

"Sooner or later, we sit down to a banquet of consequences."
- Robert Louis Stevenson

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Selenium: An Important Balance Between Sufficiency and Toxicity

by Diane Schivera, M.S., and Eric Sideman, Ph.D.

Selenium (Se) serves important functions in all animals. Called the "protection mineral," it is a key component in glutathione peroxidase, an antioxidant enzyme. The enzyme, found in red and white blood cells, heart muscle, brain, fat, lungs, liver, kidney and skeletal muscle, stops oxidation and thus protects cells and unsaturated fatty acids in cell membranes from damage by oxidizing materials, such as peroxides, that form during normal metabolism. Oxidative cell damage can lead to tissue damage and impaired function. Vitamin E functions with Se in this antioxidant enzyme system, and a deficiency of either or both can result in a deficiency of glutathione peroxidase throughout the body. Often vitamin E and Se are administered together to address a deficiency of either.

Stress increases the effects of Se deficiency and may trigger clinical disease. Stresses such as pregnancy, lactation and growth increase an animal's trace element needs.

Selenium is also involved in converting thyroid hormone, converting methionine to cysteine, and producing the immunoglobulin antibodies IgM and IgG in the immune system and in the colostrum. It also binds heavy metals.

Selenomethionine and small amounts of selenocysteine, the organic forms of Se found in forages and grains, are very bio-available. It is important to note, however, that when plants grow rapidly in the spring, their trace mineral concentrations are diluted. Also, higher levels of sulfur in fresh forages may reduce Se availability. Good rotational grazing can improve animals' chances of eliminating trace element deficiencies due to minor differences among paddocks.

Protein feeds are natural sources of Se, so dry cow rations that are low in protein may lead to Se deficiency symptoms, such as an increased incidence of retained placenta.

Selenium in Soils

Although Se is not an essential nutrient for plant growth, plants will take it up from the soil or through foliar feeding. Hence, one way to meet the Se nutritional requirements of livestock or humans is by fertilizing crops. This does not mean you should load your soil with selenium. At high concentrations it is toxic to plant tissue, and large doses in animals can cause loss of hair, nails and teeth and gastrointestinal upset. Proper levels for fertilization are very small – about 10 grams per acre – and can be supplied as seed coatings or foliar feeding. Use only commercial preparations and follow directions carefully.

Maine soils are generally very low in selenium. Recent work has demonstrated that added Se would result in more Se in feed and better plant growth. Selenium improves stress tolerance of plants, increases yield and quality of plant products, and enhances sugar and starch accumulation in leaves and tubers. But again, be aware that plants may accumulate excess Se; providing Se supplements to livestock and humans is safer than applying Se fertilizers. Bruce Hoskins of the Maine Soil Testing Service does not recommend Se fertilization but suggests that livestock producers feed the animals supplements, or buy in soy meal, alfalfa meal or grains produced in the West, where soils are high in selenium.

A map of soil Se concentrations in the United States is posted at www.ansci.cornell.edu/plants/toxicagents/selenium/map1.html.

Supplements for Animals

Chemically inorganic supplemental sources are sodium selenite and sodium selenate, which come as a trace mineral salt with selenium. Both are considered to have 100% bioactivity for ruminants – although recently available yeast sources of Se have produced higher blood levels of Se in cows than inorganic sources, indicating that they are more bioactive.

Injectable forms of selenium called Mu-Se and Bo-Se are available also, with a prescription from a veterinarian. These are given to young animals at birth, to stressed animals and to animals that have been shown to be deficient.

Using a trace mineral salt with Se is the least expensive way to increase Se intake in livestock. The FDA allows up to 120 ppm in salt for cattle and up to 90 ppm in salt for sheep. The loose form is recommended over hard block salt, which limits intake to unacceptably low amounts. When block salt is used for convenience under range conditions, semi-soft blocks are better than loose salt or hard block salt.

Supplements should be mixed to provide adult cows with an intake of 3 mg (milligrams) maximum of Se daily.

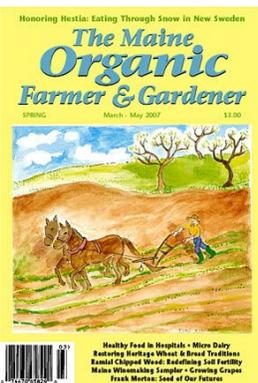
In 1993, the FDA set the maximum Se allowance in feeds and grain mixes at 0.3 ppm, due to the potential environmental impact of Se excreted by animals. (Selenium can bioaccumulate and cause deformed animals, for example.)

Livestock specialist Jerry Brunetti recommends the ruminant ration include a maximum of 1.0 -3.0 ppm selenium with supplementation; test your rations to see if they include enough selenium.

The ideal intake of Se for humans adults is 250-300 micrograms/day. Seafood, brazil nuts, brewer's yeast, butter, garlic, kelp and molasses are good food sources.

Deficiency Symptoms

Selenium and/or vitamin E deficiencies cause nutritional myopathy (myodegeneration) or white muscle disease in lambs and calves. This causes white striations in the heart and skeletal muscles and can be associated with other stresses. Animals may have a stiff gait or be unable to walk; they may eventually go down and die shortly; or heart damage may cause sudden



death. A deficiency of omega-6 fatty acids will cause the same symptoms.

Young animals with subclinical deficiencies will have impaired immune systems, causing a poor response to vaccination and resulting in greater susceptibility to infectious causes of pneumonia and scours.

Females have reduced conception rates and more frequent retained placentas, mastitis, pyometra (a uterine infection) and abortion.

Research at Ohio State University showed that a retained placenta in animals may be controlled by an intramuscular injection of 50 mg of Se as selenite and 680 IU of vitamin E given approximately 21 days prepartum; or by feeding a total intake of 1.0 mg of Se per day as selenite during the last 60 days of the dry period.

Even a marginal deficiency of Se will reduce milk volume and fat yield from dairy animals.

Sheep have lower live-weight lambs and reduced wool growth.

Other Se deficiency symptoms include diarrhea – usually profuse – and weight loss in young and adult cattle; and decreased feed efficiency, decreased weight gains and unthrifty appearance.

The most reliable way to determine the Se status of an animal is to analyze whole blood rather than serum. Blood samples collected from 10 to 20% of the animals in a herd will provide sufficient information to determine the Se status of the entire herd or flock. Retest whenever you change forages.

Testing the hair of cattle can indicate Se deficiency or toxicity. Most studies show that cattle with less than 0.25 ppm Se in their hair probably need supplementation, while more than 5 ppm may lead to clinical signs of selenosis (Se toxicity).

Soil tests and plant tissue tests may help indicate the amount of Se in animals' diets, but both can be problematic and of limited use. For example, soil test results must be adjusted for soil type, the presence of competing minerals, the plant species growing in the area and seasonal conditions.

Sources

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About the authors: Diane Schivera (dianes@mofga.org) is MOFGA's organic livestock specialist; Eric Sideman (esideman@mofga.org) is MOFGA's organic crops specialist.

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