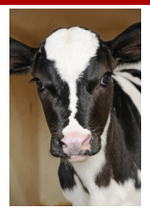

Impact of different routes of selenium administration on serum selenium, growth, and health of Holstein calves.

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Introduction

• Male Holstein calves (n=23) reared in Se (selenium) deficient Ohio and supplemented 0.3 ppm Se in whole milk commencing at 3 d age noted increased 4 wk body-weight gain (P<0.01) and numerically reduced incidence of pneumonia (30% and 0%, NSD) compared to non-Se supplemented control (Moser *et al.* 1978).

• Injectable Se (3 mg) and vitamin E (136 IU) administered at birth increased serum Se concentration (P<0.001), provided a protective effect against rotavirus infection (P=0.05) and reduced odds of treatment for diarrhea (P=0.04) in a multi-farm (n=39) study of 835 dairy calves in Se deficient Ontario. The average serum Se concentration (SD) in treated calves was 0.08 µg/mL (0.02), vs. 0.06 µg/mL(0.01) in control (Leslie *et al.* 2019).

• Serum IBRV antibody titer increased after infectious bovine rhinotracheitis virus inoculation in Se supplemented Holstein calves post-weaning compared to Se deficient calves. (Reffett *et al.* 1988).

Objective

The objective of this study was to investigate the effects of administering different routes, quantities and sources of Se and their effects on serum Se and vitamin E concentrations, on liver levels of Se, and on the health and growth of male Holstein calves.

Material and Methods

Three to 10 d old male Holstein calves (n=80) sourced from farms and auctions (BW=48.7 ±3.74 kg) were randomly assigned to receive one of 5 Se/E treatments at arrival 1.) injection of sodium selenite and vitamin E (1 ml/45 kg BW containing 3 mg of Se from sodium selenite and 136 IU of vitamin E; Dystocel, Zoetis, Kirkland, QC) (INJ n=16), or 2.) oral administration of 10 mg of Se from Se yeast and 2500 IU vitamin E (SY10 n=16) or 3.) oral administration of 3 mg Se from Se yeast and 2500 IU vitamin E (SY3 n=16) or 4.) oral administration of 3 mg Se from sodium selenite and 2500 IU vitamin E (SS3 n=16) or no supplemental Se or vitamin E (CON, n=16). Se yeast source was Sel-Plex (Alltech, Nicholasville, KY). Vitamin E source was d,l-alpha-tocopheroal acetate in all instances. SY10, SY3, and SS3 were administered in 10 g powder (dextrose carrier) blended in 30 ml water dosed orally via syringe.

Calves were fed 2x/d 26% CP, 17% fat non-med, no-additive CMR containing 0.3 ppm Se (50% Na selenite, 50% Se yeast) and 70 IU vitamin E/kg. Calves were offered 37.8 kg CMR over 56 d in a step-up, step-down fashion and pelleted starter (20% CP, 0.13 ppm Se, 95 IU/kg vit. E) commencing d 14 until wk 8 and then transitioned to a corn and pellet ration with 2% straw (18.1% CP, 0.3 ppm Se, 36 IU vit. E/kg) to d 77 study end. Se source in both grains was Selisseo (Adisseo) Se yeast. Grain intake was measured weekly. Calves were individually housed until weaned and then housed in groups of 5 in a mechanically ventilated grain-fed veal facility in Ontario.

Incidence of individual medical treatments, mortality and milk refusals were recorded. Calves were scored daily for fecal consistency for the first 28 d using a scale of 0 = normal, 1 = semi-formed or pasty, 2 = loose, and 3 = watery feces (Renaud, 2020) and for respiratory disease daily throughout the trial with a score ≥5 abnormal (Love, 2014). Body weight was taken weekly using a digital scale. Grain was weighed back weekly and new grain added was weighed. Blood was collected from calves via jugular venipuncture at arrival and days 1, 2, 14, 35, and 56. The blood was submitted to the Animal Health Laboratory (Guelph, ON) for enumeration of Se and vitamin E. In addition, d 56 a liver biopsy was taken and submitted to the Animal Health Laboratory to determine the level of liver Se.

Statistical analyses were conducted in Stata 14 (StataCorp, TX). A cox proportion hazard model was built to evaluate the impact of treatment groups on the risk of morbidity and mortality, whereas a mixed linear regression model was built to evaluate the impact on ADG and liver Se levels. A generalized linear model was used to evaluate fecal scores and respiratory scores.

Results & Conclusion

The level of serum total protein (*P*=0.56) did not differ between groups (mean 5.57 ±0.61 g/dL). 27.5% of calves had FPT. NSD (P=0.47) between groups with respect to source of calves. 3 (2 pneumonia, 1 diarrhea), 1 (pneumonia), 0, 0, and 1 (diarrhea) calves died in CON, INJ, SY10, SY3, and SS3, respectively.

A cox proportional hazard model was used to compare each treatment group to CON and noted a.) NSD in mortality, b.) treatment for diarrhea w/oral meloxicam tended (P=0.09) to be less for SY10, c.) NSD in treatment for diarrhea w/trimethoprim sulphadoxine, d.) treatment for respiratory disease with florfenicol tended (P=0.09) to be less in INJ.

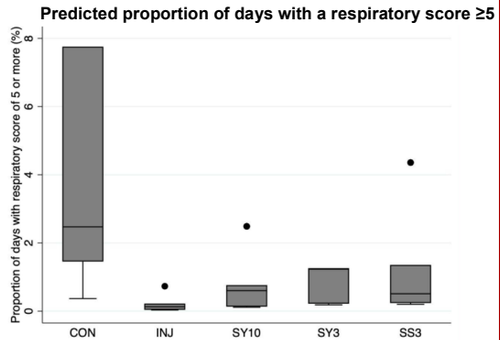
A generalized linear model was used to compare each treatment group to CON and noted a.) proportion of scoring periods with a fecal score ≥2 in the first 28 d was less for INJ (P=0.006) and SY10 (P=0.03), b.) INJ calves tended (P=0.06) less proportion of scoring periods w/fecal score 3, c.) proportion of scoring periods with a respiratory score of 0 was less (P=0.05) in INJ and, d.) proportion with a respiratory score of ≥5 (requiring antibiotic therapy) was less (P=0.002) in INJ.

A linear regression model found no differences comparing respective treatment group to CON in BW d 0, 7, 14. 21, 28, 35, 42, or 49, and noted greater pre-wean ADG for SS3 (P=0.03) and trend (P=0.08) for INJ vs. CON, and 77 d ADG for INJ (P=0.03) and SS3 (P=0.02) vs. CON.

Whole blood Se at arrival avg. 0.054 ±0.019 µg/mL (P=0.65) and vitamin E mean level was 4.34 ±2.54 umol/L (P=0.68) with no differences between groups. Blood Se was greater (P<0.05) in calves in the INJ, SY10, SY3, and SS3 group vs. CON at d 1 and 2 after arrival. No differences between groups in blood Se d 0, 14, 35, or 56. D 56 liver Se was 0.86 ±0.28 µg/g reported on an as-is basis, NSD between groups.

Conclusions:

- INJ & SY10 noted ↓ incidence of diarrhea vs. CON
- INJ noted ↓ incidence of pneumonia vs. CON
- INJ, SY10, & SS3 noted ↑ 77d ADG vs. CON
- INJ, SY10, SY3, & SS3 ↑ blood Se d 1 & 2 vs. CON



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	CON	SY10	SY3	SS3	INJ
Number (n) of calves	16	16	16	16	16
Mortality (n); NSD^	3	0	0	1	1
Arrival Serum Total Protein (g/dL); NSD	5.53	5.58	5.66	5.6	5.46
Days fecal score ≥2 (mean number of d)	4.4 ±3.8	1.8 ±2.8	4.4 ±3.8	3.5 ±3.5	2.0 ±2.2
Days fecal score 3 (mean number of d)	2.6 ±3.0	1.2 ±2.2	3.1 ±3.6	2.5 ±3.1	1.2 ±1.9
% of 1st 28 d w/fecal score ≥2*	17.2 ±17.6%^{a}	6.5 ±10.1%^{b}	15.7 ±13.6%^{a}	14.8 ±17.0%^{a}	7.0 ±8.0%^{b}
% of 1st 28 d w/fecal score 3*	10.6 ±14.3%^{x}	4.4 ±7.9%^{x}	11.1 ±12.8%^{x}	11.2 ±16.4%^{x}	4.4 ±6.7%^{y}
Treated (oral meloxicam) for diarrhea^	56.3%^{x}	25%^{y}	81.3%^{x}	56.3%^{x}	37.5%^{x}
Treated (trimethoprim sulphadoxine) diarrhea^	43.8%	25.0%	50.0%	37.5%	18.8%
% of time respiratory score 0*	81.7 ±19.2%^{x}	88.2 ±11.0%^{x}	82.5 ±14.2%^{x}	83.5 ±14.0%^{x}	90.2 ±7.6%^{y}
% of time respiratory score ≥5*	3.9 ±6.8%^{a}	0.8 ±2.1%^{a}	0.9 ±2.4%^{a}	1.3 ±2.4%^{a}	0.2 ±0.4%^{b}
% treated for pneumonia (florfenicol)^	37.5%^{x}	25.0%^{x}	18.8%^{x}	31.3%^{x}	12.5%^{y}
Pneumonia treated 2x (% of treated calves) NSD#	83.3%	50.0%	100.0%	40.0%	50.0%
Pneumonia treated 3x (% of treated calves) NSD#	40.0%	0.0%	66.7%	50.0%	0.0%
Pneumonia treated 4x (% of treated calves) NSD#	50.0%	n/a	100.0%	0.0%	n/a
Initial body weight (mean BW) (kg)*	49.1	48.9	48.4	48.7	48.9
Weaning mean BW (kg)*	92.2^{a,x}	95.8^{a,x}	91.4^{a,x}	99.2^{b}	97.2^{y}
D 77 mean BW (kg)*	128.9^{a}	137.6^{b}	131.9^{a}	136.7^{b}	135.1^{b}
Prewean ADG (kg)*	0.77 ±0.14^{a,x}	0.82 ±0.18^{a,x}	0.77 ±0.18^{a,x}	0.91 ±0.18^{b}	0.86 ±0.18^{y}
Postwean ADG (kg)*	1.77 ±0.36^{a,x}	2.0 ±0.36^{y}	1.91 ±0.32^{a,x}	1.77 ±0.32^{a,x}	1.81 ±0.27^{a,x}
ADG d 77 (kg)*	1.04 ±0.14^{a}	1.13 ±0.18^{b}	1.09 ±0.18^{a}	1.13 ±0.14^{b}	1.13 ±0.18^{b}
Prewean (d 1 - 56) Feed:Gain (grain + CMR) NSD	1.93 ±0.44	1.78 ±0.39	1.98 ±0.54	1.66 ±0.3	1.72 ±0.25
Postwean (d 56 - 77) Feed:Gain (grain) NSD	2.53 ±0.35	2.27 ±0.58	2.32 ±0.43	2.49 ±0.62	2.41 ±0.31
D 1 - 77 Feed:Gain (grain + CMR) NSD	2.17 ±0.29	1.98 ±0.37	2.1 ±0.3	1.96 ±0.25	2.01 ±0.20
^{a,b}Means within a row different superscripts differ ($P \leq 0.05$)					
^{x,y}Means within a row different superscripts differ ($P \leq 0.10$)					
*Linear regression model respective Se treatment vs. control					
^Cox proportional hazards model respective Se treatment vs. control					
$^{\#}\chi^2$ statistic					

Figure 6. Predicted means of body weight as determined using a mixed repeated measures linear regression model.

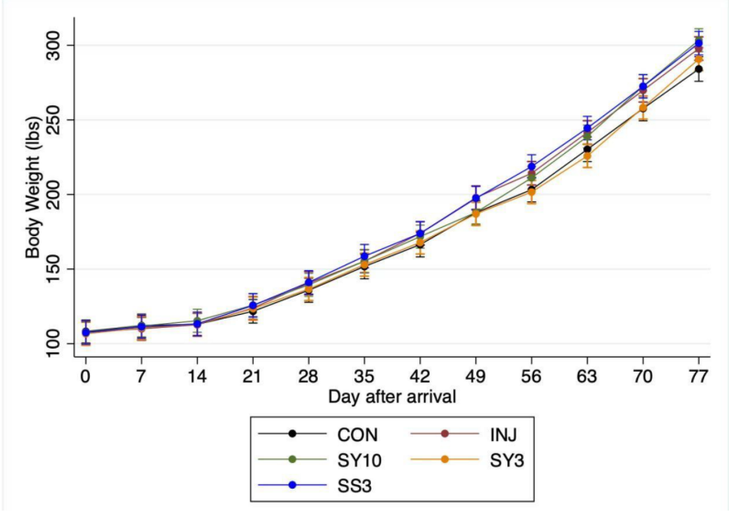

Figure 7. Predicted means of serum selenium as determined using a mixed repeated measures linear regression model.

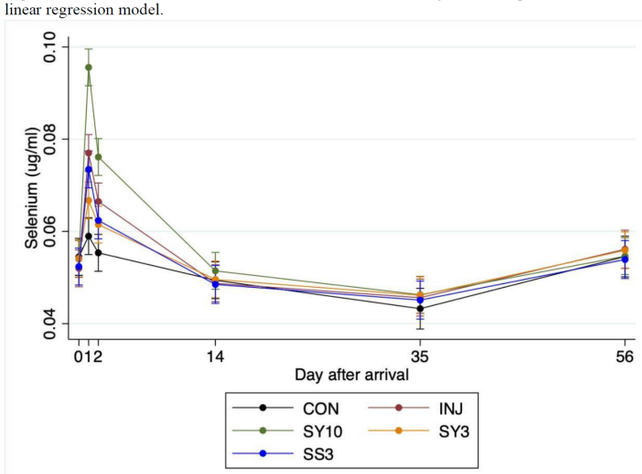

Figure 9. Predicted means of serum Vitamin E as determined using a mixed repeated measures linear regression model.

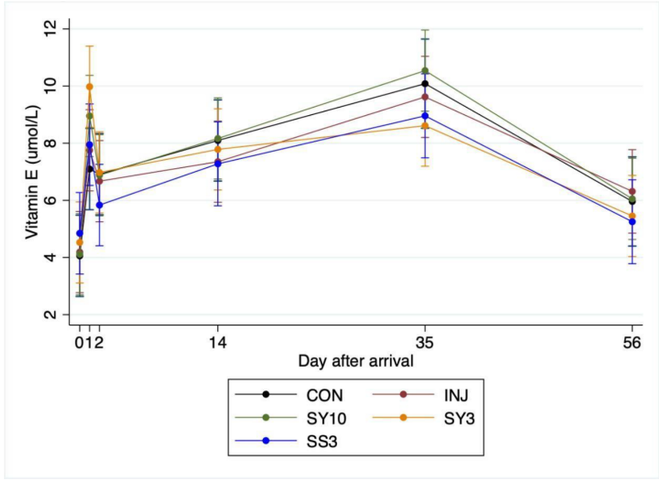

Figure 8. Levels of selenium in the liver by treatment group