Cow Calf Technical Bulletin

Dietary NPN (Urea) And High-Nitrate Feeds

Nitrate toxicity. Urea toxicity. Both are potentially dangerous conditions involving N-containing compounds that may be present in cattle feed. But contrary to frequently encountered opinion, one does not affect susceptibility to the other.

Nitrate toxicity

More properly termed "nitrite toxicity," this becomes a concern when high levels of nitrate accumulate in stressed plants prior to their consumption by cattle. Nitrate is reduced to nitrite by rumen bacteria, and under normal conditions the nitrite is further converted to ammonia. High ruminal levels of nitrite result in movement of this compound into the bloodstream before the second conversion can occur. Here nitrite binds with hemoglobin, rendering it incapable of transporting oxygen. Toxicity is due to lack of oxygen throughout the body, in other words suffocation due to a blood dysfunction.

Animals are more susceptible to nitrate toxicity if they have an inadequate water supply, poor liver function, concurrent disease challenges, cold stress, or a low-energy diet. Susceptibility is also increased when deficiencies of copper, iron, magnesium, manganese, iodine, and/or vitamin A exist.

Urea toxicity

More properly termed "ammonia toxicity," this typically occurs in cattle that have ingested large volumes of urea in a short time (e.g., after gaining access to fertilizer) or that have impaired ability to metabolize dietary urea (disease, malnutrition, liver damage). When urea is consumed, it typically is broken down in the rumen into ammonia. This ammonia is either utilized by the rumen microbes in the production of cell proteins, or sent through the bloodstream to the liver for conversion back to urea, which is either recycled or excreted. If blood ammonia levels exceed the liver's capacity for urea production, systemic poisoning occurs by affecting the central nervous system.

The only common factor of these two metabolic processes is the formation of ammonia in the rumen. As mentioned above, this ammonia (as well as that released from digestion of all dietary protein) serves as an important nutrient source for the rumen microbes. Much of the cow's protein requirement is regularly met by digestion of these bacteria and protozoa, which incorporate the ammonia into their cell proteins.

Key Points

- Neither urea nor ammonia levels impact the conversion of nitrate to nitrite, or of nitrite to ammonia
- Rumen breakdown of high-nitrate feeds does not yield significantly more rumen ammonia than degradation of other feeds with similar crude protein levels
- The presence of nitrate actually inhibits the action of the enzyme which breaks urea down into ammonia, delaying and leveling rumen ammonia supply
- Effective utilization of dietary urea AND detoxification of nitrite both rely on an adequate supply of energy to the rumen microbes

Quotes of Note

"With respect to supplementary rations, those containing urea result in less [nitrate]toxicity than soybean meal, and the presence of readily available carbohydrate (corn, sugar, etc.) offers a considerable degree of protection."
--Colorado State University Nitrate Toxicity fact sheet

"Nitrate will inhibit urease and attenuate ammonia release in the rumen. Attenuated release will avoid ammonia intoxication....In several studies, urea has proven superior to soybean meal as a protein supplement for high nitrate feedstuffs." -- ASAS Symposium, F.N. Owens & P. Dubeski

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