

# Prussic Acid Poisoning

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Prussic acid, cyanide, or hydrocyanic acid are all terms relating to the same toxic substance. It is one of the most rapidly acting toxins which affects mammals. Cyanide is a lethal ingredient that has been used in rodent and vermin killers.

## Understanding Prussic Acid Poisoning

A number of common plants may accumulate large quantities of prussic acid (cyanogenic compounds). Sorghums and related species readily accumulate these compounds. These cyanogenic compounds are located in epidermal cells (outer tissue) of the plant, while the enzymes which enable prussic acid production are located in the mesophyll cells (leaf tissue).

Any event that causes the plant cell to rupture allowing the cyanogenic compound and the enzyme to combine will produce prussic acid. Plant cells can be ruptured by cutting, wilting, freezing, drought, crushing, trampling, chewing, or chopping. Once plants containing prussic acid have been consumed, the toxin rapidly enters the blood stream and is transported throughout the body of the animal. Prussic acid inhibits oxygen utilization by the cells in the animal's body. In essence, the animal suffocates. Ruminant animals (cattle and sheep) are more susceptible to prussic acid poisoning than non-ruminant animals because the ruminal microorganisms have enzymes which will release prussic acid in the animal's digestive tract.

## Clinical Signs

Prussic acid is a potent, rapidly acting poison. Signs of prussic acid poisoning can occur within 15 to 20 minutes to a few hours after animals consume the toxic forage. Animals are often found dead. Clinical signs, when noticed, occur in rapid succession. Excitement, rapid pulse, and generalized muscle tremors occur initially, followed by rapid and labored breathing, staggering, and collapse. There may be salivation (drooling), lacrimation (runny eyes) and voiding of urine and feces. The mucous membranes are usually bright pink, and the blood will be a characteristic bright cherry red.

## Diagnosis

When livestock losses occur and prussic acid poisoning is suspected:

- Contact your veterinarian.
- Send the suspect forage to the diagnostic laboratory for analysis. Do not send grains, stomach contents, or blood samples.
- Change forages or remove animals from suspected pastures until results of the analysis are returned.

## Treatment

Treatment for prussic acid poisoning consists of re-establishing oxygen transport at the cellular level. Your veterinarian is the only qualified individual for instituting this treatment. Sodium nitrite is injected intravenously to convert hemoglobin to methemoglobin, which reacts with 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 the urine. The remaining methemoglobin is converted by other enzymes to hemoglobin, which is then available to transport oxygen normally.

Caution: Clinical signs of prussic acid poisoning and nitrate poisoning are quite similar. Be certain nitrates are not a problem before administering sodium nitrite. An injection of sodium nitrite into an animal already suffering from nitrate poisoning would be disastrous. 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. Sodium thiosulfate, alone, is also an effective antidotal therapy for prussic acid poisoning.

## Forages

Prussic acid poisoning is most often associated with sorghums and sudangrass. However, a number of other plants can be cyanogenic. A list of these plants is found in Table 1:

**Table 1**

Plants with Cyanogenic Potential	
Apple	Johnsongrass
Apricot	Lima bean
Arrow Grass	Peach
Birdsfoot trefoil	Poison suckleya
Cherry	Sudangrass hybrids
Elderberry	Sorghum-sudangrass hybrids
Flax	Shattercane
Forage Sorghums	Velvet grass
Grain Sorghums	Vetch seed
Hydrangea	White Clover
Indiangrass	

Leaves usually produce two to 25 times more prussic acid than do stems in forage grasses; seeds contain no prussic acid. Young, upper leaves have more prussic acid than lower leaves. New shoots often contain high concentrations of prussic acid. New shoots produced after frost can be especially hazardous.

Prussic acid content appears to be higher in plants grown in soils high in nitrogen and low in phosphorus. When fertilizing forage ground, use split nitrogen applications when the total amount exceeds 60 lbs of N per acre to decrease the risk of prussic acid toxicity.

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

Drought increases the chance for high levels of prussic acid in plants. This may be because the plants have not been able to mature and contain mostly leaves which are higher in prussic acid. In general, any stress condition which retards plant growth can result in higher than normal levels of prussic acid.

Frost or freezing causes plant cells to rupture, allowing prussic acid to be released. If the potential for poisoning is great before freezing (high concentrations of prussic acid containing compounds are present), then the danger of poisoning is very great while the plant is frozen and for several days following a frost. 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.

## Forage Analysis

Prussic acid analysis estimates the "potential" of the plant to cause poisoning. During the forage analysis the plant cells are broken, allowing the cyanogenic compound to mix with the plant enzymes which release the prussic acid. The toxin is then measured. Table 2 provides some guidelines for evaluating forages for prussic acid toxicity.

**Table 2**

Prussic Acid (HCN) Content of Forages

As Fed Basis	Prussic Acid Content (Dry Matter Basis)	Comments
< 200 ppm	< 600 ppm	This feed should not cause prussic acid poisoning
200 to 600 ppm	600 to 1800 ppm	This feed is potentially toxic; it should be fed at a restricted rate.
> 600 ppm	> 1800 ppm	This feed is potentially very toxic. Drying, ensiling, or allowing it to mature should reduce the prussic acid content. Retest before feeding.

## Prevention

**Plant Species:** The plants most commonly associated with prussic acid poisoning are sudangrass, Johnson grass, sorghums, and sorghum-sudangrass hybrids. Grain sorghums are potentially more toxic than forage sorghums or sudangrass. Indiangrass and chokecherry can also cause prussic acid poisoning. Hybrid pearl millet and foxtail millet generally have very low levels of cyanide.

**Plant Age and Condition:** Young, rapidly growing plants generally have high levels of prussic acid. Higher concentrations of cyanide are found in young leaves than in old leaves or stems. New forage growth following drought or frost is dangerously high in cyanide.

Plants grown in soils high in nitrogen but low in phosphorus and potassium tend to have high cyanide concentrations.

**Drought and Frost:** Prussic acid poisoning is commonly associated with plant regrowth following a drought ending rain or the first autumn frost. Wait at least seven days after a killing frost before grazing to allow HCN to dissipate.

**Feeding:** Most livestock losses occur when hungry or stressed animals graze young sorghum growth. Do not graze new growth or regrowth in sorghum or sorghum-sudan pastures. Feeding grain or hay before turning animals into pasture may reduce the rapid intake of forage and thus the amount of cyanide consumed. Animals do not develop immunity to cyanide, but they can detoxify low levels of cyanide.

**Harvest Technique:** Fresh forages have higher concentrations of prussic acid than silages or hay. However, if the forage had extremely high concentrations of prussic acid before cutting or if the hay was not properly cured, dangerous levels of prussic acid can remain. If there is any doubt as to the level of prussic acid in a forage, suspect hays and silages should be analyzed before feeding.

## Guidelines

Cattle are more susceptible to prussic acid poisoning than sheep. Horses can also be affected. Keep the following guidelines in mind when feeding forages such as sorghum and sorghum-sudan hybrids.

- Never graze sorghum less than 18 inches in height.
- Feed hungry cattle before allowing them to graze forages which may contain high levels of prussic acid.
- Do not allow animals to graze troublesome plants after a light frost or after rain has ended a summer drought. Wait several days after a killing frost before grazing.
- Chop or ensile plants high in prussic acid to reduce toxin levels.
- Analyze suspect forage samples before feeding.

If you have questions concerning submitting samples to a laboratory for analysis, you can contact the North Dakota State University Veterinary Diagnostic Laboratory at 701-231-8307.

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