

NITRATE TOXICITY IN FEED

FACT SHEET

Nitrate (NO_3^-) poisoning is a real concern for livestock producers when certain conditions exist. Some of these factors are manageable, while many are out of the hands of the producer. This fact sheet discusses the problems related to nitrate levels in feeds and what can be done to minimize the potential hazards related to them.

WHY NITRATE IS A PROBLEM

Most plants remove nitrogen from the soil primarily in the nitrate form. Under normal growing conditions, nitrate is quickly converted to nitrite, then to ammonia, and finally into plant proteins and other compounds. When plant growth is slowed or stopped, nitrate can accumulate in the plant.

Microorganisms in ruminant animals convert nitrate in feed to nitrite. Nitrite is then converted to ammonia and on to proteins and other compounds. If the rate of conversion of nitrate to nitrite in the rumen is greater than the conversion of nitrite to ammonia, nitrite levels accumulate in the animal. Nitrite is readily absorbed into the bloodstream where it oxidizes the ferrous iron of the red blood pigment hemoglobin to ferric iron, producing a modified red blood pigment called methemoglobin.

Methemoglobin is not able to transport oxygen to body tissues. This is what causes the characteristic chocolate brown blood color prior to death, which is caused by asphyxiation. Nitrite in the bloodstream also constricts the blood vessels, further reducing the flow of oxygen to vital organs. Subacute or chronic nitrate poisoning may result in reproductive problems, including abortions. Moderate nitrate levels in the diet may cause reduced milk production, lowered rates of gain, and reproductive difficulties.

CROP MANAGEMENT PRACTICES

Several environmental factors influence the amount of nitrate taken up by plants. Any condition which slows crop growth, such as drought, frost, or cool, cloudy weather can cause nitrate to accumulate. Rainfall following an extended dry period may cause an immediate increase in nitrates for 2 to 5 days until the plant can convert the nitrate to protein. Other management factors such as over-applying nitrogen fertilizer or animal manure can cause an increase in nitrate in the plant. Acid soils and phosphorus deficient soils will increase plant nitrate accumulation.

A plant's age will influence the amount of nitrate it takes up. Immature or young plants have a greater potential for nitrate accumulation than older plants. Various plant species are prone to accumulation of nitrates, including corn, wheat, oats, barley, sorghum, sweet clover, sudan grass, and most weeds.

Nitrates tend to accumulate in the lower portion of a plant when growth is slowed. Eighty to ninety percent of the nitrate in a corn stalk can be found in the lower one-third of the stalk. Elevating the cutter bar above this point will significantly reduce the amount of nitrate in corn silage.

Fresh forage and silage materials that are high in nitrate will have lower nitrate levels after being ensiled due to the microbial activity in the fermentation process. This may not completely remove the risk if the initial levels are very high since only 20-50% of the nitrate will be reduced. Be aware that the higher nitrate levels will produce more of the dangerous nitrogen oxide gas during the ensiling process.

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TESTING FOR NITRATE IN FEED

The best way to be assured of safe nitrate levels in feed is to have it analyzed. The most important goal in collecting a sample is to assure that the material sent to the lab is as representative of the field being harvested as possible. Sub-samples of corn silage can be collected at various intervals during the chopping process, combined, and mixed thoroughly. The same can be done with forages. Silage or forage can be tested either before or after the ensiling process, but results more directly related to what the animal will be fed will be obtained following the fermentation process. Hay samples can be collected by taking one core from each of 20 small bales, two cores from each of 10 large bales, or two cores each from the curved side of 10 round bales. Collect a one quart volume of feed material for testing. The sample should be sent in a paper bag to prevent any fermentation or molding during transit.

INTERPRETING LABORATORY RESULTS

Once laboratory results are obtained, be sure to convert all units to NO_3^- and on a dry weight basis. If the result is reported in units of nitrate nitrogen (NO_3^- -N), multiply the result by 4.4. Use the following table to interpret the level of risk associated with your feed sample. This interpretive table should not be used when evaluating risk levels for swine since they are extremely sensitive to nitrates.

Table 1. Safety Guidelines for Nitrate in Feed Samples Used in Ruminant Animals' Diets

Percent Nitrate (NO_3^-) Ion (Dry Weight Basis)	Risk Level
0.0 - 0.44	This level is considered safe to feed under all conditions.
0.45 - 0.66	This level should be safe to feed to nonpregnant animals under all conditions. It may be best to limit its use for pregnant animals to 50% of the total ration on a dry basis.
0.67 - 0.88	Feeds safely fed if limited to 50% of the total dry matter in the ration.
0.89 - 1.54	Feeds should be limited to about 35-40% of the total dry matter in the ration. Feeds containing over 0.88% nitrate ion should not be used for pregnant animals.
1.54 - 1.76	Feeds should be limited to 25% of total dry matter in ration. Do not use for pregnant animals.
Over 1.76	Feeds containing over this level are potentially toxic. Do not feed.

LIVESTOCK MANAGEMENT PRACTICES

Steps should be taken to reduce the level of nitrate from all sources when managing the livestock's diet. This not only includes silage and forage, but also grain, other supplements, as well as water intake. When evaluating sources, be certain that all of the levels are expressed as nitrate (NO_3^-). Determine what the animal is consuming. Add up the nitrate levels in the feed on a dry weight basis. Add to that the amount of nitrate from the water source. A total intake of 30-45 grams of nitrate ion per 100 pound of bodyweight is considered acutely toxic in normal animals, and lower levels (8-22 grams per 100 pounds) may be toxic to animals under stress.

Even if nitrate levels are determined to be high, proper management can allow the feed to be used by diluting the high level feed with material lower in nitrate content. Animals should also be conditioned by slowly increasing the portion of high nitrate level feed in the diet. Grazing animals should not be allowed on pastures until afternoon when night-time nitrate accumulations have subsided. In addition, avoid grazing shortly after a drought-ending rain. Allow hungry animals to fill prior to releasing them to pasture. Cattle in cold or inclement weather are more susceptible to nitrate poisoning because they are more likely to consume stalks which contain more nitrate. Utilize propionibacteria as a supplement in ruminant animals' diets. Some strains of the bacteria are capable of rapidly reducing nitrate to nontoxic nitrogen compounds. Once established in the rumen, they have the ability of reducing ruminal nitrite and blood methemoglobin concentrations by 40 to 50%.