Tolerance of Inorganic Selenium in Ruminants

Lisa Cristaldi
Lee McDowell
Claus Buergelt
Paul Davis
Frank Martin
Nancy Wilkinson

The maximum tolerable level of selenium for sheep is considerably higher than 2 ppm.

SUMMARY
This experiment evaluated the maximum tolerable level of inorganic Se fed to growing wether lambs for 1 yr. Sodium selenite was added to provide 0.2, 2, 4, 6, 8, and 10 ppm Se to a basal diet. Thirty-nine crossbred wether lambs initially weighing 50.2 ± 7.2 lb were randomly allotted to one of six treatments. Both serum and whole blood Se concentrations increased at each collection period as dietary Se level increased (P<0.01). At termination of the study, all tissues and wool, hoof, and bile Se concentrations had increased as dietary Se level increased (P<0.01). Liver had the highest Se concentration followed by the kidney in all but the lowest treatment of 0.2 ppm. Both gross and microscopic evaluation of tissues revealed no significant lesions for any treatment groups. There was no apparent pathological suggestion of selenosis based on tissue evaluation. Albumin and serum enzyme levels suggestive of tissue breakdown as a result of selenosis did not vary (P>0.15) among treatments. These results suggest that 10 ppm dietary Se as selenite is not toxic to wether lambs when fed for 1 yr. It seems plausible, therefore, to consider the maximum tolerable level of Se as selenite for sheep to be considerably higher than 2 ppm as previously suggested.

INTRODUCTION
Selenium deficiency is a serious problem for Florida cattle. Because of potential toxicity, the Food and Drug Administration (FDA) limits the level of Se allowed for supplementation to livestock.

The suggested Se tolerance level of 2 ppm makes no distinction between monogastrics and ruminants (NRC, 1980). This NRC estimate fails to consider that ruminal microorganisms may reduce Se to selenide which is insoluble, and that monogastrics absorbed more than 2.5 times as much Se as ruminants. The maximum tolerable level of Se suggested by the NRC for ruminants has been under-estimated and needs to be further evaluated.

The purpose of this study was to determine the maximum tolerable level of Se for growing ruminants. Sheep will be the experimental animal, it is believed that cattle and sheep have similar tolerance levels for Se.

PROCEDURE
Thirty-nine, 8-mo-old crossbred Rambouillet wether lambs weighing an average of 50.2 lb were utilized in a 365-d feeding experiment at the University of Florida. The basal diet was corn, cottonseed hulls, and soybean meal and analyzed 0.19 ppm Se.

Blood samples were collected periodically and at the end of 1 yr animals were slaughtered and tissues were collected for Se analysis and pathological evaluation. Using the mixed procedures of SAS, multiple comparisons of the means were performed for serum, whole blood, tissues, bile, wool, albumin, and enzyme concentrations.

The dietary treatments were as follows: 0.2 (control), 2, 4, 6, 8, and 10 ppm Se as sodium selenite on an as-fed basis.

RESULTS
Weight was not influenced by dietary Se level (P>0.15). The dietary intake of Se was reflected in the increased concentrations of Se in serum (P<0.01); as early as 28 d (Table 1).

Increased dietary Se elevated wool Se concentrations (P<0.01; Figure 1). For the wool, there was a linear trend (P<0.001) for all treatments. As with the serum, the wool Se concentration reflected dietary Se level as did the hair in cattle in other reported research.

Generally, liver, kidney, heart, diaphragm, and thoraco spinalis muscles (Figure 2), increased in Se concentration as dietary Se level increased (P<0.01).

Hoof Se concentrations generally increased as dietary Se concentration increased (P<0.01; Figure 2). Both the hoof and bile Se concentrations exhibited a linear tendency (P<0.001).

Clinical signs of selenosis, such as lameness, weight loss, loss of hair, and abnormal hoof growth were not observed. The liver, kidney, heart, diaphragm, and thoraco spinalis muscles showed no gross lesions at slaughter and no abnormality with microscopic evaluation in any of the treatment groups.

Results of our study suggest that feeding 10 ppm Se as selenite to wether lambs for 1 yr does not produce any signs of Se toxicosis with lambs of these genetics. There was an absence of clinical signs suggesting Se toxicosis, such as lameness, hoof malformations, and hair loss. Similarly, both gross and microscopic evaluation of tissue samples produced no evidence for selenosis. Since albumin and the enzymes were within their normal ranges it can be concluded that tissue necrosis did not occur. Accordingly, it appears that the NRC’s maximum tolerable level of Se of 2 ppm for ruminants has been substantially underestimated.

Lisa Cristaldi, Former Graduate Student; Lee McDowell, Professor; UF/IFAS, Department of Animal Sciences, Gainesville, FL; Claus Buergelt, Professor, UF/IFAS, Department of Veterinary Science, Gainesville, FL; Paul Davis, Former Graduate Student, UF/IFAS, Department of Animal Sciences, Gainesville, FL; Frank Martin, Professor, UF/IFAS, Department of Statistics, Gainesville, FL; Nancy Wilkinson, Chemist, UF/IFAS, Department of Animal Sciences, Gainesville, FL.
Figure 1. Effect of dietary Se level on wool Se concentration of wethers fed various levels of Se (selenite). S.E.M. is 0.25, 0.23–0.25, 0.23–0.31, 0.23 for 0.2, 2, and 4 ppm added Se, 6, 8, and 10 ppm, respectively.

Figure 2. Effect of dietary Se level on tissue Se content. S.E.M. is 0.63–0.83, 3.58–4.73, 0.29–0.32, 0.13–0.17, 0.09–0.12, 0.05–0.06, 0.22–0.29 for kidney, liver, heart, thoraco spinalis, diaphragm, bile, and hoof, respectively.
<table>
<thead>
<tr>
<th>Added Se (ppm)</th>
<th>Serum Se (μg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.09^d</td>
</tr>
<tr>
<td>2</td>
<td>0.09^h</td>
</tr>
<tr>
<td>4</td>
<td>0.09^g</td>
</tr>
<tr>
<td>6</td>
<td>0.10^e</td>
</tr>
<tr>
<td>8</td>
<td>0.09^d</td>
</tr>
<tr>
<td>10</td>
<td>0.10^f</td>
</tr>
<tr>
<td>12 wk</td>
<td>0.10^d</td>
</tr>
<tr>
<td>24 wk</td>
<td>0.19^d,e</td>
</tr>
<tr>
<td>40 wk</td>
<td>0.13^d</td>
</tr>
<tr>
<td>52 wk</td>
<td>0.12^d</td>
</tr>
</tbody>
</table>

*Added Se level response (P<0.01); time response (P<0.01); dietary Se level x time interaction (P<0.01).* 

*S.E.M. is 0.36 for treatments 0.2, 2 and 4 ppm added Se, 0.033-0.35 for 6 ppm Se, 0.033-0.054 for 8 ppm Se, and 0.033 for 10 ppm Se.*