NSW GOVERNMENT Department of Primary Industries

primefact

Nitrate and nitrite poisoning in livestock

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What is nitrate/nitrite poisoning?

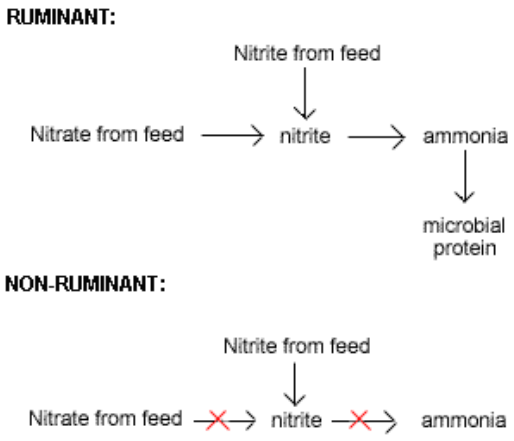
During periods of drought, the amount of nitrate in the soil can increase greatly because of:

- a lack of leaching;
- reduced nitrate uptake by plants;
- decomposition of organic matter.

When a drought breaks, nitrate uptake by plants may be high, especially in the first week after rain. If hungry animals are allowed free access to such plants, stock losses from nitrate/nitrite poisoning may be disastrous.

Nitrates and nitrites are closely linked as causes of poisoning. Nitrate is not always toxic to animals. When feed containing nitrate is eaten by ruminant animals, nitrate is converted to nitrite, and then to ammonia, by rumen microbes. Non-ruminant animals are unable to do this.

Nitrates have a direct, caustic effect on the lining of the gut if consumed in large quantities. Signs of poisoning include diarrhoea, salivation and abdominal pain.



Nitrites are much more toxic. These are formed from nitrates during ruminant digestion and may also occur if stored plant materials heat up or are attacked by bacteria or fungi. When high levels of nitrites accumulate in the gastrointestinal tract, they are absorbed into the bloodstream. Nitrite in the bloodstream changes haemoglobin (the oxygen-carrying part of blood) to methaemoglobin (which cannot carry oxygen). If enough methaemoglobin is produced, the animal will die. Some animals can tolerate up to 50% conversion of their haemoglobin without ill-effects; however, when more than 80% haemoglobin is converted, death occurs.

Sources of poisons

Plants

Nitrogen is considered the plant nutrient most widely deficient in the world's soils. Various agricultural practices have therefore been developed to increase its concentration in the soil. These practices include incorporating legume varieties in pasture and applying various nitrogen-rich fertilisers (urea, sulphate of ammonia, blood and bone) to crops. Such practices sometimes cause plants grown in these soils to have nitrate levels above safe limits, resulting in livestock poisonings.

Certain weeds, various root crops, cereal hays, and even immature cereal crops can also cause these poisonings. More than 80 specific plants are known to cause nitrate/nitrite poisoning. Some of these plants are listed in Table 1.

Table 1. Some plants associated with nitrate/nitrite poisoning

Crops/ pasture	Weeds
Oats	Capeweed
Sorghum	Variegated thistle
Maize	Mintweed
Rape	Crown beard
Lucerne	Pigweed
Kikuyu	Redroot
Turnip tops	Caltrop (cat's head)
Sugar beet tops	Marshmallow
Rye	Blackberry
Sudan grass	Fat hen
Soybean	
Wheat	
Barley	

Plant factors

Under certain soil and environment conditions, plants can contain high levels of nitrates

Factors that facilitate uptake of nitrate by plants include:

- use of nitrogen-containing fertilisers;
- low soil sulphur and molybdenum;
- areas where stock have congregated and urinated/defaecated (e.g. yards).

Factors which cause nitrate to accumulate in the plant include:

- drought;
- cloudy or cold weather;
- herbicide application – especially phenoxy herbicides such as 2,4-D;
- wilting.

The amount of nitrate in plant tissues also depends on:

- plant species;
- stage of maturity;
- part of the plant.

Nitrate concentrations are usually higher in young plants and decrease as plants mature. Most of the plant nitrate is also located in the bottom third of the stalk, hence the leaves contain less nitrate and the flowers or grain contain little to no nitrate.

Hay and silage

Hays made from cereal crops, especially those grown under drought conditions and cut while 'sappy', can develop toxic nitrite levels when they heat up. Oaten hay is particularly risky and becomes poisonous if previously dry hay is

dampened by rain or snow some time before feeding out.

Hays made from nitrate-rich materials contain almost as much nitrate as when first made, unless some is converted to nitrite by heating or mould.

Silage contains less nitrate than its parent crop due to the fermentation process that it undergoes. Forages high in nitrate can lose 40%–60% of their nitrate content during fermentation.

Water

Water can contain toxic levels of nitrates. High-risk sources include:

- water from deep wells fed by soil water from highly fertile soils;
- condensed water from ventilating shafts in piggeries where there are high ammonia levels in the air;
- fluids draining from silos containing materials rich in nitrates.

Water contaminated by fertiliser, animal wastes or decaying organic matter may also be a source of toxic levels of nitrate. Marginally toxic levels of nitrate in water, combined with marginally toxic levels of nitrate in feed, can also lead to poisoning.

Animal susceptibility

Species

There is considerable variation between species in their susceptibility to nitrite poisoning. Pigs are the most susceptible, then, in order, cattle, sheep, and horses.

Non-ruminants, such as horses and pigs, have no mechanism for converting nitrate to nitrite in their digestive tracts, so they are not susceptible to nitrite poisoning from excessive intake of nitrates. However, they are highly susceptible to poisoning from nitrite intake (for instance in mouldy hay) because they cannot convert the nitrite to ammonia.

Sheep are more efficient at converting nitrite to ammonia, so this may be the reason why they are less susceptible to nitrite poisoning than cattle.

Hungry stock

Hungry stock are at far greater risk than animals receiving regular and good fodder. This is because hungry stock consume more toxic feed, and, in the case of ruminants, their rumen microbes will not have had time to adapt to converting the nitrite to ammonia. For example, it takes about twice as much nitrate to kill a ruminant when the nitrate comes from forages that are eaten over a long period of time, compared to that which is consumed very quickly.

Ruminant animals receiving carbohydrate-rich fodders tolerate high nitrate and nitrite levels better than those that are not. This is because energy from carbohydrates (grain) helps rumen microbes convert nitrite to ammonia.

Animals that are stressed or in poor health or condition will also be more susceptible to nitrate/nitrite poisoning.

Adaptation or acquaintance

Frequent intake of small amounts of high-nitrate feed increases the total amount of nitrate that can be consumed by ruminant animals without adverse effects. This is because rumen microbes are adapted to deal with the increased nitrate content of the feed.

Signs of poisoning

Signs of nitrate poisoning are:

- diarrhoea and vomiting;
- salivation;
- abdominal pain.

Signs of nitrite poisoning usually appear 6–24 hours after the toxic material is consumed. These include:

- rapid, noisy and difficult breathing;
- blue/chocolate-coloured mucous membranes;
- rapid pulse;
- salivation, bloat, tremors, staggering;
- dark, chocolate-coloured blood;
- abortions – pregnant females that survive nitrate/nitrite poisoning may abort due to a lack of oxygen to the foetus; abortions usually occur 10–14 days after exposure to nitrates;
- weakness, coma, terminal convulsions, death.

Post-mortem findings

From nitrate poisoning:

- severe reddening and stripping of the stomach and intestinal linings.

From nitrite poisoning:

- dark red or coffee-brown blood that clots poorly;
- pinpoint haemorrhages in internal organs and on internal surfaces;
- accumulation of blood in the stomach wall.

Diagnosis

Diagnosis is based on:

- observed clinical signs;
- possible exposure to toxic plants, feeds or water;
- post-mortem findings;
- laboratory tests.

Treatment

Urgent veterinary attention is required to confirm the tentative diagnosis and to treat affected animals. Stock should immediately be removed from suspect material, and be handled as little and as quietly as possible. Hay or some other low-nitrate herbage should be fed to dilute the nitrate and/or nitrite in the stomach.

Affected animals can be treated by intravenous injections of methylene blue, a powdered dye material. Methylene blue converts the methaemoglobin back to oxygen-carrying haemoglobin.

Note: Methylene blue is no longer approved by the Australian Pesticides and Veterinary Medicines Authority (APVMA) for use in food-producing animals.

Contact your veterinarian for advice. If producers have an old supply of methylene blue on hand, they should consult their veterinarian before attempting to use it. A veterinarian may use or recommend methylene blue to treat a single animal. Written advice about the treatment, including an appropriate withholding period to manage residue risks, must be provided to the person in charge of the animal.

Prevention

The risk of poisoning can be reduced by:

- having feeds and forages analysed for nitrate when in doubt, such as drought-stressed, small-grain forages;

- not grazing stock on forages that are potentially dangerous;
- observing stock frequently when put on potentially risky feed;
- feeding hungry stock on dry hay or mature grass before allowing free access to immature cereal crops or root-crop tops;
- feeding only well-dried cereal hays;
- preventing hungry stock from gorging recently sprayed weeds;
- preventing hungry stock from gorging highly fertilised crops;
- not overstocking risky pastures / grazing crops – overstocking can result in more stalk material being consumed (the stalk contains the most nitrate in the plant). Avoid strip grazing for the same reason;
- not grazing high-nitrate pastures or crops for 7 days after periods of rainfall, cloudy days, frosts, or high temperatures that cause wilting;
- grazing stock on high-nitrate pastures or crops during sunny afternoons (when the temperature is above 15°C) and removing them at night. This reduces the amount of high-nitrate forage consumed and helps rumen microbes to adapt;
- preventing access to high-risk weeds around yards/sheds;
- feeding risky material in small amounts diluted with safe feed, preferably high-carbohydrate feed such as grain (if accustomed to grain feeding), and gradually increasing the amount fed – this applies only to ruminants;
- ensuring that water does not contain high levels of nitrates;
- not feeding green chop that has heated after cutting;
- never feeding mouldy hay.

Another option for reducing the risk of nitrate/nitrite poisoning is to harvest and feed high-nitrate forages as silage. This is because nitrate levels are reduced by the fermentation process when feed is ensiled. Harvest these feed crops at least 7 days after rain or cloudy weather, preferably later in the day.

Harvesting close to maturity is also advised to reduce the risk of nitrate toxicity (although this means reduced digestibility of the feed).

Raising the cutter head to selectively avoid stalk bases is another method of reducing the risk of poisoning.

Further information

For further information, visit www.dpi.nsw.gov.au, or contact NSW DPI or your veterinary advisor.

Acknowledgements

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