OREGON DEPARTMENT OF AGRICULTURE

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Nitrate (NO_3) Toxicosis in Animals

Different animal species have different sensitivities to nitrate (NO_3) with regard to toxicities, with ruminants (species with a compartmentalized stomach that utilize bacteria to break down feed material, such as cattle, goats, sheep, and camelids) being more sensitive than monogastric animals (species with a simple stomach, such as pigs, dogs, cats, horses, and humans). Nitrate toxicity in animals is caused by conversion to nitrite (NO_2) which is 10x more toxic than nitrate. Ruminants (particularly cattle) have bacteria that convert nitrate to nitrite within the rumen during digestion, leading to elevated blood nitrite levels. Horse's nitrate to nitrite conversion occurs in the cecum during digestion but to a reduced amount when compared to ruminants. Young pigs and other monogastric animals (similar to human infants) have an underdeveloped gastrointestinal tract that may be able to convert nitrate to nitrite as a result of higher pH in the stomach, making them potentially more sensitive. But adult monogastric animals are very resistant to nitrate intoxication.[7]

Sources of excess nitrate include feed and water, with feed being the most common source. Some feed types can concentrate nitrate, where water tends to dilute nitrate. Nitrate accumulating plants include sorghum, Sudan grass, pigweed, lambs-quarter, oat hay, soybeans, sweet clover, and cereal grains.[1,4] Drought, lower temperature, fertilizers, soils high in nitrogen and other soil factors contribute to elevated nitrate levels in plants.[1] Water can become contaminated via fertilizer, animal waste, decaying organic matter, or other sources.[1]

Nitrate toxicity can be the result of either acute or chronic exposure. Chronic exposures, which are not common, do not result in death but have been related to abortion and infertility, stunted growth, weight loss, reduced milk production, vitamin A deficiency and increase in infections. In acute exposures, high levels of nitrite are absorbed into red blood cells and combine with hemoglobin to form a compound called methemoglobin. This molecule cannot transport oxygen and causes the animal to die due to lack of oxygen in tissues.[1,7]

Ruminants

- Acute poisonings can be seen with forage nitrate levels > 10,000 ppm (1%) or water nitrate levels > 1,300 ppm. [1,4]
- Feeds should contain less than 0.6% (6,000 ppm) nitrate.[4]
- Diets for pregnant beef cattle should not have nitrate levels that exceed 0.5% (5,000 ppm).[1]

Monogastric Animals

- Dogs have been fed up to 2% nitrate (20,000 ppm) in their diets without any ill effects.[5]

General Water Guidelines

- While most animal species can safely consume much higher levels of nitrate in their drinking water, to minimize the risk of long-term exposure, 400 ppm (mg/L) or less nitrate can likely be considered safe for domestic animals.[3]
- Due to the increased risk of nitrate conversion, neonatal animals should use a lower 40 ppm (mg/L) nitrate limit in drinking water.

Diagnosis of nitrate toxicity should be made by a veterinarian that collects samples from affected animals along with samples of the suspect source material (e.g., feed, water). Plasma or serum is the preferred sample in clinically affected live animals, while ocular fluid can be collected postmortem.

Treatment strategies are not approved for use in food animals and consultation with a veterinarian prior to treatment in these cases is necessary.

Sources

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