Tolerance of Inorganic Selenium in Ruminants During Gestation and Lactation

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Summary
The objectives of this 72-wk study were to evaluate and compare the effects of six dietary levels of inorganic Se (0.2-20 ppm) on blood and tissue Se concentrations of mature ewes during lamb production and to determine the maximum tolerable level of Se. Serum, whole blood, wool, brain, diaphragm, psoas major muscle, liver, kidney, and heart Se increased with increased levels of Se in the diet (P<0.05). Microscopic evaluation of liver, kidney, diaphragm, heart, and psoas major muscle did not reveal evidence of Se toxicosis in ewes on any dietary Se level. Feedings up to 12 ppm selenium Se to ewes under stresses of production (i.e., gestation and lactation) for 72 wk did not produce any clinical or pathologic signs of Se toxicosis. Ewes fed 16 and 20 ppm Se produced some signs of Se toxicosis. It would appear that ruminants could tolerate at least 10 ppm Se for long periods of time.

Introduction
Selenium deficiency is a serious problem for Florida cattle. Because of potential toxicity, the Food and Drug Administration (FDA) limits the levels of Se allowed for supplementation to livestock. The suggested Se tolerance level of 2 ppm, however, makes no distinction between monogastrics and ruminants (NRC, 1980). The maximum tolerable level of Se suggested by the NRC for ruminants has been underestimated and needs to be further evaluated.

The purpose of this study was to determine the maximum tolerable level of Se for growing ruminants.

Procedure
This experiment utilizing ewes during two lambings was conducted at the University of Florida Sheep Nutrition Unit located in North Central Florida. Forty-one, four-year-old Rambouillet ewes were randomly assigned to one of six dietary treatments for a 72-wk study. Six dietary treatments were 0.2, 4, 8, 12, 16, or 20 ppm Se as sodium selenite (as-fed basis) added to a corn-soybean meal basal diet. Blood Se and ewe BW were measured at 4-wk intervals and samples of brain, diaphragm, heart, hoof, kidney, liver, and psoas major muscle were collected at experimental termination.

Albumin and serum enzymes were analyzed in order to determine possible tissue breakdown as a result of Se toxicosis. Tissue samples were also microscopically evaluated for evidence of Se toxicosis. Data were analyzed statistically as a complete randomized design.

Results
Ewe BW was not affected by dietary Se level (P = 0.69) or dietary Se level x time interaction (P = 0.56). Lambs crops or deaths for both years were not affected by dietary Se concentration.

During all stages of lamb production, serum Se increased in a linear fashion (P<0.001) as dietary Se level increased (Table 1).

Wool Se increased linearly (P<0.001) as dietary Se increased. Brain, diaphragm, heart, (Fig. 1) and psoas major muscle Se also increased linearly as Se increased, while liver Se responded quadratically and hoof and kidney Se responded cubically (Pd<0.05) to treatment level.

Though serum, whole blood and wool Se concentrations were elevated in ewes receiving increased dietary Se, no time did serum, whole blood or wool Se concentrations reach levels previously reported as toxic and a pattern of clinical signs of Se toxicosis was not observed. Histopathological microscopic evaluation of liver, kidney, diaphragm, heart, and psoas major muscle did not reveal evidence of Se toxicosis in ewes on any dietary Se level. Also, there was no evidence of tissue breakdown as albumin and serum enzymes were within normal ranges.

Ewes under these experimental conditions and during the stresses of production were able to tolerate up to 20 ppm dietary Se as sodium selenite for 72 wk. These findings, likewise, suggest that the maximum tolerable level of inorganic Se for sheep to be much higher than 2 ppm as was suggested previously.

Literature Cited

1Paul Davis, Former Graduate Student, Tennessee Farmers Cooperative, LaVergne, TN; Lee McDowell, Professor, UF/IFAS, Department of Animal Sciences, Gainesville, FL; Claus Buergelt, Professor, UF/IFAS, College of Veterinary Medicine, Gainesville, FL; Nancy Wilkinson, Chemist, UF/IFAS, Department of Animal Sciences, Gainesville, FL; Rachel Van Alstyne, Former Graduate Student, Farm Credit Services, Smyrna, TN; Tim Marshall, Professor, UF/IFAS, Department of Animal Sciences, Gainesville, FL; Richard Weldon, Associate Professor, UF/IFAS, Department of Food and Resource Economics, Gainesville, FL.
Table 1. Effect of dietary inorganic Se level on serum Se concentration of mature ewes at various stages of lamb production.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Stage of Production</th>
<th>Dietary Se, ppm</th>
<th>Serum Se, µg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2</td>
<td>4</td>
</tr>
<tr>
<td>Late gestation, yr 1\textsuperscript{b}</td>
<td>149\textsuperscript{g} ± 67</td>
<td>242\textsuperscript{gh} ± 67</td>
</tr>
<tr>
<td>Lactation, yr 1\textsuperscript{c}</td>
<td>151\textsuperscript{g} ± 56</td>
<td>272\textsuperscript{gh} ± 54</td>
</tr>
<tr>
<td>Dry, rebreeding\textsuperscript{d}</td>
<td>162\textsuperscript{g} ± 110</td>
<td>298\textsuperscript{gh} ± 95</td>
</tr>
<tr>
<td>Late gestation, yr 2\textsuperscript{e}</td>
<td>140\textsuperscript{g} ± 137</td>
<td>313\textsuperscript{gh} ± 124</td>
</tr>
<tr>
<td>Lactation, yr 2\textsuperscript{f}</td>
<td>127\textsuperscript{g} ± 114</td>
<td>325\textsuperscript{gh} ± 103</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Data represent least squares means ± SE.

\textsuperscript{b}Late gestation, yr 1, defined as 56 d prepartum and includes serum Se concentrations for wk 4, 8, and 12.

\textsuperscript{c}Lactation, yr 1, defined as 84 d postpartum and includes serum Se concentrations for wk 12, 16, 20, and 24.

\textsuperscript{d}Dry, rebreeding period, 168 d, includes serum Se concentrations for wk 28, 32, 36, 40, 44, and 48.

\textsuperscript{e}Late gestation, yr 2, defined as 56 d prepartum and includes serum Se concentrations for wk 52, 56, and 60.

\textsuperscript{f}Lactation, yr 2, defined as 84 d postpartum and includes serum Se concentrations for wk 60, 64, 68, and 72.

\textsuperscript{g,h,i,j}Means within rows lacking a common superscript differ (P<0.05).

Figure 1. Effect of dietary inorganic Se level on Se concentrations in brain, diaphragm, and heart of ewes; SE = 0.6 to 0.9, 0.3 to 0.4, and 0.4 to 0.6 for brain, diaphragm, and heart, respectively.