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G86-775 Prussic Acid Poisoning

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Prussic Acid Poisoning

Prussic acid poisoning and its treatment are discussed in this NebGuide, along with methods to reduce its occurrence.

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Sudangrass, forage sorghum, and sorghum-sudangrass hybrids are often used for summer pasture, green chop, hay, or silage. Under certain conditions, livestock consuming these feedstuffs may be poisoned by prussic acid (HCN).

Exposure to excessive prussic acid--also called hydrocyanic acid, hydrogen cyanide, or cyanide--can be fatal. However, producers can manage and feed their livestock to avoid problems with prussic acid.

What is Prussic Acid Poisoning?

Prussic acid does not occur freely in normal, healthy plants. Instead, certain sugar compounds called cyanogenic glycosides contain the cyanide ion (CN^-) and only form prussic acid when degraded by certain enzymes.

Living plant tissues can contain both cyanogenic glycoside (called dhurrin in *Sorghum* species) and enzymes (beta-glycosidase or emulsin) in separate cells. When plant tissues are damaged, such as by freezing, chopping, or chewing, enzymes can come in contact with the cyanogenic glycoside and produce prussic acid. Bacterial action in the rumen of cattle and sheep can also release prussic acid from glycosides.

Prussic acid production is apparently more likely to occur in ruminants because both chewing and rumen bacteria release cyanide. Hydrochloric acid in the stomachs of horses and swine destroys plant enzymes

that release the toxin. Sheep are slightly more resistant to cyanide than are cattle, and Hereford cattle have been reported to be less susceptible than other breeds.

Once cyanide is absorbed, it is readily transported throughout the body, and is very toxic to all animals. In cells, cyanide reacts with cytochrome oxidase (an enzyme involved in the electron transport system that enables cells to use oxygen) to form a stable, inactive complex. As a result, the cyanide ion inhibits the release of oxygen from the hemoglobin of blood to individual cells. Without oxygen, cellular respiration ceases and cells die rapidly due to hypoxia.

What are Signs of Prussic Acid Poisoning?

Signs of prussic acid poisoning can occur within 15 or 20 minutes to a few hours after animals consume potentially toxic forage. Excitement, rapid pulse rate, and generalized muscle tremors occur initially, followed by rapid and labored breathing, staggering, and collapse. Foaming at the mouth, excessive tearing, and voiding of urine and feces may occur. Animals often lie prostrate and have muscle spasms and convulsions. Mucous membranes are usually bright and pink, and blood will be a characteristic bright cherry red. Treatment must be administered quickly because death can occur within minutes during severe convulsions.

Horses grazing *Sorghum* species have developed a condition known as "equine sorghumn cystitis/ataxia syndrome," which may be related to chronic exposure to cyanide or other compounds from sorghum. Incoordination of the rear legs, lack of urinary control, and paralysis and inflammation of the bladder can occur. The unidentified toxic principle causes spinal cord lesions. Pregnant mares may abort, and surviving foals may have musculoskeletal deformities. Thus, *Sorghum* species pastures are not recommended for horses.

How is Prussic Acid Poisoning Treated?

In ruminants, non-lethal amounts of prussic acid are rapidly detoxified naturally in the rumen and liver by reaction with sulphide or cystine (a sulfur-containing amino acid). Thiocyanate is formed and is readily excreted in urine. Because this process is rapid, few animals are lost yearly due to prussic acid poisoning.

When cyanide concentrations in blood are higher than can be rapidly detoxified, death can occur quickly. Immediate treatment by a veterinarian is necessary to save animals whenever prussic acid poisoning is suspected.

Sodium nitrite is injected intravenously to convert hemoglobin to methemoglobin, which reacts with the cyanide from the cyanide-cytochrome complex to form cyanmethemoglobin. A simultaneous injection of sodium thiosulfate provides sulfur to convert cyanmethemoglobin to the less toxic thiocyanate, which is excreted in urine. The remaining methemoglobin is converted by other enzyme systems to hemoglobin, which is again available to transport oxygen normally.

Caution: Injecting sodium nitrite induces methemoglobinemia identical to that produced by nitrate poisoning. Since many signs of nitrate and prussic acid poisoning are similar, be certain that nitrates are not a problem before administering sodium nitrite. The blood of animals affected with nitrate poisoning will be chocolate brown in color, compared to the cherry red color of blood from prussic acid poisoning. Thiosulfate alone is also an effective antidotal therapy.

What Factors Affect Prussic Acid Concentration in Forages?

Plant species

Leaves and stems of all *Sorghum* species can contain prussic acid glycosides. Sudangrass generally has the least amount of prussic acid production potential, while forage and grain sorghums, shattercane, and johnsongrass often produce dangerous concentrations. Sorghum-sudangrass hybrids are usually intermediate, but a wide range of prussic acid production potential occurs within this group. Sow hybrids known to be lower in prussic acid potential when grazing is planned.

Arrowgrass, velvetgrass, and white clover can also have prussic acid glycosides in their leaves. Chokecherry, pincherry, wild black cherry, apricot, peach, apple, and elderberry trees contain prussic acid glycosides in leaves and seeds (pits). However, little or no prussic acid potential is present in the fleshy part of the fruit. These trees can by hazardous around grazing areas because cattle often graze leaves for variety in their diet.

Plant parts

Leaves usually produce 2 to 25 times more prussic acid than do stems in forage grasses; seeds contain none. Young, upper leaves have more prussic acid than lower leaves. New shoots often contain very high concentrations of prussic acid glycosides. New shoots produced after frost can be especially hazardous.

FertiIization

High application rates of nitrogen fertilizer are often needed to obtain high yields of *Sorghum* species. However, prussic acid production potential may also increase with high nitrogen rates. This problem is most severe on soils deficient in phosphorus.

Maintain proper soil phosphorus levels according to soil test recommendations to reduce prussic acid potential in forage. Use split applications of nitrogen when the total amount exceeds 60 lbs of N per acre to decrease the risk of prussic acid toxicity.

Herbicides

Foliar herbicides such as 2,4-D can increase prussic acid concentrations in forage for several weeks after application. Plan grazing operations accordingly.

Drought

Drought-stricken plants contain mostly leaves and are slow to decrease their potential for prussic acid production. Grazing stunted plants during drought is the most common cause of poisoning of livestock by prussic acid-producing plants.

Frost

Plants that are frozen may release high concentrations of prussic acid for several days. After wilting, prussic acid release from plant tissues will decline. Dead plants have less free prussic acid. Do not graze or green chop for several days after a killing frost.

When only plant tops have been frosted, new shoots may regrow at the base of the plants. These can be very dangerous because of high prussic acid glycoside content, and because cattle will selectively graze

them. Do not graze frosted summer annuals until regrowth of shoots is 15 to 18 inches tall, or until several days after the entire plant and shoots are killed by subsequent frost.

How Can Prussic Acid Poisoning be Avoided?

Pasture

To reduce danger from poisoning, do not graze sudangrass and sorghum-sudangrass hybrids until they are 15 to 18 inches tall, and several feet tall for forage sorghums. Heavy stocking rates and rotational grazing will reduce the opportunity for livestock to selectively graze young, succulent, and potentially hazardous shoots.

Hungry animals may consume forage too rapidly to detoxify prussic acid. Feed ground cereal grains or a full feed of hay before first turning animals onto pasture. Turn animals out to new pasture later in the day, since prussic acid release potential is reported to be highest during early morning hours. Use less valuable, test animals to graze potentially toxic pastures prior to risking the entire herd.

Sulfur is used to detoxify prussic acid, and most *Sorghum* species contain marginally adequate amounts in forage. Thus, free choice salt and mineral with added sulfur may help protect against prussic acid toxicity. Always have plenty of clean, fresh water available.

Monitor grazing closely during periods of environmental stress, such as drought or frost. Feed good quality grass or alfalfa hay with pasture during these times to reduce potentially high prussic acid concentrations in the animals' total intake.

Grain sorghum stubble is usually safe to graze, but small green shoots of sorghum or shattercane may develop in the stubble. Abundant regrowth can be dangerous. Wait for these shoots to be frozen and wilted before grazing.

Green Chop

Green chop forces livestock to eat both stems and leaves, thereby reducing problems caused by selective grazing. The cutting height can be raised to minimize the inclusion of regrowth. If nitrates are a potential problem, green chop can still be dangerous. See NebGuide *G74-170, Nitrates in Livestock Feeding*, for more information.

Hay and Silage

Sorghum hay and silage usually lose 50 percent or more of the prussic acid they contain during curing and ensiling processes. Free cyanide is released by enzyme activity and escapes as a gas. However, hazardous concentrations of prussic acid may still remain in the final product, especially if the forage had an extremely high cyanide content before cutting. Hay has been dried at oven temperatures for up to four days with no significant loss of cyanide potential.

Although hay and silage rarely contain hazardous concentrations of prussic acid, analyze these feeds in a laboratory prior to use whenever high concentrations are suspected. Dilute or mix potentially toxic feed to a safe concentration with grain or forage that is low in prussic acid.

What are Safe Prussic Acid Concentrations in Feeds and Forages?

Chemical analysis of cyanide in forages is the only reasonably accurate method of predicting potential toxicity to animals. Hay, green chop, silage, or growing plants containing more than 200 ppm (20 mg%) cyanide as HCN on a *wet weight* (as is) basis are very dangerous as animal feed. Forage containing less than 100 ppm HCN, wet weight, is usually safe to pasture. Analyses performed on a *dry weight* basis have the following criteria: more than 75 mg% HCN is hazardous, 50 to 75 mg% HCN is doubtful, and less than 50 mg% HCN is considered safe. Ideally, forage samples should be quick frozen as soon as possible and maintained in a frozen state until submitted for analysis. Dry hay or silage may also be submitted. The Veterinary Diagnostic Center, University of Nebraska-Lincoln provides this service for a nominal fee. Contact your Extension Agent for instructions on collecting and submitting samples.

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