An Investigation Into The Selenium Requirement For Rocky Mountain Bighorn Sheep

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Abstract. Causes for declines in bighorn sheep populations often go undetermined. Selenium deficient forage has been suspected as a possible contributing factor on several occasions. Generally, the basis for this concern results when the selenium content of the forage is compared to the nutritional requirement for domestic sheep. Hay with 20-30ppb of selenium was fed to captive bighorn ewes and their lambs for approximately two months following the birth of the lambs. Both lambs and ewes were monitored for physical signs of a deficiency. In addition, levels of blood selenium and glutathione peroxidase (GPX) were monitored as well. Physical signs of selenium deficiency were not detected in either the ewes or lambs. Lambs showed a decrease in blood selenium and GPX levels. While the study did not attempt to identify selenium requirements for bighorn sheep, the results did show that hay low in selenium caused drops in both blood selenium and GPX, particularly with lambs. Some limitations of the application of nutritional information to wild bighorn sheep, which has been taken from domestic animals, are discussed, as are some possible relationships.

Rocky Mountain Bighorn sheep (*Ovis canadensis canadensis*) that winter on Whiskey Mountain and summer on Middle Mountain, near Dubois, Wyoming have experienced several years of low lamb survival. Close surveillance of the lambs revealed signs similar to those seen with selenium deficiencies in domestic livestock. An examination of forage consumed by the sheep showed selenium levels to be greatly below minimum requirements of domestic sheep. A review of the literature revealed that the dietary nutrient requirement for selenium by bighorn sheep apparently was not available. This study was designed to feed hay low in selenium and make the following observations. One, monitor the blood levels of indicators used to assess the status of selenium in animals (blood selenium and GPX) while the sheep were being fed a diet low in selenium and, second, monitor both ewes and lambs for the various signs known to be associated with selenium deficiencies, particularly those seen with the Whiskey Mountain sheep.

METHODS

The study was designed to mimic, as close as possible, the situation that was felt to exist on Whiskey Mountain-Middle Mountain sheep, i.e., ewes being on forage with adequate selenium until after they gave birth to their lambs, followed by spending the summer foraging on feed low in selenium. Seven pregnant ewes were held in common pasture (forages in this geographical area have adequate selenium) and supplemented with hay that had 500 ppb of selenium. As each ewe gave birth to a lamb, these sheep were put into a common pen with a concrete floor and fed hay with 20-30 ppb of selenium.

The hay was fed ad libitum and its nutrient composition is shown in Table 1.

Table 1. Nutrient analysis of hay fed to bighorn ewes and lambs.

TDN	64%
ADF	30.9%
Protein	16.8%
Ca	1.3%
P	0.25%
K	1.2%
Fe	200ppm
Cu	14ppm
Zn	16ppm
Mg	0.34%
Mn	32ppm
Se	20ppb/30ppb
Mo	2.1 ppm
Vitamin E	3.87 IU/g

Blood samples were taken from each ewe on May 16, which was just after the first ewe gave birth to her lamb (May 14). Blood samples were taken from each ewe four other times during the summer. The lambs had blood samples taken four times (on the same dates as the ewes) over the course of the summer. The Wyoming Game & Fish Department Veterinarian observed the animals, looking for physical signs of selenium deficiencies, throughout the course of the study.

RESULTS

The first ewe to lamb was on May 14 and the last was on June 2nd. The range of time that the ewes were fed the hay with low selenium varied from 59 to 78 days. The lambs on Middle Mountain exhibited rough coats, swelling around the eyes, nasal secretions, high respiratory rates, slumped shoulders, and a stiff gait approximately 6-8 weeks after ewes were on a low selenium diet. None of the signs seen with these sheep were detected with the bighorns in this study.

The results of the selenium blood tests are shown in Table 2 and Figure 1. The level of selenium in the blood of the ewes showed a slight elevation (0.04ppm) following their initial exposure to the hay with low selenium levels. The level returned to the pre-treatment level (0.24ppm) and remained there throughout the remainder of the study, showing only minor changes (0.01ppm). The level of selenium in the blood of the lambs dropped steadily throughout the study, being 0.19ppm in the beginning and ending with 0.12ppm.

Table 3 and Figure 2 show the results of the response of serum GPX to the low selenium diet. The ewes showed an initial drop of 86 millimoles/s/l during the first 35 days which then remained fairly stable through the remainder of the study. The level of GPX with the lambs declined throughout the study, with the exception of the third sampling period, where an increase of 89 millimoles/s/l occurred. This increase was the result of one lamb showing a value of 865 millimoles/s/l while the remainder of the group averaged 171 millimoles/s/l, which is intermediate between the previous and following levels.

CONCLUSIONS

The level of selenium in the hay was below the deficiency level of 50ppb for domestic sheep on good quality feed as reported in Underwood and Suttle (1999), but was 6 times higher than for most summer forages sampled on

Table 2. The average and range of blood selenium levels (ppm) taken from bighorn sheep.

	EWES		LAMBS	
Date	Average	Range	Average	Range
May 16	0.24	0.22-0.28		
June 20	0.28	0.24-0.31	0.19	0.14-0.22
July 6	0.24	0.22-0.25	0.18	0.17-0.21
July 17	0.23	0.21-0.25	0.13	0.11-0.14
July 30	0.23	0.21-0.25	0.12	0.10-0.14

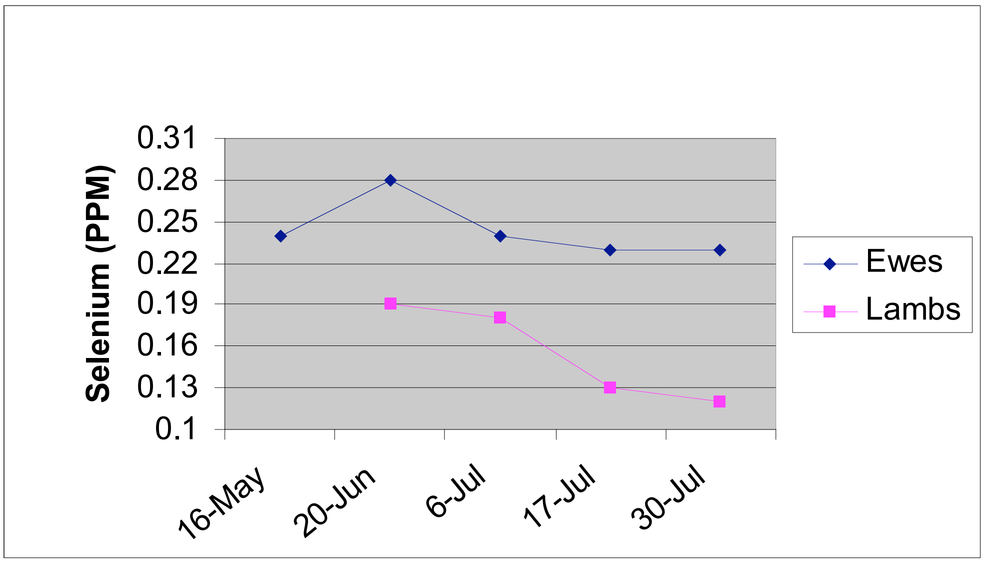

Figure 1. Blood selenium changes for bighorn ewes and lambs.

Middle Mountain. For this reason, the data cannot be used to help evaluate the field observations of free ranging sheep in the Whiskey Mountain herd. They do, however, provide some insight into the selenium metabolism of bighorn sheep.

The conditions of this study did not produce deficiency signs to lambs when born from ewes in good selenium at the time of parturition and subsequently fed low selenium hay for the first couple of months of life. It should be pointed out that selenium deficiency problems commonly develop with domestic animals when pregnant females are on deficient diets during late pregnancy. Signs are seen with the offspring in the subsequent months following parturition.

It appears that, with the lambs, 20-30ppm of selenium in the feed caused a drop in both selenium and GPX, each of which is used as an indicator of the selenium status of animals (Underwood and Suttle, 1999). The cause of increase in the blood selenium observed with the ewes on June 20 (the first sampling following the consumption of low selenium hay) is not known, but may have arisen from the mobilization of stored selenium from the liver following the sudden switch in diet from one of

Table 3. The average and range of glutathione peroxidase (millimoles/s/l) taken from bighorn sheep.

	EWES		LAMBS	
Date	Average	Range	Average	Range
June 20	311	252-401	343	197-341
July 6	281	242-299	198	94-362
July 17	308	258-388	287	96-865
July 30	286	254-334	153	135-179

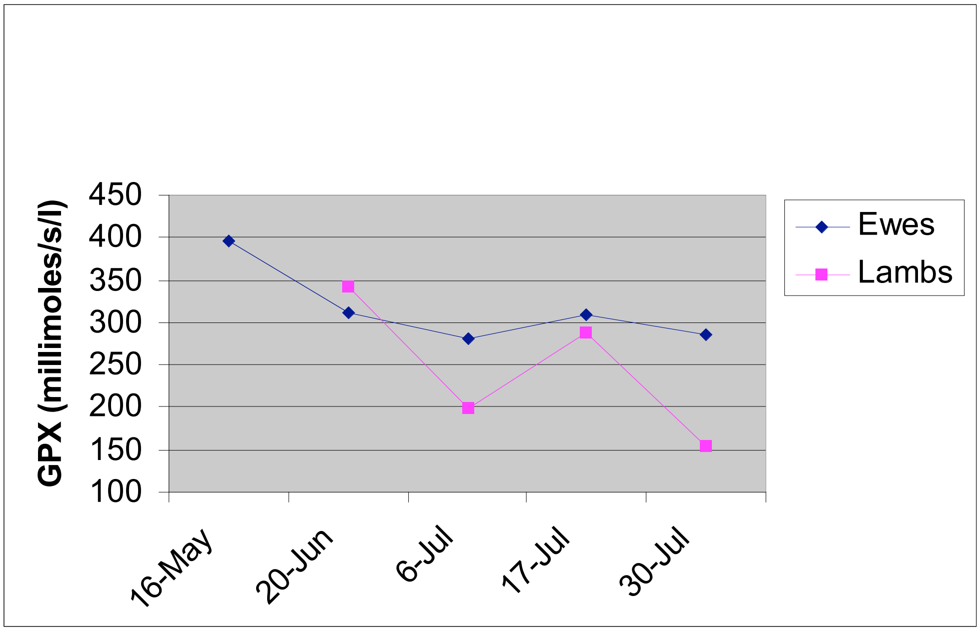

Figure 2. Changes in serum glutathione peroxidase levels in bighorn ewes and lambs.

500ppb to one of 20-30 ppb of selenium. Also, the increase in the serum GPX seen with the lambs during the third sampling period was the result of one individual having a very high reading of 865 millimoles/s/l. Excluding this lamb, the average serum GPX was 171 millimoles/s/l, resulting in a decreasing trend over the time period of the study. The blood levels of both selenium and GPX appear to indicate animals were in an adequate nutritional state with regard to dietary selenium during this study (approximately 2 months in duration). This would be consistent with observations from bighorns in Alberta where blood selenium levels that were considerably lower (0.025ppm) were found in sheep that had good reproduction and herd health (Samson, et. al. 1989). However, caution should be used when assessing nutritional state of an animal with regard to selenium. The nature of the selenium deficiencies is varied, but typically results in reduced reproductive efficiency and reduced immune responsiveness of offspring. The presence or absence of environmental stresses may have a significant effect on dietary requirements for selenium and offers a possibility as to why selenium may affect herd health in one situation and not another. While blood selenium levels for the ewes in our study would not be considered deficient for domestic animals, the levels seen in the bighorn lambs would be considered as marginal in domestic cattle (calves). Calves with blood selenium levels between 0.1 and 0.2ppm would be predisposed and would be susceptible to challenges from environmental stresses (parasites, cold weather, etc.).

Observations with domestic livestock indicate that a difference may exist between individuals based on their previous exposure to low levels of dietary selenium. For example, cattle on a given ranch may live and reproduce successfully for years on forage low in selenium. When cattle accustomed to higher levels of selenium are added this herd, deficiency signs may develop. This possibility of trace mineral adaptation may have been seen with the bighorns in this study. While deficiency symptoms did not develop, the decreasing levels of blood selenium and GPX indicate that 20-30ppb of dietary selenium were not adequate to maintain the levels of these indicators. The bighorns used in our study were accustomed to forage very high in selenium when compared to that received during the study. The sudden switch in dietary selenium may have elicited a response that sheep accustom to forage with low selenium may not have shown. This raises questions regarding the transplanting of bighorns from areas of higher levels to areas of lower areas and the possibility of increased susceptibility to environmental stresses.

In summary, the identification of required levels of trace minerals is difficult, especially with free ranging animals. Trace minerals are required in such small amounts. Sources of variation in measuring intake, the interactions of trace minerals with other nutrients, differences in laboratory analysis, possible adaptation differences, and varying levels of environmental stresses are all factors that confound the measurement of actual requirements. If mineral imbalances are thought to have a significant affect on bighorn sheep herds, perhaps the best method of identifying deficiencies will be to evaluate the responsiveness or the lack of responsiveness of these herds to treatments, such as mineral supplementation. Given the inherent difficulties of determining trace mineral requirements by other techniques, this approach was suggested for domestic animals by Underwood and Suttle, 1999.

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