Lack of Growth Response in Selenium Deficient Veal Calves Injected with Selenium Midway Through Fattening

Steven E. Wikse, *D.V.M.,** **Dale D. Hancock,** *D.V.M., Ph.D.,** **Robin Van Horn Ecret,** *MS.,** *and* **Robert I. Krieger,** *Ph.D.**
College of Veterinary Medicine
Washington State University
Pullman, WA 99164

Summary

Growth rates and infectious disease incidence were monitored following Se/vitamin E supplementation of 2 batches of approximately 2 month old veal calves with serum selenium levels ranging from 0.02 to 0.04 ppm. Results from a total of 55 control calves and 59 Se-treated calves were evaluated. There were no significant differences in slaughter weight between control calves and those injected with 5 mg Se and 50 mg Vitamin E (p=.61). Mean carcass weights at approximately 4 months of age in the 2 batches of calves for controls were 112.4 kg and 119.9 kg, and for Se-treated calves were 111.2 kg and 118.8 kg. The incidence of infectious disease determined from antibiotic treatment records also did not differ significantly between control and Se-treated calves (p=.24). In batch 1, the mean number of antibiotic injections during the last 7 weeks of feeding was 2.1 for control and 1.4 for Se-treated calves. One or more antibiotic injections were required by 46% of control and 31% of Se-treated calves. In batch 2, the mean number of antibiotic injections during the last 8 weeks of feeding was 2.0 for control and 1.5 for Se-treated calves. One or more antibiotic injections were required by 41% of control and 27% of Se-treated calves. Full evaluation of any potential health effect would require larger sample sizes.

Selenium (Se) is an essential trace element necessary for optimal health of cattle. Deficiencies in calves result in several problems, including nutritional myodegeneration (NMD),[1] unthriftiness,[2] impaired immunity[3 4] and reduced weight gains.[5 6 7 8] Selenium is an essential component of glutathione peroxidase (GSH-Px) and exerts its presently known biological functions through activity of that enzyme.[9] GSH-Px protects cells from peroxidative damage by reducing hydrogen peroxide and lipid peroxides.

Selenium supplementation of young calves on Se deficient diets sometimes results in increased weight gains. Weaned dairy,[5] dairy/beef,[6] and beef calves,[7] and nursing beef calves[8] on Se deficient pastures had improved weight gains when injected with Se/Vitamin E preparations. Nursing beef calves of Se deficient cows placed on a high Se salt supplement also had improved weight gains.[10] In contrast, other nursing beef calves[11] on Se deficient pastures and dairy calves[12 13 14] fed Se deficient milk replacers had no increase in growth rates when supplemented with Se. Thus, a benefit in calf growth rate from Se supplementation can only be expected under certain situations of Se deficiency.

Previous studies on Se supplementation of milk-fed calves have been limited to laboratory experiments utilizing small sample sizes.[12 13 14 15] This report describes a field trial on the effect of Se/vitamin E injections on growth rates and infectious disease incidence of veal calves of marginal to deficient Se status.

Materials and Methods

The study was conducted in an Eastern Washington veal operation. Newborn Holstein bull calves originating from Western Washington farms were transported several hundred miles to the veal unit. Batches of approximately 60 calves were raised on slatted wooden stalls overlying a manure pit in heated and mechanically ventilated rooms. On arrival, processing included injections of iron and Se/vitamin E, and vaccinations with intranasal modified live virus IBR/PI3 and *Clostridium perfringens* type C and D toxoid. Followup disease prophylaxis consisted of boosters of the 2 vaccines in 3 weeks and administration of iron by injection or orally as needed based on periodic hemoglobin determinations. Calves were fattened for 4 months on an all-milk diet containing 0.10 mg Se (sodium selenite) and 136.0 mg vitamin E (DL – α tocopheral acetate) per kilogram dry matter.

Two batches of calves were used in the trial. In addition to the Se/vitamin E injection given at entry, a 1 ml intramuscu-

**Field Disease Investigation Unit, Department of Veterinary Clinical Medicine and Surgery.*
***Washington Animal Disease Diagnostic Laboratory, Department of Veterinary Comparative Anatomy, Pharmacology and Physiology.*

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lar injection containing 5 mg Se and 50 mg vitamin E[a] was given to calves in odd numbered stalls in batch 1 at 59 days and batch 2 at 53 days. There were 32 control and 31 treated calves in batch 1 and 28 control and 31 treated calves in batch 2. Serum samples were collected for Se analysis[16] from 5 randomly selected calves from control and treatment groups in each batch just before the second Se injection and at slaughter.

Carcass weights were recorded at slaughter. The number of antibiotic injections given to each calf from 9 weeks to slaughter was obtained from owner records as a measurement of infectious disease incidence.

Differences in mean slaughter weights were tested for significance using 2-way analysis of variance with Se/vitamin E treatment and batch as effects. Differences in disease incidence rates were tested for significance using log linear analysis with batch, Se/vitamin E treatment and antibiotic treatment (none, 1 or more) as variables.[17 18 19]

Results

The day before the second Se injection, calves in both rooms had serum Se levels ranging from 0.02 to 0.04 ppm (Table 1). Their serum Se levels the day before slaughter were unchanged or within 0.01 ppm. of initial levels (Table 1). Numbers of calves in each group declined slightly during the trial. Five calves were lost to early slaughter, 1 calf was slaughtered late, 1 calf was culled, and 1 calf died (Table 2). Data was evaluated from 28 control calves and 29 Se-treated calves in batch 1 and 27 control calves and 30 Se-treated calves in batch 2.

There were no significant differences in slaughter weight between control calves and those that received a second Se/vitamin E injection (p=.61). Mean carcass weights in the 2 batches of calves for controls were 112.4 kg and 119.9 kg; for calves receiving an additional Se/vitamin E injection mean weights were 111.2 kg and 118.8 kg (Table 2). Calves of batch 2 were fed 8 days longer than batch 1.

The incidence of infectious disease determined from antibiotic treatment records did not differ significantly between Se-treated and untreated groups (p=.24). In batch 1, the mean number of antibiotic injections during the last 7 weeks of feeding was 2.1 for control and 1.4 for Se-treated calves (Table 2). One or more antibiotic injections were required by 46% of control and 31% of Se-treated calves. In batch 2, the mean number of antibiotic injections during the last 8 weeks of feeding was 2.0 for control and 1.5 for Se-treated calves (Table 2). One or more antibiotic injections were required by 41% of control and 27% of Se-treated calves.

TABLE 1. Serum Selenium concentration (ppm) in 5 randomly selected calves from control and treatment groups in 2 batches of veal calves*

Batch 1					
	Controls			Treated	
Calf	59 Days	114 Days	Calf	59 Days	114 Days
196	0.04	0.03	260	0.03	0.04
199	0.03	0.03	264	0.03	0.03
259	0.03	0.03	266	0.03	0.04
269	0.03	0.03	313	0.03	0.04
320	0.02	0.02	R-38	0.04	0.04
Means	0.030	0.028		0.032	0.038

Batch 2					
	Controls			Treated	
Calf	53 Days	122 Days	Calf	53 Days	122 Days
192	0.03	0.03	311	0.03	0.03
324	0.02	0.03	318	0.03	0.03
348	0.02	0.02	337	0.02	0.03
370	0.02	0.03	349	0.03	0.03
374	0.03	0.02	377	0.03	0.03
Means	0.024	0.026		0.028	0.030

* Treated calves received an injection containing 5 mg Se and 50 mg vitamin E at 59 days (batch 1) or 53 days (batch 2) after arrival in the veal unit. Serum samples were taken prior to injection and at slaughter.

[a] *Mu-SE, Schering Corp., Kenilworth, NJ.*

TABLE 2. Summary of Results.

	Batch 1		Batch 2	
	Controls	Treated	Controls	Treated
Number of calves start of trial	32	31	28	31
Calves lost from groups				
Early slaughter	2	2	—	1
Late slaughter	1	—	—	—
Culled	1	—	—	—
Died	—	—	1	—
Number of calves at slaughter	28	29	27	30
Mean Carcass Weight(kg)	112.4[a]	111.2[a]	119.9[b]	118.8[b]
Std error	3.2	3.2	3.3	3.1
Mean Number antibiotic injections per calf*	2.1[a]	1.4[a]	2.0[a]	1.5[a]
Percentage of calves requiring 1 or more antibiotic injections	46[a]	31[a]	41[a]	27[a]

* During the period 9 wks to slaughter.

Means or rates sharing a common superscript did not differ significantly (p > .10).

Discussion

Normal bovine serum Se values range from 0.08 to 0.30 ppm.[20] Calves in this study were of marginal to deficient Se status with serum Se levels ranging from 0.02 to 0.04 ppm. However, this degree of Se deficiency may not be great enough to affect growth rates. Extremely low whole blood

Se levels of 0.01 ppm[7] and 0.02 ppm[6] were present in trials where Se supplementation dramatically increased growth rates. In contrast, calves in this trial were not as deficient, because their whole blood Se concentrations would be expected to be over double their serum Se levels.[21]

Selenium requirements are influenced by levels of other dietary components such as vitamin E, sulphur amino acids, and polyunsaturated fatty acids.[20] In this study, the Se requirement may have been reduced by amounts of vitamin E in the milk replacer several times the recommended 15 to 35 mg/kg dry matter.[22] Vitamin E and Se both act as antioxidants and it has been noted that adequate levels of one may reduce the requirements for the other.[23] Depressed growth rates of lambs fed milk replacers deficient in both Se and vitamin E were shown to be corrected by supplementation with either Se or vitamin E, however, Se was more effective in lambs less than 9 weeks of age.[24 25]

The low activity level of veal calves raised in small individual stalls also may have reduced the Se requirement in this trial. Inhibition of muscular activity markedly reduced the amount of muscle degeneration of lambs on a diet resulting in NMD.[26] The authors of that study concluded that muscles of animals on a Se deficient diet become susceptible to degeneration only when exercised.

Recent findings on the necessity of Se for optimal bacteriocidal activity of neutrophils[3 4] and production of immunoglobulins[27 28] suggest that Se deficient animals may be at greater risk to infectious disease. That relationship was not found in this study, possibly because the sample sizes were too small or serum Se levels are not reliable indicators of susceptibility to infectious disease.

Practitioners who assist clients in production management would be aided by a method of predicting whether Se supplementation of Se-deficient calves would benefit growth rates. Whole blood Se levels and/or erythrocyte GSH-Px activity are commonly recommended to evaluate Se status, but may not be adequate on their own, because they reflect Se intake over the past several months and are not accurate measurements of current Se intake.[29] During erythropoiesis GSH-Px with its associated Se is incorporated into erythrocytes which have a lifespan of 135 to 162 days in the circulation.[30] Thus, erythrocyte GSH-Px levels are slow to respond to changes in Se intake. Whole blood Se behaves similarly, because the Se in erythrocyte GSH-Px makes up a large portion of Se in whole blood.[29] Studies have demonstrated that following a change in dietary Se intake, liver, plasma, or serum Se concentrations reflect the new Se status of cattle months before whole blood Se levels or erythrocyte GSH-Px activity.[21 31] Selenium concentrations in plasma, serum, and liver were the best indicators of current dietary Se intake, however, it was speculated that erythrocyte GSH-Px activity may be useful in predicting which calves might benefit from Se supplementation. Growth rates of pastured beef steers with erythrocyte GSH-Px levels below 1000 mU/ml were improved following Se injections.[6]

The optimal estimate of Se status relating to growth rate may be muscle GSH-Px activity. If that is so, the blood analysis that correlates best with muscle GSH-Px activity may predict which calves would benefit from Se supplementation. There have been studies in cattle relating muscle GSH-Px activity to other measurements of Se status at one point in time,[32 33] however, they did not follow dynamics of the relationships during changes in Se status.

Depressed growth rates of low Se calves may be due to mild subclinical NMD. If that is so, plasma creatine phosphokinase (CPK) levels may aid in prediction of response to Se supplementation. Activity of plasma CPK has been shown to be an excellent indicator of subclinical NMD in lambs due to its high correlation with amount of muscle damage.[34] Growth rates of Se deficient dairy calves with normal serum CPK activity were not improved by Se supplementation.[14] Elevated plasma CPK levels were associated with decreased growth rates in lambs of ewes on a Se deficient diet.[35] Selenium supplementation of the ewes' diet resulted in improved weight gains and normal plasma CPK levels in their lambs.

In this field trial, Se supplementation of calves with marginal to deficient serum Se levels did not significantly benefit growth rates or health. Full evaluation of any potential health effect would require larger sample sizes. Identification of laboratory tests capable of predicting whether Se supplementation of Se-deficient calves would improve growth rates awaits further research.

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