S.Afr. J. Anim. Sci. 11, 183 – 186 (1981)

SELENIUM DEFICIENCY IN CATTLE

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(Key words: *Selenium deficiency, cattle)*
(Sleutelwoorde: *Selenium, tekortsimptome, beeste)*

The feeds grown in Ohio are, in general, deficient in selenium for farm animals. Patrias & Olson (1969) studied the selenium content of corn samples produced in major corn growing states west of Ohio. Selenium values in their samples ranged from 0,05 ppm to over 0,15 ppm. Mahan, Smith, Latshaw, Moxon & Cline (1973) found an average selenium content of 0,020 ppm in 62 corn samples from southwestern Ohio countries with 58% of these samples containing less than 0,020 ppm selenium. Thirteen soybean samples from southwestern Ohio averaged 0,067 ppm selenium. In February, 1974, the U.S. Food and Drug Administration approved the addition of inorganic selenium at a level of 0,1 ppm to swine and chicken diets and 0.2 ppm to turkey diets (Schmidt, 1974). The approval of selenium additions to sheep, dairy cattle and beef cattle was delayed until 1979 (Hile, 1979) even though deficiency symptoms has been observed and reported over a period of several years.

Lamb losses due to "stiff lamb" disease were observed in the "Experiment Station" flocks before selenium was shown to be an essential element in 1957 (Schwartz & Flotz, 1957). Muth, Oldfield, Remmert & Schubert (1958) demonstrated that selenium, and vitamin E were effective in the treatment of "stiff lamb" disease (white muscle disease). Reports on the incidence of white muscle disease in calves are not as numerous as in lambs.

Table 1

Blood and milk selenium levels of Angus cows

John Wise Angus Herd – May 31, 1972		
Cow	ppm Se Blood Plasma	ppm Se Milk
120	0,027	0,003
87	0,040	0,003
28	0,064	0,009
5	0,050	0,0025
7 (treated)	0,107	0,0025
96	0,052	0,005

A high incidence of white muscle disease in beef calves came to my attention in May, 1972, in a herd of Angus cattle near Wooster, Ohio. This Angus breeder had experienced deaths in newborn calves which appeared to be weak and stiff when they attempted to stand and walk. Blood and milk samples were taken from a number of cows soon after calving and blood samples were also obtained from young calves. Selenium levels in the blood samples were low, so treatment with injectible selenium-vitamin E preparation was initiated. The treatment with selenium was reflected in the blood levels of the element and death losses were prevented (Tables 1 & 2). Feed samples taken on the farm were low in selenium content: hay (dry) 0,038 ppm and grass (dry) 0,042 ppm selenium. Death losses in calves in this Angus herd are under satisfactory control with added selenium in cow diets and injection of calves with selenium-vitamin E at birth.

Beef cow-calf trials were conducted in Virginia and in Florida to obtain data on selenium content of tissues in connection with a petition for approval by the U.S. F.D.A.

Table 2

Blood selenium levels of Angus calves

John Wise Angus Herd – May, 1972		
Calves #	Birth Date	Se on 5/31/72
120 untreated	5/30/72	0,034
87 untreated	5/30/72	0,044
43 untreated	5/30/72	0,055
5 untreated	5/30/72	0,038
7 untreated	5/27/72	0,066
139 BO-SE	4/22/72	0,098
24 BO-SE	5/26/72	0,091
BO-SE	5/25/72	0,108
3 BO-SE	Late March	0,086
BO-SE	Late March	0,074
202 BO-SE	1/26/72	0,035

for the addition of selenium as a supplement to beef cattle rations. In these trials the selenium supplementation did not significantly increase the live weight of cows or birth weight of calves, but it did tend to increase the weaning weight of the calves (Ammermon, Chapman, Bouwman, Fontenat, Bagley & Moxon, 1980). Cows were fed protein supplement in the form of soybean meal or linseed meal. Sodium selenite was added to the soybean meal to equal the amount of natural selenium in the linseed meal. Based on analytical values the cows on the soybean meal + inorganic selenium recieved 0,980 mg selenium per day and those on linseed meal 0,969 mg selenium per day. The muscle of calves from the cows on linseed meal contained 0,076 ppm selenium as compared with 0,042 ppm selenium for muscle of calves from cows fed the soybean meal plus inorganic selenium. Inorganic selenium as sodium selenite is subject to reduction by rumen microorganisms (Cousins & Caixney, 1961) and is thus made less available for absorption than organic forms of selenium which occur naturally in feeds. The soybean meal used in the Virginia trial (Ammermon *et al.*, 1980) contained 0,056 ppm selenium and the linseed meal contained 0,451 ppm selenium. Kincaid, Miller, Neathery, Gentry & Hampton (1977) fed Holstein calves on a basal diet containing 0,3 ppm selenium and found that supplementation with either 0,1 ppm or 1,0 ppm selenium or sodium selenite did not effect calf gains.

In connection with a petition for use of selenium in dairy rations, producing dairy cows were fed rations with supplemental selenium (Conrad & Moxon, 1979). The addition of selenium as sodium selenite to silage and grain, which were considered selenium deficient, resulted in 4,8% of the added selenium being transferred to milk. The addition of selenium in an organic form (in dried brewers grains) resulted in 19% being secreted in the milk.

Some feedlot trials have been conducted involving different levels of selenium intake. Burroughs, Kohlmeier, Borringer, Kawashima & Trenkle (1963) added selenium at levels of 0,05 ppm and 0,10 ppm as sodium selenite in high concentrate rations. They reported significantly faster gains in the cattle with the added selenium.

Two feedlot studies were conducted in Ohio, involving 96 Hereford steers, to assess the relationship between selenium adequacy and protein requirements of growing and finishing cattle (Byer & Moxom, 1980). The first

Table 3

*Performance and Plasma Parameters of Growing Cattle Fed Various Protein and Selenium Levels (98 days)**

	Protein level, %						
	11,6		14,1		16,5		SEM
	Selenium level						
	Basal	Added	Basal	Added	Basal	Added	
No steers	16	16	16	16	16	16	
Initial wt., kg	234,3	230,9	232,7	235,6	232,0	229,5	
ADG, kg [g]	0,97 [a]	1,05 [a]	1,08 [a]	1,10 [a,b]	1,21 [b,c]	1,25 [c]	0,06
Dry matter per unit gain [g]	5,96 [a]	5,56 [a]	5,64 [a,b]	5,55 [b,c]	5,12 [c]	5,01 [c]	0,15
Crude protein, %	11,6	11,6	14,1	14,1	16,5	16,5	
Dietary Se, ppm	0,048	0,131	0,048	0,133	0,049	0,132	
Plasma Se[h] ppm (98 days)	0,024 [d]	0,045 [e]	0,027 [d]	0,045 [e]	0,029 [d]	0,046 [e]	0,001
Plasma urea nitrogen, (mg/100 ml)[g]	7,6 [d]	8,0 [d]	10,2 [e]	11,1 [e]	15,2 [f]	15,2 [f]	0,94

a, b, c, d, e, f Means within same line bearing different superscript letters differ ($P < 0{,}05$; $P < 0{,}01$).

g Main effect of protein level was significant ($P < 0{,}01$).

* from data by Byers & Moxon (1980)

Table 4

*Performance and Tissue Selenium Levels of Finishing Cattle Fed Various Levels and Sources of Protein and Selenium - 112 days**

	Protein Source						
	Basal		Soybean meal Selenium level		Linseed meal		SEM
	Basal	Added	Basal	Added	Basal	Added	
No. animals	16	16	16	16	16	16	
Initial weight	342,2	338,8	343,8	338,5	340,6	340,8	
Av. daily gain	1,15 [a]	1,11 [a]	1,27 [b]	1,28 [b]	1,26 [b]	1,27 [b]	0,04
Dry matter per unit gain	6,19	6,37	5,78	5,87	6,03	6,06	0,21
Selenium mineral supplement	...	0,42	...	0,43	...	0,42	
Crude protein % of diet	9,8	9,8	12,0	11,9	12,2	12,2	
Dietary selenium level, ppm	0,043	0,117	0,043	0,112	0,121	0,189	
Liver Se, ppm	0,63 [c]	0,88 [d]	0,65 [c]	0,90 [d]	1,15 [e]	1,15 [e]	0,024

[a, b, c, d, e] Means within same line bearing different superscript letters differ (P < 0,05; P < 0,01)
[f] Adjusted to average dressing percentage of 63,75
* from data by Byers & Moxon (1980)

(growing) study was a 98-day growing trial with feeder steers as they grew or gained from an average of 230 kg up to 340 kg (Table 3). They were fed diets containing corn silage 55% (dry matter basis) plus shelled corn and were supplemented with soybean meal and sodium selenite to provide three levels of protein, each with and without added selenium. There were 2 lots of 8 cattle on each treatment. After the 98-day growing period the cattle were all reassigned to a 112 day finishing period (Table 4). They were fed diets including whole shelled corn and 7% corn silage with basal or added protein as soybean meal or linseed meal with or without supplemental selenium as sodium selenite. In the growing period, cattle fed on the three protein levels consumed 676, 858 and 1 026 grams crude protein per day. They gained 1, 01, 1,09 and 1,23 kg/day over the 98 days. Feed conversion averaged 5,76, 5,60 and 5,07. The rate (P < 0,01) and efficiency of growth were improved by 23% and 12% respectively, for the 16,5% protein and 14,1% protein over the basal protein level (11,6% protein). Plasma urea nitrogen increased (P < 0,01) with protein level (7,8, 10,7, 15,2 mg/100 ml). Cattle responded positively to selenium in rate and efficiency of gain, with the greatest response in those fed on the lowest protein level. Plasma selenium levels were marginal for the cattle fed the basal diets, indicating a deficiency, and increased (P < 0,01) about two-fold with supplemental selenium 0,027 to 0,045 ppm selenium).

Table 5

Calves in John Wise Herd not treated with Selenium and Bled July 16, 1975

Calf No.	Plasma Selenium
173	0,007 ppm
50A	0,013 ppm
302	0,013 ppm
233	0,022 ppm
307	0,011 ppm

During the finishing phase of this feedlot trial supplmental selenium added in the inorganic form (sodium selenite) or the organic form in linseed meal did not alter performance. These data indicate that selenium levels are most critical during early stages of growth when cattle are fed diets marginal or deficient in protein. Selenium nutrition in dairy cattle is much more critical than in beef cattle probably because the high producing dairy cow is under much more stress and tends to deplete her tissues of selenium by secreting it through the milk. We have had the opportunity to study selenium requirements of dairy cattle in connection with an O.A.R.D.C. study of metabolic disturbances in parturient cows associated with dietary deficiencies in corn-based rations (high corn silage rations).

It was observed that retained placenta was absent in a group of selenium-supplemented cows (0,066 ppm added selenium) compared to an incidence of over 50% in the unsupplemented groups (Julien, Conrad, Jones & Moxon, 1976). In a field trial in Ohio involving 193 parturient cows it was found that an intra muscular injection of 50 mg of selenium as sodium selenite plus 680 IU of alpha tocopherol acetate (vitamin E) 20 days prepartum reduced the incidence of retained placenta (Julien, Conrad & Moxon, 1976). The incidence in the control (untreated) cows was 51,2% while in the treated cows it was 8,8%.

The mature dairy cows require selenium for uterine health. The selenium may be provided by injection of 50 mg 20 days prepartum or by feeding 1,0 mg selenium per day the last 60 days of the dry period (Conrad & Moxon, 1978). It is my opinion that dairy cows should have a plasma selenium level near 0,1 ppm and beef cattle probably need plasma levels of 0,06 to 0,07 ppm. In young calves it is advisable to keep plasma levels near 0,05 ppm selenium to avoid muscular dystrophy and other problems (Table 5).

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