Blood Trace Mineral Concentrations of Cows and Heifers from Farms Enrolled in the Arkansas Beef Improvement Program

M.S. Gadberry, T.R. Troxel, and G.V. Davis[1]

Story in Brief

The objective of this study was to evaluate blood mineral concentration differences of cows and heifers and to determine the occurrence of mineral deficiencies in beef cattle in Arkansas. Blood samples were collected from mature cows on 22 farms and from replacement heifers on five farms. All farms provided a complete, free-choice mineral. Cow and heifer samples were not collected from the same farms. Fifty-nine heifer samples were analyzed for iron (Fe), zinc (Zn), copper (Cu), and selenium (Se), and 106 cow samples were evaluated for all listed minerals except for Cu (n=316) and Se (n=350). Serum Cu averaged 0.72 ± 0.07 and 0.67 ± 0.03 ppm for heifers and cows, respectively (P = 0.50). Blood Se averaged 0.13 ± 0.02 and 0.11 ± 0.01 ppm for heifers and cows, respectively (P = 0.46). The average blood concentration of Cu and Se for both heifers and cows were at the low end of the Michigan State University recommended, adequate range. The percentage of farms with heifers or cows that were adequate (80% and 54.6%) or below adequate (20% and 45.4%) for Cu was not different (P = 0.30). The percentage of farms with heifers or cows adequate (20% and 36.4%) or below adequate (80% and 63.6%) for Se did not differ (P = 0.48). Zinc was adequate for all farms. Producers should provide mineral supplements containing adequate trace mineral concentrations and monitor and adjust intake of supplements to ensure adequate consumption.

Introduction

Beef cattle producers in Arkansas rely on forages to supply most of the nutrients needed by the herd, including protein, carbohydrates, vitamins, and minerals. Minerals contribute only a small part of the entire diet; however, they are essential for normal growth, reproduction, and immunity.

Mineral composition of forages is affected by many factors including mineral composition of the soil, soil pH, moisture, plant species, and plant stage of maturity. Hay analyses have indicated Arkansas forages are typically deficient in the trace minerals copper, zinc, and selenium (Davis et al., 2002).

The objective of this study was to compare blood trace mineral levels of cows and replacement heifers enrolled in the Arkansas Beef Improvement Program (ABIP) to determine the occurrence of mineral deficiencies in Arkansas beef cattle herds.

Experimental Procedures

Blood was collected randomly from either cows or heifers enrolled in ABIP projects. Each herd was provided a free choice mineral supplement. Blood samples were collected from mature cows on 22 farms enrolled in either ABIP whole farm projects, breeding and calving season projects, or supplemental feeding projects. Blood samples from heifers were collected from five farms enrolled in the replacement heifer development project.

Blood samples were collected in Vacutainer (366430) red top tubes for iron (Fe) zinc (Zn), and copper (Cu) analysis, and in Vacutainer (266454) lavender top tubes for whole blood selenium (Se) analysis. Samples were analyzed by Schering-Plough Technical Services from 1992 to 1996 for Cu and Se. From 1996 to 2002, samples were sent to Michigan State University. In addition to serum Cu, Michigan State also reported serum calcium, phosphorus, sodium, potassium, magnesium, Fe, and Zn.

An average of 13 cows and 12 heifers were sampled per farm, representing an average of 17% of the total cows and 74% of the total heifers on each farm. A total of 106 samples from cows were analyzed for Fe and Zn, 316 were analyzed for Cu, and 350 were analyzed for Se. Fifty-nine samples from heifers were analyzed for Fe, Cu, Zn, and Se.

Blood levels were analyzed by the GLM procedure of SAS (SAS Inst., Inc., Cary, NC) with farm as the experimental unit and animal within farm as the error term to determine differences in cow farms and heifer farms. Under research conditions, comparing blood levels would be accomplished by exposing both cows and heifers to similar planes of nutrition on the same or similar pastures to reduce environmental variation and experimental error. However, a comparison across environments with field data is justifiable when multiple farms are used and the variation among animals within farm is used as the experimental error realizing that differences seen could be due to factors other than age of the animal. Management or other environmental conditions might make the cow farms different from the heifer farms. Michigan State suggested blood levels were used to categorize samples as below adequate, adequate, or above adequate (Table 1). The percentage of all heifer and cow samples that were below adequate, adequate, or above adequate was determined with the FREQ procedure of SAS. Average Fe, Zn, Cu, and Se concentrations of animals within a farm were used to establish farm blood mineral concentrations. Chi-square analysis of farm blood classifications was used to determine if the percentage of heifer farms that was below adequate, adequate, or above adequate differed from the percentage of cow farms.

Results and Discussion

Under field conditions across multiple environments, heifer blood mineral concentrations did not differ significantly (P > 0.10) from cow blood mineral concentrations for Fe, Zn, Cu, or Se (Table 2). The average concentration of Cu, 0.72 and 0.67 ppm, and Se,

[1] University of Arkansas Cooperative Extension Service, Little Rock

0.13 and 0.11 ppm, for heifers and cows, respectively, were at the low end of the MSU adequate range. The NRC (1996) indicates that Fe, Zn, Cu, and Se requirements are similar for both growing and mature cattle. Similarities in requirements may indicate why no differences were observed in these minerals for cows and heifers.

The percentage of heifer samples and cow samples that were below adequate, adequate, or above adequate are presented in Tables 3 and 4, respectively. Sixty-nine percent of the heifers and 76% of the cows sampled were above the MSU recommended Fe range. Eighty-one percent of the heifers and 84% of the cows were within the range defined as adequate for Zn. Thirty-three percent of heifers and 53% of the cows were below the adequate range for Cu, and 50% and 63% of the heifers and cows, respectively, were below the Se adequate range.

Since variability occurs within farm as well as across farm for blood mineral concentrations, a pooled average blood concentration within a farm was used to determine whether or not a farm was deficient for a particular trace mineral. Percentages of farms below adequate, adequate, or above adequate for Fe, Cu, Zn, and Se are presented in Table 5. All farms with cows were above average for Fe; however, heifer farms tended to differ (P = 0.07) from cow farms with 60% of the farms being above adequate and 20% below adequate. Iron deficiency hasn't been identified as a major problem in Arkansas, and cattle are generally exposed to enough Fe through forages and contact with soil.

One hundred percent of the farms with either heifers or cows were adequate for Zn. There are concerns with the possibility of elevated Zn concentrations of samples due to Zn in the rubber stopper of red top vacutainer tubes. The potential amount of contamination is unknown.

Twenty percent of the heifer farms had below adequate Cu concentrations and 45% of the cow farms were below adequate. The percentage of farms that were adequate or below adequate for Cu did not differ (P = .30) by farm type (heifer vs. cow farm). Liver Cu is a better indicator of Cu status; however, if blood levels are below adequate, copper deficiency is a concern. Some cattle with adequate serum Cu might have been mobilizing liver Cu and therefore could be moving toward a deficiency. Copper deficiency on these farms may be occurring due to low levels of Cu in the forage, low levels of Cu in the mineral supplement or poor mineral supplement intake, and (or) high levels of antagonistic minerals in the diet such as sulfur (S), Fe, and (or) molybdenum (Mo). Breed of cattle has also been shown to affect Cu status (Mullis et al., 2003; Ward et. al., 1995). Davis et al. (2002) indicated that 24%, 10% and 1% of AR hays contained antagonistic levels of S, Fe, and Mo, respectively that can interfere with copper metabolism.

Eighty percent and 63.6% of the heifer and cow farms, respectively, were below adequate for Se, and the percentage adequate or below adequate did not differ (P = 0.48) by farm type.

Implications

Copper and selenium deficiencies are typically seen in Arkansas forages and cattle herds, despite mineral supplementation. Cattle producers need to evaluate the mineral concentration of their mineral supplements and monitor and adjust supplemental mineral intake to ensure adequate consumption.

Literature Cited

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Table 1. Michigan State University suggested mineral concentrations.

	Adequate Range
Serum iron (Fe), ppm	1.30 to 1.40
Serum zinc (Zn), ppm	0.80 to 1.40
Serum copper (Cu), ppm	0.65 to 1.50
Serum selenium (Se), ppm	0.120 to 0.250

Table 2. Serum concentrations[a] of iron, zinc, and copper, and whole blood selenium of heifers and cows.

	Heifers	Cows	P-value
Iron (Fe), ppm	1.60 ± 0.09	1.69 ± 0.07	0.44
Zinc (Zn), ppm	1.14 ± 0.05	1.08 ± 0.04	0.39
Copper (Cu), ppm	0.72 ± 0.065	0.67 ± 0.03	0.50
Selenium (Se), ppm	0.13 ± 0.02	0.11 ± 0.01	0.46

[a] Least-squares means ± standard error

Table 3. Percentage of heifers with below adequate, adequate, or above adequate serum concentrations of Fe, Zn, and Cu, and whole blood Se concentrations.

	Number of Samples	Below adequate (%)	Adequate (%)	Above adequate (%)
Iron (Fe)	59	17.3	13.5	69.2
Zinc (Zn)	59	5.8	80.8	13.4
Copper (Cu)	59	32.7	67.3	0
Selenium (Se)	59	50	50	0

Table 4. Percentage of cows with below adequate, adequate, or above adequate serum concentrations of Fe, Zn, and Cu, and whole blood Se concentrations.

	Number of Samples	adequate (%)	Below Adequate (%)	Above adequate (%)
Iron (Fe)	106	17.9	6.6	75.5
Zinc (Zn)	106	6.6	84.0	9.4
Copper (Cu)	266	53.4	46.6	0
Selenium (Se)	286	63.0	36.0	1.0

Table 5. Percentage of farms with below adequate, adequate, or above adequate serum concentrations of Fe, Zn, and Cu, and whole blood Se concentrations.

	Heifer farms				Cow farms				
	Number of Samples	Below Adequate (%)	Adequate (%)	Above Adequate (%)	Number of Samples	Below Adequate (%)	Adequate (%)	Above Adequate (%)	X^2 P-value
Iron (Fe)	5	20	20	60	12	0	0	100	0.07
Zinc (Zn)	5	0	100	0	12	0	100	0	---
Copper (Cu)	5	20	80	0	22	45.4	54.6	0	0.30
Selenium (Se)	5	80	20	0	22	63.6	36.4	0	0.48