

Selenium

Which Form Is Best for Lambs?

Just like people, sheep need selenium for good health.

But people and sheep both require selenium in extremely small amounts. That's because selenium can kill. And the difference between healthful amounts and harmful ones is exceptionally small, leading to selenium's reputation as a "Jekyll and Hyde" nutrient.

Now, studies by Agricultural Research Service scientists at the Poisonous Plant Research Laboratory in Logan, Utah, about 70 miles from Salt Lake City, and at Utah State University-Logan, are providing new details about how lambs absorb, break down, and eliminate selenium. The studies give a new, more detailed look at selenium poisoning and may lead to new strategies to avoid it, says laboratory director Lynn F. James.

Having such strategies would benefit everyone concerned with the health of not only sheep, but also other animals susceptible to selenium poisoning—cattle, horses, pigs, goats, and wildlife such as deer and elk. The increasing interest in selenium's cancer-fighting properties in humans suggests that the selenium experiments may also be of value in medical research, notes James.

A Little B-a-a-ckground

Scientists designed the investigations to reveal unknown details about precisely how selenium poisons an animal and to answer a key question: Are there significant differences in the animal's responses to two different forms of selenium, namely, organic and inorganic?

The plants that sheep nibble in pastures, meadows, or rangelands may contain mainly organic selenium. Inorganic selenium is the form traditionally mixed into feed or perhaps added to salt-lick-type mineral blocks. Such supplemental selenium is "essential in most parts of the United States where soils—and the plants growing on them—are selenium deficient," says Kip E. Panter, an animal scientist at the Poisonous Plant lab. Without selenium

PEGGY GREB (D546-1)



Animal scientist Kip E. Panter examines a forage sample in preparation for a selenium study in sheep to compare absorption, distribution, and elimination profiles of two forms of selenium: organic and inorganic.

supplements, the animals "may develop white muscle disease, which destroys their muscles and hearts," points out Bryan L. Stegelmeier, veterinary pathologist at the laboratory.

Most western, north central, and north-eastern states have selenium-deficient areas. Oddly, deficient sites "might be close to ones with excess selenium," Panter says.

Plants such as two-grooved milkvetch, woody aster, and prince's plume actively accumulate selenium and can kill hungry animals that eat them.

Right now, "there's no cure for selenium toxicity except to remove animals from the high-selenium sources in time for them to recover," notes Stegelmeier. "But poisoned sheep may be difficult to identify because they may not show any of the usual symptoms until they've eaten too much selenium." By the time poisoned

animals develop symptoms such as a wobbly gait or difficult breathing, "it's too late to save them."

Of Rodent and Ruminant

Today, most of the world's animal-based studies of selenium toxicity have been done not with grazing animals but with laboratory critters such as mice or rats. That's a good start. But sheep, of course, aren't rodents; they're ruminants, with complex, four-compartment stomachs. A rodent and a ruminant may thus deal differently with selenium.

What's more, most of the rodent studies have been done exclusively with inorganic selenium, Panter says. "That leaves holes in what we know about the organic forms."

Besides being the predominant form in green plants that grazing animals eat, organic selenium is also becoming popular

in supplements once made exclusively with the inorganic form.

Add up these factors and you have good reasons for the sheep studies with the two kinds of selenium. Panter and Stegelmeier collaborated in this research with Jeff O. Hall of the Animal Diagnostic Laboratory at Utah State University-Logan, which funded part of the study, and with Asheesh K. Tiwary, formerly at the university and now with the University of California-Davis.

The Dose Makes the Poison

For the investigation, more than three dozen healthy, nearly mature, crossbred lambs were given either no selenium, organic selenium in the form of selenomethionine, or inorganic selenium as sodium selenite, with their feed for 7 days. Doses topped out at 8 milligrams per kilogram of body weight.

To develop a detailed profile of each animal's responses to the doses and kind of selenium given, scientists took samples at regular intervals of whole blood, red blood cells, liver cells, and breath, for example.

"Every type of tissue we examined—liver, kidney, cortex, and heart—retained

more organic than inorganic selenium, regardless of dose," says Panter. "In areas where animals may get only marginal amounts of selenium, giving the form that they retain better allows them to stay selenium-sufficient—instead of deficient—for a longer time."

Analyses of blood samples, taken several times during the first day and about once a day thereafter, showed that lambs "absorbed organic selenium much more rapidly than inorganic," says Hall. And analyses of those specimens also showed that the organic selenium was "much more bioavailable"—that is, ready for the body to use—than the inorganic kind, adds Stegelmeier. "This suggests that organic selenium may be a better form to use for supplementing the animals. Less may be needed, and less may be wasted."

These studies are likely the first to so thoroughly compare and contrast the effects of the two selenium forms in sheep, according to James. The research fills in some missing pieces of the puzzle of exactly how, in its various forms, selenium poisons sheep. That knowledge may help prevent selenium from silencing America's lambs.—By **Marcia Wood**, ARS.

This research is part of Rangeland,



Technician Kermit Price (left) and range scientist James Pfister examine herbarium specimens of seleniumiferous plants in preparation for field studies to determine why sheep graze high-selenium forages.

Pasture, and Forages, an ARS National Program (#205) described on the World Wide Web at www.nps.ars.usda.gov.

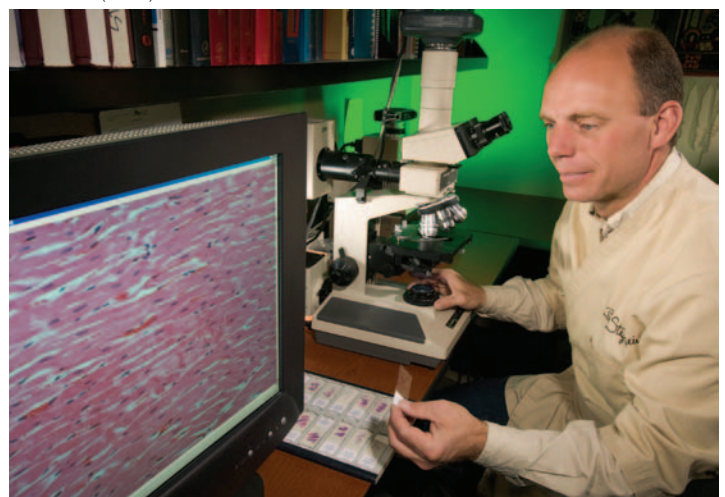
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KIP E. PANTER (D580-1)



Prince's plume (*Stanleya pinnata*), a selenium accumulator, is a beautiful but deadly warning that nearby forages likely contain toxic levels of selenium.

PEGGY GREB (D545-1)



Technician Ed Knopel examines a microscopic tissue section of a sheep's muscle after selenium poisoning.