SELENIUM SUPPLEMENTATION AND CONCENTRATION OF SELENIUM IN CATTLE TISSUES AND FLUIDS

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SUMMARY

An experiment was conducted for 22 mo to determine Se status of grazing Brahman cows and their calves as affected by Se supplementation and season of the year. The three treatments administered to grazing cows for 120 days (November to March), either orally in a concentrate mixture or injection intramusculary, were: 1) control (no Se), 2) control + .25 ppm Se + intramuscular injection of 5 mg Se plus 1,500 mg vitamin E, and 3) control + .25 ppm Se. Soil, forage and animal tissue samples were collected six times during the 22-mo experiment. Two collections were in the winter season, and four were in the grazing (spring-fall) season. Animal samples collected were liver, hair, serum colostrum and milk from 36 cows and serum from their calves. The most consistent finding was low Se concentration of soils and pastures, which were reflected in low Se concentrations in serum, liver, hair and feces. Both supplemental dietary Se and dietary plus injectable Se-vitamin-E resulted in higher ($P<.05$) Se tissue levels. Cows fed supplemental dietary and dietary plus injected Se and vitamin E had more Se in both colostrum and milk than did cows fed no supplemental Se. Likewise, blood Se concentration of calves from Se-supplemented cows was higher ($P<.05$) than controls. Low tissue and dietary Se concentrations found in this study, plus the persistent reports of white-muscle disease in the state of Florida, emphasize the need for increasing intake of Se.

The two principal conclusions from this study were: 1) the Se status of Brahman cattle was low based on Se concentrations in soil, forage, serum, liver, hair and milk and 2) Se supplementation increased the Se status based on tissue analyses, including milk, and the increase was reflected in higher serum Se in calves of supplemented cows.

INTRODUCTION

Nutritional muscular dystrophy and other related diseases are reported in ruminants in many countries of the world where forages contain less than .05 ppm Se. Some researchers have indicated that tissue concentration or selenium (Se) increases as intake of Se increased, regardless of the tissue sampled. Likewise, injections of supplemental Se increased both serum and tissue concentrations of this element. Serum and liver Se concentrations provide good indicators of dietary Se status in cattle. The objectives of the present study were to investigate Se status of soil, forage and tissues of Brahman cattle and to determine the effect of supplemental Se on cow/calf status.

MATERIALS AND METHODS

The experiment was conducted at the University of Florida Pine Acres Beef Research Unit located in central Florida. In general, the soils (Entisol) are coarse-textured, acid (pH 6.0) and low in natural fertility, Thirty-six registered Brahman cows (4 to 10 years old) in early pregnancy were studied. During the experiment, cows were confined to four fenced pastures (three Cynodon dactylon and one Paspalum notatum) and grazed rotationally to minimize pasture effect on treatments. Annual fertilization of pastures consisted of 304 lb of 15% (N), 5% (P_2O_5), and 10% (K_2O) per acre. Cattle were allotted randomly to three lots of 12 cows each. Each lot was offered, from November 1980 to March 1982, Paspalum notatum hay ad libitum (15.0 lbs av. consumption) and one of the three following supplements: 1) control -- receiving 4.0 lbs of shelled corn-urea concentrate (97% corn meal and 2.57% urea), free-choice white salt block (NaCl only) and a complete commercial mineral mixture (Table l); 2) control plus .25 ppm dietary added Se (97% corn meal, 1.5% urea and .6% sodium selenite) and intramuscular injection of 5 mg Se + 1500 mg vitamin E; and 3) control plus concentrate mixture plus fortified mineral mixture (8.2%). Ingredient composition for the fortified mineral mixture is shown in Table 1.

Selected mineral composition of hay was as follows: .28% Ca, .10% Mg, .11% P, .80% K, .01% Na, and .02 ppm Se. The experiment was divided into six collection periods for soil, forage, and animal tissues. The collection dates, May 1980, October 1980, June 1981 and October 1981 (1, 2, 4, and 5) were within the spring-summer season and February 1981 and March 1982 (3 and 6) were within the winter season. Liver, hair, and serum samples were collected from the 36 cows at the beginning of each of the six periods, while bone, fecal, and milk samples were taken four times (dates 3, 4, 5 and 6). Composite duplicate forage and soil samples were collected six times from the four pastures where cattle were grazing.

RESULTS AND DISCUSSION

Production response. The 36 experimental animals calved twice, with no production response (calving percentage and growth rates) related to treatment. There were no signs (i.e., white muscle disease) related to Se-vitamin E deficiency.

Soil and forage selenium. Mean Se concentrations of soil and forage by period presented in Table 2 with differences (P<.05) in forage Se found among periods of collection. Season affected forage Se, with values lower (P<.05) in winter vs spring-fall (.026 vs .037 ppm) and three with no detectable difference (P>.05) in soil Se concentrations between seasons (Table 3). Some research has indicated that soil Se concentrations of less than .5 ppm are found in areas where Se deficiency in livestock occurs. Based on this critical level, all samples were deficient in Se. An earlier study reported similar low levels of soil Se in Florida, with values ranging from .020 to .038 ppm.

Forage Se was greater (P<.05) during the grazing months than in winter, .037 vs .026 ppm respectively. All forage samples analyzed were deficient in relation to the beef cattle requirement of .1 ppm as found in the 1976 National Research Council (NRC) publication or the revised requirement of .2 ppm as found in the newest publication of 1984.

Animal Se concentrations. Mean Se concentrations by season (Table 3), period (Table 4) and treatment (Table 5) are presented. Seasonal differences (P<.05) were found, with serum, fecal and hair Se higher in the winter season. Differences (P<.05) among treatments for Se concentrations were found for liver, feces, hair and serum. Hair, fecal and serum Se concentrations were higher (P<.05) during the winter season, while there were no seasonal differences (P>.05) in liver Se. Period differences (P<.05) were found with lower values in liver and serum during the initial period before supplemental Se was provided. The critical Se level in the liver of cattle usually is between .25 to .50 ppm DM. Thus, mean liver Se levels reported in the present study were low during both seasons, especially period I (initial period) where all samples were deficient.

Mean serum Se contents were higher (P<.05) during the winter than during spring-fall periods (Table 3), .021 and .084 ppm, respectively. Based on the critical level of .03 ppm, 73% and 20% of the serum samples analyzed for Se were deficient during the spring-fall and winter seasons, respectively.

Mean hair Se concentrations were .125 and .403 ppm in the spring- fall and winter seasons, respectively. A report from Canada showed that cows with hair Se values ranging from .06 to .25 ppm produced calves with white-muscle disease, while cows with hair Se higher than .25 ppm had normal calves. Hair Se therefore was considered deficient (<.25 ppm) in the spring-fall season but adequate in the winter season. Mean fecal Se was higher (P<.05) in the winter than spring-fall (.080 vs .049, respectively), likely reflecting supplemental Se provided during the winter.

TABLE 1. INGREDIENT AND ELEMENT COMPOSITION OF FORTIFIED MINERAL SUPPLEMENT TREATMENT 3)[a]

Ingredient	% of total mixture
BioFos[b]	27.453
Potassium chloride	12.861
Dyna-Mate[c]	32.976
Sodium chloride	20.610
Selenium premix (.02% Se)	5.153
Cobalt carbonate	.00089
Cupric sulfate	.1649
Manganous oxide	.0861
Zinc oxide	.2865
Ferrous carbonate	.1472
Additional trace mineral premix[d]	.2618
Total	100.00

a Treatments 1 and 2 had free choice access to common white salt, trace mineral salt (Cu, .035%; Co, .007%; Fe, .175%; I, .007%; Mn, .28% and Zn, .35%) and a complete commercial mineral mixture (20% Ca, 6% P, 26% NaCl, 1% Fe, .15% Cu, .03% Co, .02% Mn, .5% Mg, and .04% Zn). In 1980-1981 daily consumption of total minerals was 18.2 grams per head, of which 20% was common salt, 44% was trace mineral salt and 36% was of a complete mineral mixture. For 1981-1982 the daily consumption per head was 16.2 grams, of which 13, 31, and 56% were consumption values of the different mixtures, respectively.
b Contains 18% Ca and 21% P.
c Contains 18% K, 22% S, and 11% Mg.
d Calculated to provide 2 ppm Ni, 2 ppm Sn, .1 ppm Cr, .1 ppm V and .1 ppm I.

Liver, serum, fecal and hair Se were higher for oral and oral plus injectable Se treatments than for controls (Table 5). Supplemental Se likewise increased (P<.05) concentration of the element in both colostrum and non-colostrum (Table 6) milk. The treatment containing both injectable and dietary Se was likewise higher (P<.05) than the oral Se treatment (treatment 3) alone. One research group (Purdue University), however, reported that milk Se concentrations in dairy cows were not good indicators of dietary Se. Higher milk Se resulting from supplementation of the element increased (P<.05) calf serum Se over the control group (Table 6).

TABLE 2. SOIL AND FORAGE SELENIUM CONCENTRATIONS (PPM) AS AFFECTED BY SAMPLING PERIODS (DM BASIS)[a,b]

Item	Sampling Periods P1 5/80	P2 10/80	P3 2/81	P4 6/81	P5 10/81	P6 3/82	Overall mean	% deficient[c]	SE range
	Mean								
Soil	.035	.042	.047	.040	.052	.045	.043	100	.012-.017
Forage	.036[e]	.031[ef]	.032[ef]	.049[d]	.032[ef]	.020[f]	.033	100	.002-.005

a Least squares estimates for sample numbers are based on 28 soil and 52 forage samples.
b Samples were collected four times during the spring-summer and twice during the winter, between June 1980 to March 1982.
c Percentage deficient is based on the critical level of .5 ppm for soil (Cary et al., 1967) and .1 ppm for forage.
d,e,f Means in the same row with different superscripts differ (P<.05).

TABLE 3. SELENIUM CONCENTRATIONS OF FORAGE, SOIL AND ANIMAL TISSUES IN THE SPRING-FALL VS WINTER

Item	Season[a] Spring-Fall	Winter
	ppm	
Forage	.037b	.026[c]
Soil	.042	.046
Liver	.338	.335
Serum	.021[b]	.084[c]
Feces	.049[b]	.080[c]
Hair	.125[b]	.403[c]

a Spring-fall (periods 1, 2, 4 and 5) and winter (periods 3 and 6).
b,c Means in the same row with different superscripts differ (P<.05).

TABLE 4. LIVER, SERUM, HAIR AND FECAL SELENIUM (PPM-DM BASIS) CONCENTRATIONS AS AFFECTED BY SAMPLING PERIOD[a]

Item	Sampling Periods P1 5/80	P2 10/80	P3 2/81	P4 6/81	P5 10/81	P6 3/82	Overall mean	% deficient[c]	SE range
	Mean								
Liver	.14[f]	.24[ef]	.27[ef]	.58[d]	.39[de]	.40[de]	.47	40	.06-.08
Serum	.007[g]	.018[f]	.056[e]	.034[f]	.025[f]	.112[d]	.038	55	.005-.008
Hair	.094[g]	.076[g]	.599[d]	.186[ef]	.143[f]	.206[e]	.217		.014-.016
Feces			.087[d]	.062[e]	.036[f]	.072[e]	.064		.004

a Least squares estimates for liver, serum and hair are from 146 samples each and for feces, 130 samples.
b Samples were collected four times during grazing months [(periods 1, 2, 4 and 5 and twice (periods 3 and 6) during non-grazing months (winter)].
c Percentage deficiency is based on the critical level of .25 ppm for liver and .03 ppm serum.
d,e,f,g Means in the same row with different superscripts differ (P<.O5).

TABLE 5. LIVER, SERUM, HAIR AND FECES SELENIUM CONCENTRATIONS (PPM, DM BASIS) AS AFFECTED BY TREATMENT[a]

		Mineral Supplementation[b]						
		T1		T2		T3		
Item	Critical level[c]	Mean	% deficiency	Mean	% deficiency	Mean	% deficiency	SE range
Liver	.25	.25[e]	69	.63[d]	27	.54[d]	34	.04
Serum	.03	.024[e]	81	.055[d]	52	.045[d]	62	.005-.006
Hair		.115[f]		.282[d]		.245[e]		.010-.011
Feces		.041[d]		.077[d]		.068[d]		.004-.005

a T1, T2 and T3 stand for control, injectable and dietary Se, and dietary selenium, respectively.
b LS means for liver, serum and hair are based on the following number of samples: 66, 69 and 66 for treatments 1, 2 and 3, respectively. LS means for feces represent 44, 45 and 41 for treatments 1, 2 and 3, respectively.
c McDowell and Conrad and McDowell.
d,e,f Means in the same row with different superscripts differ (P<.O5).

TABLE 6. EFFECTS OF TREATMENT ON SELENIUM CONCENTRATIONS (µG/ML) IN MILK AND CALF SERUM[a]

Treatment	Colostrum	Milk	Calf serum
1	.015[d]	.0046[c]	.030[c]
2	.049[b]	.0097[b]	.053[b]
3	.031[c]	.0062[c]	.049b
SER	.004	.0008	.0009

a Least squares means for treatments 1, 2, and 3, respectively, are based on 72 colostrum, 132 milk, and 175 calf serum samples. Treatments 1, 2 and 3 are control, injectable and dietary Se-vitamin E and dietary selenium, respectively.
b,c,d Means in the same column with different superscripts differ (P<.O5). Treatment 1 for milk was different