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Nitrates in Cattle Feeding

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Nitrate is a normal constituent of plants. The amount of nitrates that plants contain varies with the kind of plant, the amount of fertilizer applied, and the growing conditions. The form of fertilizer, organic or chemical, makes very little difference in the nitrate uptake of plants. The type of soil has some effect. Heavy wet soils may be expected to produce less nitrates. Commercial nitrogen fertilizer applied in excess of the plant's needs may cause an increase of nonprotein nitrogen in the plant.

The stage of growth, rate of growth, and species of plant all influence the nitrate content. Nitrate content generally is highest in plants during early vegetative stages of growth and decreases steadily as the plant matures. The stems, especially near the base, contain the highest concentration of nitrate. Leaves of the plant may also contain considerable nitrate, but little is found in the seeds.

Water may be a source of excess nitrates. Nitrates may reach dangerous levels in ponds and wells, particularly where there is runoff from feed lots, corrals, or other sources of high nitrate contamination. Excessive nitrates will not be found in ponded water with abundant plant growth.

Crops most apt to contain a high concentration of nitrates are: corn, as fodder and silage; sorghums, as silage; oats, as silage and hay; sudan, as silage; hay and pasture; alfalfa, as hay and silage.

The problem

Acute nitrate poisoning of cattle has been recognized for many years. Symptoms include severe depression, rapid and difficult respiration, abortion, severe decline in milk production, and death. Death often occurs suddenly. Recently there has been an increased number of reported cases in which nitrates are suspected of causing chronic or subclinical toxicity. Symptoms reported are lowered milk production, decreased rate of gain, digestive upsets, unthriftiness, rough hair coat, vitamin A deficiency, and occasional abortions.

In a number of recent carefully conducted experiments involving both sheep and cattle, no evidence of subclinical or chronic nitrate poisoning occurred. These experiments were conducted on a considerable number of animals fed varying amounts of nitrate, either as high-nitrate forage or nitrate added to the rations. Exceedingly high nitrate diets (above 1.5%) resulted

in deaths, abortion, lowered milk production, and decreased fertility in some animals. Other animals that were fed identical rations remained normal.

A wide variation in the reaction of both plants and individual animals to nitrates must be recognized as a very important part of this problem. The situation is complicated by the interactions of temperature, soil type, kind of plants, rate of growth, level of animal nutrition, and the possibility of other minor elements in the ration. More extensive and heavier fertilizer applications may increase nitrate uptake by plants. Increased production rates in animals may add to the problem.

Toxic nitrate levels

Toxic levels of nitrates may vary widely, depending upon circumstances at a given time. Therefore, toxic levels cannot be definitely stated. This causes confusion in any attempt to analyze and find answers to the nitrate poisoning. The following table indicates possible toxic levels.

Level of Nitrate and Expected Animal Response

Level of KNO ₃ (potassium nitrate) Percent of total ration dry matter	Animal response
.0 to 0.5%	Normal if on adequate ration
0.6 to 1.0%	Milk drop, vitamin A deficiency symptoms in 6 to 8 weeks in some cases
1.0 to 1.5%	Milk production loss in 4 to 5 days, possible reproduction difficulty over the period fed in some cases
1.5% plus	Sudden death, abortions, severe depression, difficult respiration

Water Nitrate Levels in Relation to Nitrate Toxicity

	Potassium nitrate (KNO ₃) Parts per million
Safe	0- 74
Doubtful	74- 220
Risky	220- 370
Do not use	370- 740
Do not use—sublethal but toxic	740-1,110
Do not use—acute toxicity and lethal	1,110- over



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Toxic levels may vary with the net energy of the ration and the tolerance of the individual animal. In the animal, nitrates are reduced in the rumen (or first stomach) to nitrites, which interfere with the metabolic oxidation process. Nitrates combined with the hemoglobin of the red blood cells form methemoglobin. Methemoglobin cannot supply the necessary oxygen to the tissues, and the animal develops symptoms of oxygen starvation. The color of the blood turns from red to brown. Some animals may develop a tolerance to nitrate poisoning, increasing the number and size of their red blood cells so that adequate amounts of oxygen can be delivered to the tissue. Other animals do not respond in this manner and poisoning occurs. There is considerable research indicating this variability of toxic levels. At Oregon State University high producing milking cows were fed a ration which had 1.25% KNO_3 in the total dry matter, with no detrimental results. The cattle were fed this amount for nine weeks.

Roughage feeds are the major offenders in nitrate toxicity. As a rule, the potassium nitrate (KNO_3) intake should not exceed 50 grams per cow per day, or 0.5% of the ration.

Analytical interpretation

The interpretation of feed and water analysis is sometimes difficult because different values are used.

The three most common values are nitrate nitrogen ($\text{NO}_3\text{-N}$), nitrate (NO_3), and potassium nitrate (KNO_3). For interpretation purposes, $0.068\% \text{NO}_3\text{-N} = 0.3\% \text{NO}_3 = 0.49\% \text{KNO}_3$, or $\text{NO}_3\text{-N} \times 4.43 = \text{NO}_3 \times 7.21 = \text{KNO}_3$. Percent and ppm (parts per million) also add to the confusion. A simple method of ppm-percent interconversion is shown below.

Interconversion of percent of ppm

$$\% \times 10,000 = \text{ppm}$$

$$\frac{\text{ppm}}{10,000} = \%$$

If a sample of hay is reported to have 2.0% KNO_3 and this hay makes up 50% of the total dry matter of the ration, the cow could be expected to be eating 1.0% KNO_3 daily from this source.

Nitrate poisoning prevention and treatment

1. Feed high energy feeds such as corn, barley, molasses.
2. A balanced ration should be fed at all times.
3. Dilute high nitrate roughage with grains or other roughage known to be low or free from nitrates.
4. Symptoms may be very similar to many other disorders, so when nitrate is suspected, have feed analyzed and consult a veterinarian.