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Multi-Elemental Analysis of Liver Biopsies and Serum to Determine Trace Element Status of Cows

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Summary

Liver biopsies and serum were collected from 20 MARC II cows four times annually during the three-year study conducted at the Dalbey - Halleck Farm in southwest Nebraska. The 20 cows were randomly selected from a herd of 200 cows. The entire herd did not receive trace element supplementation. Liver and serum samples were collected pre- and post-calving, mid-summer and at weaning in the fall of each year. All samples were analyzed for trace elements by an inductively coupled argon plasma emission spectrophotometer. Copper concentration in the liver and serum did not change during the study and was not effected by season. Molybdenum concentration was highest in the summer and fall, but had no effect on liver or serum Cu. Liver Zn did not change during the 3 years, but was higher pre-calving. Serum Zn was higher during the summer. Liver Mn was higher post-calving and in the fall and also increased in concentration each year. Mean liver concentration of trace elements did not decrease during the study. Results indicate some seasonal flux in trace element concentrations in the serum and liver; however, reproductive performance was maintained without trace element supplementation.

Introduction

Cattle producers have commonly supplemented trace elements to prevent deficiencies. The beef cow, primarily grazing forage or fed harvested forage, may be able to store adequate amounts of trace elements in the liver during periods of excess availability to maintain homeostasis during periods of marginal availability. Therefore, the objective of this study was to determine the seasonal effects on trace element status of multiparous cows in the absence of supplementation. Trace element concentrations in the liver biopsy were compared with serum concentrations removed at the same time.

Procedure

Twenty, multi-parous Marc II March and April calving cows were randomly selected from a herd of 200 at the UNL owned Dalbey - Halleck Farm, Virginia, NE. The entire herd received no supplemental trace elements, grazed smooth bromegrass and mixed warm season grasses in the summer, and were supplemented with mixed warm season hay and alfalfa during the winter.

Cattle Management

The trace mineral supplement was eliminated at the time of the first liver biopsy in the spring of 1992. All cows were bred by natural service during a 60-day period except during the 1993 breeding season when a 21 day A. I. period was followed by 39 days of natural service. Calves born in 1991 and 1994 were sired by Angus bulls and calves born in 1992 and 1993 were MARC II sired. Breeding started on May 21 of each year for a projected calving start date of March 1. Calves were weaned between Oct. 5 and Oct. 20 of each year.

Sampling Procedure

The 20 cows were liver biopsied four times annually during the three-year study. Biopsies were taken pre-calving (2/15) and post- calving (5/1), during the summer (8/1) and at weaning (10/15). Liver biopsies were removed between the twelfth and thirteenth rib, 20 cm ventral to the mid-line using a Tru-Cut® biopsy needle. Samples of 5-8 consecutive biopsies weighed approximately .1 g (wet weight). Liver biopsy samples were placed in plastic tubes and frozen at 0°F until mineral analysis. Blood samples were collected at the same time by jugular bleeding. Serum was stored at 0°F until mineral analysis.

Mineral analysis

Serum was analyzed directly and biopsy samples were dried, digested overnight in nitric acid, and analyzed for trace elements using an inductively coupled plasma emission spectrophotometer equipped with an ultrasonic nebulizer.

Statistical Analysis

Statistical analysis was performed using the General Linear Models procedures in SAS.

Table 1. Mean trace element concentrations in the liver during the fall of each year (mg/kg, dry wt.).

Year	Cu	Zn	Mn	Fe	Mo
92	71.2[a]	109[a]	8.59[a]	283[a]	1.35[a]
93	81.0[a]	116[a]	9.70[b]	341[b]	4.06[b]
94	72.6[a]	111[a]	10.2[c]	358[b]	2.47[a]

[abc]Means in a column with different superscripts are different (P < .05).

Table 2. Mean trace element concentrations of the liver at different times (mg/kg, dry wt).

Element	Summer	Fall	Pre	Post	S.E.
Cu	75.3[a]	76.8[a]	68.3[a]	65.5[a]	5.78
Zn	91.0[a]	102[a]	147[b]	96.9[a]	6.70
Fe	305[a]	364[c]	358[bc]	321[ab]	16.9
Mn	9.12[a]	10.3[b]	8.60[a]	10.4[b]	.398
Mo	3.75[a]	4.66[a]	1.96[b]	1.59[b]	.470

[abc]Means in a row with different superscripts are different (P < .05).

Table 3. Mean trace element concentrations of the serum at different times of the year (mg/kg, dry wt.).

Element	Summer	Fall	Pre	Post	S.E.
Cu	.616[a]	.612[a]	.603[a]	.598[a]	.238
Zn	.758[a]	.655[b]	.658[b]	.555[b]	.036
Fe	2.12[ab]	1.87[a]	2.22[b]	1.84[a]	.08

[abc]Means in a row with different superscripts are different (P < .05).

Results

Sodium chloride and dicalcium phosphate were supplemented free-choice. Grass tetany had been a problem, so cows were allowed access to a Mg supplement post-calving. Magnesium was highest (P < .01) post-calving, but can be explained by the additional supplementation at that time.

Liver Cu and Zn concentrations did not change (P < .05) during the study (Table 1). Copper concentrations in the liver and serum (Table 2 and Table 3) were not effected by season (P < .05). But, liver Zn was greatest pre-calving and serum Zn was greatest during the summer.

The ratio between Cu and Zn has been used as an indicator of health to predict culling in dairy cattle. The Cu:Zn serum ratio was lowest during the summer (P < .05) and higher pre- and post-calving. Whereas, the Cu:Zn ratio in the liver was lowest pre-calving (P < .05) and highest during the summer.

Liver and serum Fe demonstrated some seasonal flux and was high at all time points when compared to published values (Puls, 1994. Mineral Levels in Animal Health: Diagnostic Data). Manganese and Fe increased, and Mo was greatest during the second year (P < .05). Manganese was highest in the liver post-calving and in the fall, but is considered to be in the adequate range. Liver Mo was highest during the summer and fall probably because the Mo concentration in the forage was increasing as the plant matured (1994 Nebraska Beef Report, pp. 8-11). Molybdenum did not have a negative impact on liver or serum Cu.

There was no statistical correlation between liver element levels and serum levels. This is due to the homeostatic control mechanisms that maintain serum element concentrations within an adequate range, at the sacrifice of liver mineral stores.

Herd reproduction and calf performance data are shown in Table 4. The data for 1991 are with trace element supplementation and 1992 through 1994 data reflect the performance without supplementation. Reproductive performance did not decrease when trace element supplementation was removed. Also, mean liver concentration did not decrease (P < .10) for any element during the three years. Previous analysis (1994 Nebraska Beef Report, pp. 8 - 11) indicated that the forage was adequate to meet the cows requirement most of the time. The cow also has the ability to store elements during times of excess to be used during periods of marginal availability. Calf weaning percentage was higher in 1991 and 1994, probably due to to a change in sire breeds rather than nutrition. Weaning weights increased during the four years and cows tended to calve earlier in 1994 than in 1991 or 1992.

Results of the three-year study

(Continued on next page)

Table 4. Reproduction and performance data of the entire herd[a] by year.

	Year			
	1991	1992	1993	1994
Pregnant[b], %	95.5	88.0	92.3	95.0
Weaning[c], %	92.2	82.0	86.0	92.0
Weaning[d] wt, lb				
Heifers	459	480	518	522
Steers	492	527	536	549
Calving date[e]	3/22	3/24	3/20	3/16

[a]Herd size was maintained at 200 cows and heifers.
[b]Percentage of cows exposed that calved in year indicated.
[c]Percentage of cows exposed that weaned a live calf.
[d]Actual weaning wt of calves.
[e]Mean calving date of all pregnant cows.

indicate some seasonal flux in liver trace element concentrations. A need for additional trace element supplementation was not established for this area, because reproductive performance of the herd was maintained in the absence of trace element supplementation.

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