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Nitrate Poisoning of NORTH DAKOTA LIVESTOCK

(OAT HAY POISONING, SILO DISEASE, LOWLAND ABORTION)

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ALL PLANTS REQUIRE SOME NITRATES for growth, and there is normally little nitrate accumulation in plants unless the normal factors involved in conversion to plant protein are inadequate. These factors include availability of water, energy (sunlight) and temperature.

Nitrates in the rumen are converted to nitrites → ammonia → amino acids and finally to protein. Higher than normal consumption of nitrates or interference with conversion will result in accumulation of nitrates or nitrites and varying degrees of toxicosis in the animal.

The concentration of nitrates in plants is highest in the stems, less in leaves and least in seeds. The concentration of plant nitrates will vary with the amount of nitrate or ammonium in the soil. The nitrate uptake of the plants reportedly can be increased in acid soil, in soils deficient in molybdenum, sulfur, or phosphorus, or in conditions of low moisture. Nitrates are highest in plants just prior to flowering, when plants receive sublethal amounts of herbicides, or when plants are shaded such as occurs in overplanting. Young growing plants and cereal grains used for hay often contain large amounts of nitrates. Under adverse conditions, many domestic forages can become accumulators of nitrates. Cereal grain hay that becomes wet through rain or melting snow can develop high nitrate content through bacterial or plant enzyme action.

SOURCES OTHER THAN PLANTS

Water may be a source of toxic levels of nitrates for livestock or humans. Nitrates and nitrites are water soluble, and may leach through soil to the water table resulting in contamination. Sources of contamination include fertilizer, animal wastes, decaying organic matter, wind and water erosion and large numbers of nitrogen-fixing bacteria. Shallow wells with poor casings are most subject to contamination, but deep wells have occasionally become contaminated.

Acute toxicity will be produced if livestock consume nitrates such as nitrate fertilizer. Care should be taken when spreading fertilizer to avoid pasturing immediately after application. Head lands, where the fertilizer spreader turns, or areas where filling takes place will often have excessive quantities of nitrates freely available to livestock. Fertilizer sacks should be discarded with care to avoid livestock having access to concentrated quantities of nitrates.

Livestock deprived of salt and other minerals may develop an appetite for nitrates, and fertilizer may be mistaken for common salt. Pickling or meat-curing solutions are high in nitrates and should not be discarded where livestock will have access to them.

SYMPTOMS WILL VARY

The most frequent source of nitrate toxicosis is consumption of plants containing nitrates.

Nitrates, although less toxic than nitrites, are readily converted to nitrites by ruminants. Nitrites are readily absorbed from the digestive tract and combine with hemoglobin, which provides the red color to blood and is the essential portion for oxygen transportation throughout the body. When nitrites combine with hemoglobin, the compound methemoglobin is formed. This compound has a reduced oxygen-carrying capacity so the symptoms observed from nitrate poisoning are usually varying degrees of suffocation.

Nitrate toxicosis from plants usually occurs with a rapid onset and includes difficult breathing, rapid pulse, cyanotic membranes and below normal temperatures. These signs are most characteristic, and if no additional nitrate is consumed the animal usually recovers. If additional nitrate is consumed, weakness, muscle tremors, low tolerance to exertion, convulsions and even death may ensue.

Earlier reports indicated that nitrates interfered with conversion of the precursors to Vitamin A, resulting in Vitamin A deficiency signs. Interference with Vitamin E, decreased milk production, weight gain and milk fat content have also been reported. More recent investigations indicate that the mature ruminant animal can acclimate itself to the consumption of very high concentrations of nitrates with no decreased levels of Vitamin A, milk production, milk fat content or interference with growth.

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The consumption of fertilizers or other non-plant sources will result in acute symptoms including gastroenteritis, vomition, salivation, diarrhea, colicky signs and frequent urination.

Inconsistent and infrequent signs include abortion, decreased milk production, infertility, milk fat decrease, Vitamin A deficiency in calves and slower weight gain.

Other diseases that may be confused with nitrate toxicosis include cyanide poisoning, pulmonary emphysema, grass tetany or any infectious disease causing abortion or infertility.

PREVENTION

Because of the various forms of nitrates and nitrites used in research and reports, comparisons and interpretations can only be made by converting data to desired forms of nitrogen or quantity designation.

In feeds, the nitrate content is usually expressed as a percentage of the dry weight of the feed. In water, the nitrate content is usually expressed as parts per million (ppm) on a weight basis or as milligrams per liter (mg/liter) on a weight per volume basis. One mg/liter is equal to 1 ppm.

The conversion factors in the table serve for either percentages, ppm or mg/liter in changing from one compound to another as the basis of expressing the results. To change percentages to ppm, multiply by 10,000. One percent is equal to 10,000 ppm.

Nitrate poisoning can be prevented by having suspected forages or water analyzed before consumption by livestock. Test animals may be utilized to determine the safety of forages before feeding to the entire herd or flock. Nitrate-containing forages can be diluted with nitrate-free forage or by increasing the concentrates in the ration. The addition of corn or molasses may be helpful in preventing nitrate poisoning.

It is usually assumed 1.0 to 1.5 percent nitrate in the total ration is the highest level that can be safely fed to cattle. Two percent has been fed without adverse reactions, providing the cattle have been gradually acclimated to this high a concentration of nitrate. Water should contain no more than 1500 ppm of nitrate. Poisoning can be avoided in healthy mature animals by acclimation to high levels of nitrates in the feed or water. Sudden changes in the ration often results in nitrate toxicosis.

SILO DISEASE

Fermentation of silage will reduce nitrates to nitrous dioxide or nitric oxide gas which reacts with air to produce nitrogen dioxide and some nitrogen tetraoxide. The nitrogen dioxide gas is a yellowish brown, pungent, heavier than air gas that will pass down silo chutes and cause severe lung irritation and even death to humans, livestock or poultry. The first signs include difficult breathing, coughing, sensation of chest constriction, elevated temperature and weakness. Overexposure to this gas may result in death.

* Different methods of expressing nitrate and nitrite contents of feeds and water, the molecular or ionic weights of the different substances and factors for converting from one designation to another.

Method of expressing the form of nitrogen	Chemical formula or designation	Factors for converting from one designation to another (relative weights) N-1[a]	NO_2=1	NO_3=1	KNO_3=1
Nitrate-nitrogen	NO_3-N	1.0	0.30	0.23	0.14
Nitrite-nitrogen	NO_2-N	1.0	0.30	0.23	0.14
Nitrite	NO_2	3.3	1.00	0.74	0.46
Nitrate	NO_3	4.4	1.34	1.00	0.61
Sodium Nitrate	$NaNO_3$	6.1	1.85	1.37	0.84
Potassium Nitrate	KNO_3	7.2	2.20	1.63	1.00

[a] Either NO_3-N or NO_2-N

Examples:

1.0% NO_3-N = 4.4% NO_3 or 7.2% KNO_3
1.0% NO_3 = 0.23% NO_3-N or 1.63% KNO_3
1% KNO_3 = 0.61% NO_3 or 0.14% NO_3-N

1 ppm NO_3-N = 4.4 ppm NO_3 or 7.2% ppm KNO_3
1 ppm NO_3 = 0.23 ppm NO_3-N or 1.63 ppm KNO_3
1 ppm KNO_3 = 0.61 ppm NO_3 or 0.14 ppm NO_3-N

* The Nitrate Problem Special Report, No. 34, Iowa State University, August 1963.

SPECIES OF PLANTS USUALLY INVOLVED

Corn stalks, either silage or fodder
Cereal grains, oats, wheat and barley; either as hay, straw or silage.
Other crop plants that may be involved include the leaves of beets, rape, sudan grass, rye or flax.

WEEDS THAT ARE FREQUENTLY INVOLVED

Pigweed, lambsquarters, Canada thistle, Johnson grass, Russian thistle.
Others that may be involved include Jimsonweed, nightshade, wild sunflower, fireweed and smartweed.



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