Nitrate and Oxalate Poisoning

Plants absorb nitrates from the soil and metabolize them to form plant proteins. If plants absorb excess nitrates and are consumed by livestock before they are converted to proteins, nitrate poisoning can occur. Forage crops that are over fertilized before being harvested or grazed can be a common cause of nitrate poisoning. However, excess nitrate accumulation also occurs readily in some common pasture weeds. Nitrate concentration can vary widely among plants and growing conditions. Nitrates are highest in plants in mornings and evenings, and on cool, cloudy days (when plant metabolism is slower). Drought, fertilization and nutrient deficiency can result in nitrate accumulation in plant tissues. Highest concentrations occur generally in stems, rather than leaves, flowers or fruit/seed.

Animal metabolism converts nitrate (NO$_3^-$) to nitrite (NO$_2^-$), which is toxic. This occurs less frequently for horses which do not readily convert nitrate to nitrite. In small quantities, nitrates are reduced by beneficial bacteria in the rumen to microbial proteins. It is the rapid absorption of large quantities of nitrates that can lead to poisoning, overwhelming the rumen’s ability to convert nitrates into proteins. Increasing the carbohydrates (energy content) in an animal’s diet can prevent poisoning as it allows the conversion of nitrates to proteins to occur more quickly, thus reducing the likelihood of nitrate poisoning.

Symptoms of nitrate poisoning include drowsiness and weakness followed by muscular tremors, increased heart and respiratory rates, staggering gait and recumbency (inability to stand upright without support). Sub-lethal doses can cause abortion and reduced milk production. Animals suspected of having nitrate poisoning should be kept stress free and the suspect food source removed. Forages assumed of being high in nitrates, especially if they have been heavily fertilized with N-fertilizer or experienced drought, should be tested.
Rather then absorbing excess nitrates, some plants store high quantities of potassium and sodium oxalates (salts). If large quantities of oxalate accumulating plants are eaten, the rumen is overwhelmed and unable to metabolize the salts and they are absorbed into the bloodstream. In the bloodstream they form insoluble salts that precipitate in the kidney, causing kidney failure.

Sheep are most susceptible, then cattle. Cattle are able to detoxify large quantities of oxalates in their rumen, reducing chances of poisoning. Animals can develop a tolerance for oxalate accumulating plants by building up the concentration of oxalate-degrading bacteria in the rumen. If eaten in small amounts over time, with other feed to dilute the concentrations in the rumen, oxalate accumulating plants cease to be a problem.

Within a few hours of poisoning, animals develop muscle tremors, tetany (calcium deficiency), weakness and recumbency (inability to stand upright without support). Coma and death can follow within 12 hours of consumption.

Livestock should be adapted to oxalate plants over four days, incrementally increasing the time allowed to graze the plants, before being left in pastures containing high concentrations of oxalate-accumulating plants.

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<th>Common Pasture Plants Causing Nitrate and Oxalate Poisoning</th>
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Provided by Karin Neff, Andy Hulting, Mylen Bohle and David Hannaway
Redroot Pigweed, *Amaranthus retroflexus*

**Identification:** Two- to three-foot annual; lower stems red or red-striped. Leaves are alternate and ovate to lanceolate with long petioles and prominent veins. Small green flowers arranged in tight, spike-like terminal clusters. Flowers with long, spine-tipped bracts. Bright red taproot. Prolific seed production.

**Habitat:** Common in cultivated land, pastures and waste areas.

**Animals Affected:** Cattle and pigs.

**Toxin family:** Nitrate and oxalate accumulator: toxicity (and palatability) increases with drought or spraying.

**Other:** Can cause abortion or death, Hay and silage are toxic.

Provided by Karin Neff, Andy Hulting, Mylen Bohle and David Hannaway
Lambsquarter, *Chenopodium album*

**Identification:** Variable annual plant; erect, branched, blue-green stems, sometimes with red-purple stripes; alternate leaves with mealy-white undersides; terminal clusters of small petal-less flowers

**Habitat:** Cultivated fields, roadsides, pastures, waste areas; high water use

**Animals Affected:** Sheep and pigs

**Toxin family:** Nitrate and oxalate accumulator

**Other:** Poisonous if eaten in large amounts, young leaves palatable

Provided by Karin Neff, Andy Hulting, Mylen Bohle and David Hannaway
Common Mallow, *Malva neglecta*

**Identification:** Low spreading winter annual or biennial, with a substantial tap root. Prostrate stems can reach three feet in length. Long-petioled, heartshaped leaves with prominent veins and white to lavender fused flowers. Fruits are flat sided, arranged in a pie shape.

**Habitat:** Waste areas, gardens, cultivated land

**Animals affected:** All

**Toxin family:** Nitrate accumulators.

**Other:** Symptoms include “staggers” or violent tremors.

Provided by Karin Neff, Andy Hulting, Mylen Bohle and David Hannaway
Dock, *Rumex spp.*

**Identification:** Various: Erect perennials, alternate oblong to lanceolate leaves, whorls of small fruits encased in 3-winged parianth (shape of parianth parts is best way to distinguish between species). Stems usually unbranched below inflorescence, nodes slightly swollen, lower leaves long-stalked, stipules membranous, fused and sheathing stem above nodes, small greenish flowers in whorls at upper stem nodes.

**Habitat:** Moist areas, cultivated lands, pastures, ditchbanks, waste areas.

**Animals Affected:** Sheep and horses, cattle less susceptible.

**Toxin family:** Oxalate accumulator: not a common source of oxalate poisoning, but *Rumex spp.* will cause poisoning if eaten in excess.

**Other:** May cause irritation to the skin and digestive tract. Dangerous levels are rare. Can cause hypocalcemia. Toxin is detoxified by the rumen except if eaten in large quantities. *Rumex spp.* in silage is not a critical problem.

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