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Barium Selenate Supplementation of a Crossbred Cattle Herd in Puerto Rico

[1]Rafael Ramos Santana, [2]Lee R. McDowell, [1]Francisco Javier Fuentes,
[3]Benjamin Rivera and [2]Nancy S. Wilkinson
[1]Agronomy and Soils Department Agricultural Experiment Station Corozal, Puerto Rico 00783
[2]Animal Sciences Department, University of Florida, Gainesville, FL 32611-0910
[3]College of Agricultural Sciences, Animal Sciences Department, Mayagüez, Puerto Rico 00783

Abstract: Crossbred beef cows (30) were split into two groups, with half receiving injectable selenium and half serving as the control. The injectable selenium was Deposel multidose. This is a slow realease barium selenate product. Blood was collected four times during the year, with cows receiving the Deposel having higher ($P<0.01$) serum selenium. Animals receiving the selenium also had higher ($P<0.01$) liver selenium than controls. Calves from cows receiving the injectable selenium also had higher ($P<0.01$) serum selenium than controls. During the one year trial barium selenate was effective for elevating selenium status of cattle.

Key words: Selenium, cows, calves, selenium status

Introduction

One of the important microelements in ruminant diets is selenium, which is essential for body functions such as growth, reproduction, prevention of various diseases and protection of the integrity of tissues (McDowell *et al.*, 1997). Beginning in 1957, selenium deficiency in livestock was recognized as a problem in many areas of the world. As a consequence of deficiency selenium has been added to diets to provide an adequate supply (Hansen *et al.*, 1996). In cows from 15 dairy herds, serum selenium concentrations ranged from 0.02 to 0.79 mg L^{-1}, whereas 0.05 to 0.40 mg L^{-1} is reported to be the adequate range for serum selenium concentrations in cattle (Stevens *et al.*, 1985). According to McDowell *et al.* (1997), 0.03 mg L^{-1} of selenium in the blood and 0.25 ppm in the liver (dry basis) are considered the critical levels for selenium deficiencies.

According to Ellis *et al.* (1997), normal cattle serum ranges are from 0.05 to 1 mg L^{-1}. Normal liver selenium concentrations are considered to range between 1.2 and 2.0 ppm on a dry weight basis. In cattle it appears that the liver is a more sensitive indicator than serum of selenium intake above requirements (Ellis *et al.*, 1997).

Recently (Valle *et al.*, 2002) studied five methods of supplementing selenium to a herd of 75 Angus cows. The cows receiving barium selenate had the highest liver selenium at the end of the experiment. Also the barium selenate blood levels during the two-year experiment were consistently above the critical levels suggested for cattle. The accumulation of selenium in the liver suggested that this slow release product could go on providing selenium for the animal for periods longer than two years.

The objective of the present study is to evaluate the effect of supplying injectable barium selenate to a herd of crossbred cattle under the tropical rangeland conditions of central Puerto Rico.

Materials and Methods

The experiment started September 6, 2000 at the Agricultural Experiment Station of Corozal in central Puerto Rico. Yearly mean precipitation for both years averaged 1683mm and the mean temperature averaged 25.4°C. A group of thirty cows was selected for the experiment. All selected cows were crossbred Senepol, Holstein, and Charbray. The cows were assigned to two treatments according to the criterion of liveweight and stage of pregnancy. The treatments were with and without injectable selenium. The product was Deposel Multidose (Vericore Limited, Talkin, Brampton, Cumbria, UK). The product contains selenium (as Barium Selenate, 175 mg ml^{-1}, with 50 mg of selenium per ml. This is a slow release selenium product. During the first year of the experiment (2000-2001) the first group of 13 cows and two heifers were treated with an injectable form of selenium at the rate of 9 cc per cow and 6 cc per heifer. The second group, 13 cows and 2 heifers, was the control, with no application of selenium. Because of a problem in the applied injectable Barium selenate of the first year, no data inferences were possible during that period. A second application with the corrected amount of product (10 cc per cow) was given during 2001-2002. Four cows died in the selenium-treated groups during the evaluation period of 2000-2002. None of the deaths were treatment related. One death was related to the biopsy, one to an injury and two to anaplasmosis.

The cows of both treatments were grazing on four rangeland plots in an area of 61 ha. In the plots the cows had free access to a commercial salt block free of selenium. Fourteen salt blocks were eaten during the first two years of the experiment. Blood was collected, via jugular venipuncture with an 18-gauge needle, into heparinized vacuum blood collection tubes. Liver biopsy samples were collected with trocar and cannula by the procedure of Chapman *et al.* (1963) at the 11th intercostal space. Selenium concentrations in blood and

liver samples were determined by using the Whetter and Ullrey (1998) fluorometric method.
Blood samples were collected every three months from the cows of both treatments. Every six months the cows were subject to liver biopsy and weight gain measurements. All data were analysed by using a statistical model for repeated observation of each individual animal (SAS 1989) and the means were compared by using the Tukey Test.

Results and Discussion

Table 1 presents average weight and average yearly weight changes of cows evaluated in each of the two treatments. In all cases, cows maintained their body weight during the evaluation period. The four cows that died were replaced by four other cows to continue with the evaluation during the second year.

Table 1: Average weight (kg) and average yearly weight change of cows treated and non treated with injectable selenium during the period between September 6, 2001 and September 11, 2002

Group	September6, 2001	September11, 2002	Average Yearly Change
Treated Barium Selenate	930	1,031	+101
Untreated (control)	870	1,059	+189

Table 2 shows the mean plasma selenium concentration of treated and control groups during the second year of evaluation. Significant (P<0.01) differences were observed between the dates of plasma collection. The first collection period was considerably lower in selenium than the rest of the collections under evaluation. In almost all cases, adequate ranges in plasma selenium concentrations were observed from all collection dates. The average selenium concentration on each date after the selenium injection was always higher for the selenium treated group, fluctuating between 0.007 to 0.023 units above that for control cows. The mean selenium concentration of the four tested periods was significantly (P<0.01) higher for the treated group than for the control. Similar results were obtained by (Valle *et al.*, 2002), who found significant (P<0.05) differences compared to the control in the selenium content of serum in Angus cows treated with barium selenate for a two-year period. In general, the plasma selenium concentrations of free-choice mineral yeast, barium selenate and sodium selenite (Mu - Se) of Valle *et al.* (2002) were lower than the observed values on this experiment. Possibly the heterogeneous genetic composition of the present herd in comparison with the Angus herd was the reason for such differences.

Table 2: Plasma selenium concentrations (mg L^{-1}) of cows receiving injectable barium selenate from September 6, 2001 to September 11, 2002[a]

Cows No. Treated	Dec-12-01	Mar-12-02	Jun-11-02	Sept-11-02	Mean per cow
124	0.065	0.086	0.098	0.078	.082
127	0.086	0.108	0.087	0.101	.095
11	0.073	0.073	0.093	0.092	.083
6	0.078	0.073	0.082	0.069	.075
27.7	0.082	0.078	0.098	0.083	.085
1	0.086	0.099	0.115	0.069	.092
818	0.108	0.091	0.093	0.083	.094
65	0.082	0.086	0.098	0.078	.086
371	0.065	0.078	0.087	0.06	.072
441	0.052	0.095	0.109	-----	.085
866	0.086	0.117	0.196	0.101	.125
55	0.082	0.096	0.104	0.083	.091
865	0.101	0.101	0.115	0.092	0.102
885	0.096	0.11	0.131	0.106	0.111
Mean	0.0816	0.0922	0.107	0.0842	0.091
Cow No. Control	0.014	0.011	0.023	0.068	
120	0.056	0.065	0.098	0.069	0.072
3.8	0.06	0.082	0.076	0.097	0.079
126	0.056	0.078	0.087	0.069	0.072
21	0.06	0.082	0.093	0.092	0.082
61	0.056	0.082	0.093	0.065	0.074
1.8	0.065	0.069	0.071	0.083	0.072
2	0.065	0.082	0.076	0.046	0.067
19.5	0.065	0.104	0.065	0.065	0.075
993	0.086	0.095	0.087	0.092	0.090
13.6	0.065	0.069	0.087	0.092	0.078
9.7	0.065	0.073	0.071	0.078	0.072
57	0.073	0.082	0.098	0.069	0.080
18	0.083	0.092	0.115	0.083	0.093
8	0.069	0.069	0.065	0.083	0.071
424	0.101	0.087	0.082	0.078	0.087
Mean	0.068	0.081	0.084	0.0774	0.078
Mean for treated and control dates	0.075 d	0.086 b,c	0.096 b	0.081 c,d	0.0845

[a]Selenium concentration was higher (P<0.01) for all collection periods for selenium treated versus controls.
[b-d]Means with different superscripts within a row differ (P<0.01)

The mean liver selenium concentration of the cows in the treated group was also significantly (P<0.01) higher (1.93 vs. 1.59 mg kg^{-1}) in relation to that of the control (Table 3). The liver concentrations in cows of the treated group were always in the normal range (1.2 to 2.0 mg kg^{-1}). In the case of the control cows, however, 6 animals were below the critical liver selenium concentrations during at least one period. This fact indicated that the injectable barium selenate application was able to raise liver Se concentration to a normal level in all cows under evaluation. These results are similar to those of Valle *et al.* (2002) in which treated animals had the highest selenium concentration above that of the control and the highest levels of various free-choice minerals two years after the experiment initiation.

Table 3: Liver selenium concentrations (mg kg^{-1}, dry basis) of cows receiving injectable barium selenate from September 6, 2001 to September 11, 2002[a]

Cow No. Treated	Mar. 12-02	Sep. 11-02	Mean per cow
127	1.99	2.09	2.04
11	1.86	2.2	2.03
6	1.68	1.48	1.58
27.7	2.26	-	2.26
1	1.59	-	1.59
818	2.23	2.03	2.13
65	1.53	1.72	1.62
371	1.79	2	1.89
441	1.66	-	1.66
866	2.2	-	2.20
55	2.43	2.36	2.39
865	1.44	1.26	1.35
885	2.29	2.33	2.31
Mean	1.92	1.94	1.93
Cow No. Control			
120	0.87	1.35	1.11
3.8	1.32	1.62	1.47
126	1.55	1.11	1.33
21	1.03	1.26	1.14
61	1.23	0.97	1.10
1.8	0.97	1.16	1.06
2	1.12	1.12	1.12
19.5	1.2	1.41	1.30
993	1.5	1.19	1.34
13.6	1.22	1.88	1.55
9.7	1.44	1.57	1.50
57	1.03	0.95	0.99
18	1.37	1.2	1.28
Mean	1.22	1.29	1.25
Mean treated and control	1.57	1.61	1.59

[a]Selenium concentration was higher ($P<0.01$) for treated versus control cows

Table 4: Plasma selenium concentration (mg L^{-1}) of calves whose dams were supplemented with injectable selenium (Barium Selenate)[a]

Cow No. Treated	Day one to two	First month	Second month	Mean
124	0.06	0.046	0.046	0.051
127	0.06	0.05	0.046	0.052
65	0.046	0.046	0.046	0.046
885	0.055	0.05	0.083	0.063
55	0.087	0.064	0.041	0.064
Mean	0.062	0.051	0.052	0.055
Control				
120	0.041	0.041	0.05	0.044
13.6	0.041	0.046	0.046	0.046
8	0.041	0.037	0.046	0.041
424	0.023	0.037	0.041	0.034
Mean	0.036	0.040	0.046	0.041
Mean treated and control	0.049	0.045	0.049	0.048

[a]Selenium concentration was higher ($P<0.01$) in calves whose dams received injectable selenium

Table 4 presents the plasma selenium concentrations of calves whose dams were supplemented with the injectable selenium. Again treated cows were able to significantly ($P<0.01$) increase plasma selenium levels of the calves above those of controls. Consistently in each of the three periods the average Se levels were higher for calves from treated cows than for controls.

Conclusion

Injectable selenium as Deposel Multidose was effective in elevating selenium in the blood and liver of cows as well as blood of calves of treated cows.

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References

Acevedo-Maldonado, N., P.F. Randel and E.O. Riquelme, 1999. Suplementación de selenio a vacas lecheras por medio de folo ruminal o inyectable. 1999. J. Agric. Univ. P.R., 83:223-228.

Chapman, H.L., L. Cox, C. Haines and G.K. Davis, 1967. Evaluation of the liver biopsy technique for mineral nutrition studies with beef cattle. J. Anim. Sci., 22:733-741.

Ellis, R., T.H. Herdt and H.D. Stone, 1997. Physical, hemathologic, biochemical and immunologic effect of supranutritional supplementation with dietary selenium in dairy cows, 1997. Am J. Vet. Res., 58:760-764.

Hansen, J.C. and Y. Deguchi, 1996. Selenium and fertility in animals and man. A review. Acta Vet. Scand., 37:19-30.

McDowell, L.R., J. Velázquez-Pereira and G. Valle, 1997. Minerales para rumiantes en pastoreo en regiones tropicales 1997. Boletín de tercera edición. Universidad de Florida (IFAS), Gainesville, FL.

SAS, 1989. SAS/STAT User's Guide, Version 6, 4th Ed., SAS Institute: Cary, NC.

Stevens, J.B., W.G. Olson, R. Kramer and J. Archambeau, 1985. Serum selenium concentrations and glutathione peroxidase activities in cattle grazing forage of various selenium concentrations. An J. Vet. Res., 46:1556-1560.

Valle, G., L.R. McDowell, D.L. Prichard, P.J. Chenoweth, D.L. Wright, F.G. Martin, W.E. Kunkle and N.S. Wilkinson, 2002. Effects of supplementing selenium to a beef cattle cow-calf herd on tissue selenium concentration. J. Anim. Vet. Adv., 2:95-101.

Whetter, P.A. and D.E. Ullrey, 1978. Improved fluorometric method for determining selenium. 1978. J. Assoc. off. Anal. Chem., 61:927-934.