeared to be an effective way to improve the trace mineral status, specifically of liver copper (Cu) and selenium (Se), of Angus and Simmental calves when compared to controls receiving sterilized saline.

Introduction

Trace minerals are essential to biochemical processes in the body, including skeletal development, immune response, reproductive performance, and antioxidant capacity. Unfortunately, cattle diets do not always contain sufficient trace minerals to adequately meet body demands. Although cattle may be provided with a free choice mineral supplement, this is not always sufficient to overcome mineral antagonists that may be present in the diet. In order to bypass negative interactions that may occur during the process of digestion and absorption of minerals it may be beneficial to provide trace minerals directly to the animal via an injectable mineral. Minerals would be circulated throughout the body and picked up by cells as needed with the remainder being filtered through the liver where minerals could be stored or excreted from the body. Increased animal stress at handling and cost of the injectable mineral are two implications that producers may wish to consider when strategizing for a mineral supplementation plan.

Due to the limited information concerning the influence of cattle breed on the clearance rate of trace minerals, the objective of the present study was to examine a new formulation of injectable mineral on liver and plasma concentrations of Cu, manganese (Mn), Se and zinc (Zn) of Angus and Simmental cattle following injection of a trace mineral product.

Materials and Methods

Ten Angus and 10 Simmental steers were blocked by breed and initial BW (731.9 ± 72.7 lb) and injected with either Multimin[®]90 (MM) or sterilized saline (CON) at a dose of 1 mL/100 lb BW. The Multimin[®]90 contained 60 ppm Zn, 10 ppm Mn, 15 ppm Cu, and 5 ppm Se. Calves were weight matched and treatment was balanced within pen (2 head per pen). Calves received a corn-silage based diet and Mn, Cu, Zn and Se were supplemented in the diet at NRC recommended levels.

Body weights were collected prior to initiation of the trial to determine proper dosage for the injectable mineral or saline. Jugular blood for plasma mineral analysis was collected immediately prior to injection and at 8, 10, 24 hr and d 8 and 15 post injection. Liver biopsies were collected on d -3, and d 1, 8 and 15 post injection. Liver and plasma analysis for Zn, Cu, Mn and Se were determined using inductively coupled plasma spectroscopy. Erythrocyte glutathione peroxidase (GSH Px) was determined on d -3, 10 hr, d 1, 8 and 15 post injection.

Data were analyzed as repeated measures using the MIXED Procedure of SAS (SAS Institute Inc, Cary, NC).

Results and Discussion

Plasma Cu status of the MM calves tended to be greater ($P < 0.12$; Table 1) over the 15 d period compared with the CON calves. Regardless of treatment, Simmental cattle exhibited lower ($P < 0.05$; Table 1) plasma Cu compared with Angus cattle. Based on several measures over the 15 d period liver Cu concentration was elevated ($P < 0.01$; Table 2) in MM calves. Liver Cu was not affected by breed.

During digestion and absorption Cu is susceptible to antagonistic interactions with several minerals, including Molybdenum (Mo), Iron (Fe), Sulfur (S) and Zn. One of these interactions is the formation of thiomolybdate complexes, an irreversible binding of Cu to Mo and S in the rumen which decreases dietary Cu availability to the animal. Evidence in this study suggests an injectable trace mineral is an effective way to increase liver Cu status of cattle; however, it should be noted these cattle were not deficient in Cu, as adequate liver Cu status ranges from 100-200 ppm.

Plasma Se concentrations were greater ($P < 0.01$; Table 1) over the 15 d period post injection in MM calves compared to CON calves. Simmental cattle displayed lower ($P < 0.01$) plasma Se values compared to Angus cattle. Across the 15 d period post injection liver Se was greater ($P < 0.01$; Table 2) in MM calves compared with CON calves. No evidence of a breed effect on Se storage in the liver was observed. In addition to improving liver Cu status, addition

of an injectable trace mineral appears to be an effective way to increase liver Se status of cattle. However, producers should be cautioned when cattle are not deficient in Se, as liver Se concentrations measured in the present study were above the normal range of 1-2 ppm Se expected in cattle.

Erythrocyte GSH Px activity was greater ($P < 0.01$; Table 1) in MM compared with CON calves throughout the 15 d period. Enhanced GSH Px activity suggests injected Se was successfully incorporated into a biochemical process and contributed to improved antioxidant status of the cattle.

Plasma Zn was elevated ($P < 0.01$; Table 1) in MM calves in the 15 d period after injection compared with CON calves. Simmental cattle exhibited lower ($P < 0.01$; Table 1) plasma Zn concentrations compared to Angus cattle. Liver Zn was elevated ($P < 0.02$; Table 2) in MM calves compared with CON calves. Liver Zn was not affected by breed.

Zinc is essential for the proper function of numerous enzymes, including those involved in nucleic acid, protein, and carbohydrate metabolism, and also aids in development and maintenance of normal immune function. Research has indicated that Zn concentrations increase in bovine conception products (placenta, placental fluids, and fetus) as the fetus grows. During the perinatal period, immunological cells are susceptible to Zn deficiency, suggesting this period may benefit from supplemental Zn.

Plasma Mn was greater ($P < 0.01$; Table 1) in the MM calves compared with the CON calves following injection with an injectable trace mineral. Plasma Mn was not different between breeds. Liver Mn had a tendency to be higher ($P < 0.06$; Table 1) in the MM calves compared with CON calves. Simmental calves exhibited greater ($P < 0.01$; Table 2) liver Mn concentrations compared with Angus calves, regardless of treatment. These data suggest that Angus cattle clear Mn from the body at a faster rate than

Simmental cattle, which may have implications on supplementation strategies. Manganese plays an important role in many aspects of production and deficiencies can result in poor neonatal growth and bone malformation in calves, and delayed estrus, poor conception rates and abortions in cows.

Trace mineral supplementation during times of stress and critical production periods may prove beneficial to overall animal health and performance. Decreased trace mineral status may negatively impact reproduction, immunity, and general performance of the animal. Because the ruminant diet often forage-based, the concentrations of trace minerals in forages may be a determining factor in the need for trace mineral supplementation. A study examining the trace mineral status of forages across the US, indicated that Se, Zn and Cu concentrations were ideal in only 30.2%, 23.0% and 33.3% of 709 samples, respectively, while only 0.6% of samples were deficient in Mn.

In conclusion, Multimin®90 improved the trace mineral status of Angus and Simmental calves when compared to controls receiving sterilized saline. It should be noted that calves used in this study were not deficient in any of the trace minerals investigated. Though this approach has value because cattle do not often experience deficiencies of all four of these minerals at the same time, this may have contributed to an increased liver clearance rate as the calves did not have an excessive need for trace minerals. Future research should examine the impacts of injectable trace minerals on status of calves experiencing mild to moderate deficiencies of Cu, Se, Zn and Mn.

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Table 1. Effect of injectable mineral on bovine plasma mineral concentration and red blood cell glutathione peroxidase activity.

Item	Treatment			Breed			P Value	
	CON	MIN	SEM	Angus	Simm	SEM	Treatment	Breed
Plasma mineral								
Cu ^a , mg/L	1.2	1.3	0.03	1.3	1.2	0.03	0.12	0.05
Zn ^{a-c} , mg/L	1.0	1.2	0.04	1.2	1.0	0.04	0.01	0.01
Mn ^{a-c} , µg/L	2.0	7.9	0.4	4.7	5.2	0.4	0.01	0.3
Se ^{a-d} , µg/L	77.6	175.3	6.2	138.0	115.0	6.1	0.01	0.01
Red blood cell								
GSH Px ^a , U/g Hb	160.4	226.2	15.5	186.2	200.4	15.6	0.01	0.5

^aOverall means based on repeated measures analysis; d 0 values as covariates, except Mn.

^bTime ($P < 0.001$).

^cTime*treatment ($P < 0.001$).

^dTime*breed ($P \leq 0.05$).

Table 2. Effect of injectable mineral on bovine liver mineral concentration.

Item	Treatment			Breed			P Value	
	CON	MIN	SEM	Angus	Simm	SEM	Treatment	Breed
Liver mineral								
Cu ^{a,b} , mg/kg DM	113.5	177.6	5.3	140.9	150.2	5.3	0.01	0.2
Zn ^a , mg/kg DM	77.8	88.3	3.0	83.2	82.8	3.0	0.02	0.9
Mn ^a , mg/kg DM	6.2	6.8	0.19	6.0	7.0	0.19	0.06	0.01
Se ^{a-c} , mg/kg DM	1.7	6.2	0.37	3.7	4.3	0.38	0.01	0.3

^aOverall means based on repeated measures analysis; d 0 values as covariates.

^bTime ($P < 0.05$).

^cTime*treatment ($P < 0.05$).