AARHUS UNIVERSITET
DCA - NATIONALT CENTER FOR FØDEVARER OG JORDBRUG

Til Fødevarestyrelsen

Vedr. bestillingen: 'Vurdering af Kommissionens forslag til vejledende grænseværdier for nitrit og nitrat i foder'

DCA - Nationalt Center for Fødevarer og Jordbrug

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Specialkonsulent

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Fødevarestyrelsen har i bestilling dateret d. 16. december 2016 bedt DCA – Nationalt Center for Fødevarer og Jordbrug – om en faglig vurdering af vejledende grænseværdier for nitrit og nitrat i foder.

Besvarelsen er udarbejdet som led i "Aftale mellem Aarhus Universitet og Fødevareministeriet om udførelse af forskningsbaseret myndighedsbetjening m.v. ved Aarhus Universitet, DCA – Nationalt Center for Fødevarer og Jordbrug, 2016-2019".

Baggrunden for bestillingen er, at Kommissionen har fremlagt et forslag om vejledende grænseværdier for nitrit og nitrat i foder og nogle tilhørende principper for GMP. Fødevarestyrelsen ønsker på denne baggrund en vurdering af, om de vejledende grænseværdier er passende og om de øvrige anbefalinger er dækkende og tilstrækkelige til at sikre, et ikke for højt indhold af nitrit og nitrat i foder.

Herunder er besvarelser af de spørgsmål der er rejst. Kommissionens forslag om vejledende grænseværdier er vedlagt besvarelsen som bilag 2. Bilag 1 er litteratur der henvises til i svarene.

Besvarelsen er udarbejdet af **Seniorforsker Peter Lund og Professor Hanne Damgaard Poulsen, Institut for Husdyrvidenskab, Aarhus Universitet**.

Spørgsmål 1: Er de foreslåede grænseværdier passende?

Svar: Litteraturen vedrørende LOAEL (Lowest Observed Adverse Effect Level) og NOAEL (No Observed Adverse Effects Level) for nitrit og nitrat i dyrefoder er særdeles sparsom, og på ingen måde entydig med hensyn til effekt og grænseværdi indenfor dyreart eller eventuelle forskelle i grænseværdier mellem dyrearter. Det er derfor svært både at fastlægge og vurdere eventuelle vejledende grænseværdier for nitrit og nitrat i dyrefoder, som skal være dækkende for alle dyrearter. Desværre er dokumentationen for de forskellige niveauer af nitrat og de tilhørende anbefalinger til brug ikke præsenteret i dokumentet. I EFSA rapporten[1] henvises til Rogers (1999) som, på baggrund af en internet-artikel, anbefaler, at ved 5600-9400 ppm nitrat kan det pågældende foder max udgøre 25% af rationens tørstof. I den detaljerede guideline anbefales det derimod, at foder med helt op til 15400-17600 ppm kan udgøre 25% af rationens tørstof.

En amerikansk hjemmeside fra University of Georgia angiver anbefalinger, som er tilsvarende den fremsendte (Hancock, 2016), og dette dokument er vedhæftet. Tilsvarende har Iowa State University opsummeret anbefalinger fra forskellige amerikanske stater. Dette dokument (Ensley & Barnhart, 2016) er også vedhæftet. Bemærk at enhederne varierer i dokumenterne (ppm nitrat eller ppm nitrat-N, men at tilsvarende enheder kan findes i de fremsendte guidelines).

På baggrund af ovenstående amerikanske data vurderes grænseværdierne at være passende, omend udokumenterede i selve dokumentet.

Spørgsmål 2: Hvilken af de foreslåede guidelines under punkt 5 i Kommissionens forslag er mest korrekte og anvendelige?
Svar: Da litteraturen indenfor området er sparsom og ikke entydig, anbefales det, at der anvendes en så simpel guideline som muligt vedrørende nitrat, og det vil i dette tilfælde være den guideline i ”Recommendation on good practises....”, som kun anvender 3 kategorier. Ønsker man i stedet alligevel at anvende den mere detaljerede guideline med 6 kategorier, som er tilsvarende de amerikanske guidelines, så virker det underligt, at der for niveauet 1500-2000 ppm nitrat ikke er anbefalinger med hensyn til særlige forbehold i relation til drægtighed, da disse forbehold er taget allerede for det lavere niveau på 1000-1500 ppm.

Guideline vedrørende indhold af nitrit i foder i ”Recommendation on good practises....” vurderes at være tilstrækkeligt på nuværende tidspunkt.

Spørgsmål 3: Er de øvrige anbefalinger dækkende og tilstrækkelige til at sikre et ikke for højt indhold af nitrit og nitrat i foder?
Svar: Anbefalingerne til arbejdsgange for at undgå højt indhold af nitrat og nitrit i fodermidlerne (punkt 4) synes at være fyldestgørende. Under nitrit bør det dog nævnes, at det er vigtigt, at man også er opmærksom på arbejdsgange for at undgå et højt indhold af nitrat, da nitrat hos drøvtyggere kan konverteres til nitrit i vommen.

Spørgsmål 4: Bør der fx inkluderes en beskrivelse af brugbare foranstaltninger for kritiske punkter?

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[1] https://www.efsa.europa.eu/en/efsajournal/pub/1017

Svar: Spørgsmålet er ikke klart formuleret. Punkt 2 i dokumentet bør uddybes da f.eks. grise er særligt følsomme overfor høje niveauer af nitrit i blodet jfr. vores tidligere redegørelse fra 2015[2].

Spørgsmål 5: Bør der nævnes specifikke fodermidler i dokumentet og i så fald hvilke?
Svar: Det anbefales, at afgræsningsgræs tilføjes under punkt 1. Endvidere bør det nævnes, at der er stor international interesse for anvendelse af nitrat i foderet til reduktion af produktionen af metan fra drøvtyggere. Internationale forsøg har da også vist gode resultater med indhold på op til 20 g nitrat pr kg fodertørstof, når dyrene tilvænnes til nitrat over en periode. Fremadrettet forventes det derfor, at der vil komme specielle produkter på markedet med et højt indhold af nitrat, som er målrettet en reduktion af produktionen af metan fra drøvtyggere.

Venlig hilsen

Ulla Sonne Bertelsen

Kopi til Innovation, Landbrugs- og Fiskeristyrelsen.

Bilag 1: Samling af artikler der henvises til i svarene.
Bilag 2: Kommissionens forslag om vejledende grænseværdier for nitrit og nitrat i foder og tilhørende principper for GMP

[2] http://pure.au.dk/portal/da/publications/graensevaerdier-for-nitritnitrat-i-dyrefoder(656d7a43-9b11-4212-880f-6c1c326e5994).html

Bilag 2 til besvarelsen 'Vurdering af Kommissionens forslag til vejledende grænseværdier for nitrit og nitrat i foder' sendt fra DCA, AU til FVST den 3. februar 2017. Samling af artikler der henvises til i besvarelsen

UGA extension

Nitrate Toxicity

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Nitrate Toxicity at a Glance:

Identify and test all forages that may have accumulated nitrates.

Nitrogen fertilization increases the risk of nitrate accumulation.

Some plants accumulate nitrates at a greater rate.

Split applications of nitrogen fertilizer (organic or inorganic) within the growing season.

Do not harvest or graze forage within seven days following a drought-ending rain.

Do not feed green chop until the whole plant has been tested for elevated nitrate concentrations.

Harvest the crop as silage when possible.

Nitrates tend to be highest in the lower stem and leaves.

Increase the harvest height to minimize the inclusion of lower plant parts and low growing weeds.

Do not graze crops closely.

Use field test kits to rule out samples low in nitrates, but confirm field results with a laboratory analysis when results indicate moderate or higher levels of nitrate (>2,500 parts per million-ppm).

Dilute high nitrate forages with feedstuffs that are high in energy.

Provide plenty of clean water and supplement with sufficient vitamins and minerals.

Avoid or minimize feeding forages that are high in nitrates to lactating, pregnant, or sick animals.

Limit animals to 3 or 4 hours of access to high-nitrate hay per day so that intake is limited to approximately 50 percent of normal. Supplement the lower hay intake by feeding a grain or by-product feed (6 to 10 pounds per day depending on lactation status and forage quality) BEFORE allowing the animals to access the high-nitrate hay.

Stressful growing conditions often result in high concentrations of nitrates in plant tissue. When feeding animal forages containing toxic levels of nitrates, poor productivity or death may occur. This publication summarizes the effect that high nitrates have on the animal, presents the conditions to expect in toxic concentrations of nitrates, and outlines strategies that could prevent or reduce the risk of nitrate toxicity.

The Effects of High Nitrates in the Animal Diet

Nitrate (NO_3^-) is reduced to nitrite (NO_2^-) by microbes in the digestive tract of cattle, sheep, goats, horses, and other animals. In most cases, the microbes further convert the nitrite to anunonia and ultimately to amino acids and proteins. However, ingestion of high concentrations of nitrates builds up nitrite levels and the nitrite is absorbed into the animal's bloodstream. Once in the bloodstream, nitrites bind with hemoglobin (creating methemoglobin) and prevent the normal transfer of oxygen. Depending upon the amounts consumed, symptoms of nitrate poisoning may be hardly noticeable. Low nitrate intake levels often cause lower milk production, abortion, breeding problems, or symptoms that mimic a nutritional deficiency (Vitamin A and E, rickets, phosphorus, or calcium imbalance).

Signs of acute nitrate toxicity are a result of severe inhibition of oxygen transfer and are strikingly obvious. Symptoms include bluish color of mucous membranes, rapid and difficult breathing, a rapid pulse 150 beats/minute), tremors, staggering, collapse, and death. A key diagnostic feature of acute nitrate toxicity is dark brown or "chocolate-colored" blood. Unfortunately, acute toxicity may appear suddenly (often within one to two hours of ingesting toxic nitrate levels) and animals are often simply found dead. In most cases, treatment is not practical due to the rapid onset of symptoms. Thus, prevention is the primary way to combat nitrate toxicity.

Nitrate Accumulation in the Plant

Plants take up nitrogen primarily in the fom1 of nitrate. Early in the plant's growth, nitrate uptake is relatively high and nitrates may become concentrated. As plant growth slows, the plant continues to take up nitrates, but the nitrates do not convert to amino acids and proteins. This causes a buildup of nitrates in the plant. Periods of drought or cloudy weather that slows the rate of photosynthesis are often associated with slowed plant growth and the accumulation of nitrates. Plants in vegetative stages are most likely to have high nitrate levels. In addition, nitrates are more highly concentrated in stems and leaves closer to the soil surface.

Rapid uptake of nitrates during the first few hours following a drought-ending rain may also cause nitrate levels to be high. The conversion of nitrates to amino acids within the plant may take several days. Thus, expect nitrates to remain very concentrated for seven or more days after the crop has received enough rain to sustain growth.

Forage crops that receive high nitrogen fertilization are more likely to contain high nitrate concentrations. Thus, it is common for summer annuals, warm-season perennials, and small grains to have high nitrates (Table I on page 3). In addition, many conunon weed species naturally accumulate high levels of nitrates. It is difficult to predict when high nitrate levels will occur because of the various rates of fertilizer application, variable weather conditions, and the variety of crops grown for pasture, hay, and silage. Therefore, when weather or management are suspected factors in creating the potential for toxicity, evaluate the levels of nitrate in the forage.

Decreasing the Risk of Nitrate Toxicity

Fertilization - Nitrogen fertilization is critical to high forage yields. However, splitting the nitrogen applications throughout the growing season rather than applying the full rate at the beginning of the season reduces the risk of high nitrate concentrations. Furthermore, plants may also have higher nitrate concentrations when soils are deficient in other major nutrients (phosphorus , potassium, etc.).

Harvest techniques - Harvest management also plays a critical role in lowering the risk associated with nitrate toxicity. Animals may graze forages with high nitrate concentrations, but producers should limit the intake of such forage. Effectively limit the total nitrate intake by providing supplements (cottonseed, com gluten, or soybean hulls) or feeding low-nitrate roughage prior to turning animals into pasture that is high in nitrates.

In general, the most risky harvest method is to green chop. In addition to high initial nitrate levels, forage harvested as green chop will often undergo a heat cycle that increases the conversion of nitrates **to** nitrites. In contrast, ensiling tends to reduce the nitrate content of forages by 30 to 60 percent. However, employ proper ensiling techniques. Forage that is too dry, poorly packed, or fed too early may have not fermented or reduced nitrate levels sufficiently. Hay harvest may also be a feasible option, but nitrate concentrations DO NOT change substantially when stored as hay.

Avoid elevated nitrate concentrations in the lower parts of the plant stem and any low growing weeds by raising the cutting height. For example, corn silage harvested at 6' to 8' may be 20 to 25 percent lower in nitrate concentration than when harvested at a height of 2' to 4'. Similarly, sufficiently lowering stocking rates will help prevent animals from grazing too closely to the forage. However, higher harvest heights result in significant yield reductions.

Reducing the Risk of Nitrate Toxicity

To prevent nitrate toxicity, producers should test several representative samples from any forage suspected to be high in nitrates. It is common for some portion of the forage lot to be extremely high in nitrates, while other portions are safe. A major cause of this variation is variability in the productivity within a field (i.e., droughty soils, zones with higher weed pressures, etc.). Thus, it is best to test the forage prior to harvest when possible. This is important for two reasons. First, it gives as much time as possible to receive accurate results from a laboratory analysis. Second, suspected "hot spots" within the field can be identified and sampled accordingly. Forage from these "hot spots" may hide within the lot during harvest and may or may not be represented if the hay lot or silage is sampled prior to feeding.

Test kits that approximate nitrate concentration in the forage are commercially available for use in the field. Most county extension offices have field kits to test for high nitrate concentrations and your local County Extension Agent may be available to help you to do a field evaluation. Though the field test kit may be a very useful screening tool, forages that test positive for moderate or higher levels of nitrate (for example, values greater than 2,500 ppm in forage for beef cattle) should undergo quantitative analysis in the laboratory. For the development of rations that safely dilute the nitrate, the nitrate concentration in the forage needs to be accurately determined.

For a small fee, submit samples for nitrate analysis to the University of Georgia's Agricultural and Environmental Services Laboratories (AESL) in Athens, Georgia (http://aes I.ces.uga.edu D. Visit with your local county extension agent for submission procedures.

The results of the laboratory analysis from the AESL is reported as the concentration of nitrate in parts per million (ppm) of the dry forage. Table 2, on page 3, provides management guidance for the safe use of forages containing increasing levels of nitrates when feeding beef cattle. Other animal classes may have different critical values. For example, dairy cattle may begin to exhibit sub-clinical symptoms at nitrate concentrations above 1,000 ppm. In contrast, there is some evidence that hay containing nitrate concentrations up to 10,000 ppm can be safely fed to horses. BEFORE using high nitrate forages in a feeding program, consult your veterinarian.

If the laboratory analysis indicates moderate to high levels of nitrate (>4,500 ppm), the forage can still be fed to most beef cattle if it is managed properly. One management option is to dilute the nitrate concentration by blending the high nitrate forage with feedstuffs that are low in nitrates. In many cases, growing animals (non-lactating, non-gestating) may become acclimaed tohigher nitrate levels by slowly increasing the proportion of higher nitrate feed. However, producers should minimize or avoid feeding forages that are high in nitrates to lactating, pregnant, or sick animals.

Supplementation with grain, grain by-products, and other feedstuffs that are high in energy may aid the conversion of nitrite to ammonia and reduce the risk of nitrate toxicity. Vitamin and mineral supplementation may also help to counter sub-clinical toxicity symptoms. Keeping plenty of clean water available to the animal will also help dilute nitrate concentrations.

Treatment of Acute Nitrate Poisoning

Although prevention is the primary method of combating nitrate toxicity, there are some treatment options when nitrate poisoning is diagnosed. The rapid onset of nitrate toxicity requires quick action. Counteract acute nitrate poisoning by slowly administering an intravenous solution of methylene blue in isotonic saline (1% W/V). Methylene blue reduces methemoglobin to oxyhemoglobin, restoring the blood's ability to exchange oxygen. Repeat the treatment in 15 to 30 minutes, if needed. Before any treatment, consult your veterinarian.

Tables

Tab le 1. Aselection of common plants known to accumulate nitrates.

Grasses		Forbs
Bermudagrass	Rescuegrass	Cudweed
Brown top millet	Rye	Dock
Crabgrass	R yegrass	Horsenettle
Corn	Sorghum	Jimsonweed
Tall fescue	Sudangrass	Lambsquarter
Johnson grass	Sorghum x Sudan	Nightshade
Oats	Wheat	Pigweed
Pearl millet		

Table 2. Management of various nitrate levels in beef cattle rations.

Forage Nitrate (ppm dry forage)	Guidance
<4,500	Safe to feed with adequate feed and water
4,500 - 6,500	Safe under most conditions b ut, if feeding pregnant animals, restrict to one-half (1/2) of the ration
6,500 - 9,000	Limit to one-half (1/2) ofthe ration
9,000 - 15,000	Limit to one-third (1/3) of the ration
15,000 - 18,000	Limit to one-quarter (1/ 4) of the ration
>18,000	Potentially lethal, very risky, dilute carefully

Circular 915 Reviewed October 2013

Iowa Beef Center

IOWA STATE UNIVERSITY

NITRATE TOXICITY

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Nitrogenous products accumulate in plants when soil nitrogen levels are high and readily available but the plant is unable to utilize it. In the rumen of cattle and sheep, nitrates (N03) are reduced to highly toxic nitrites (N0 2) which in turn are reduced to ammonia and then incorporated into bacterial protein. When nitrate consumption is excessive, the reduction of nitrite to ammonia becomes overloaded, and toxic levels of nitrites accumulate in the rumen.

Excessive levels of nitrites oxidize iron in the hemoglobin molecule from the ferrous to the ferric form. This compound is called methemoglobin and lacks the capacity to carry oxygen to the tissues. The result is a lack of oxygen throughout the body. High levels of methemoglobin give blood a chocolate color.

Nitrate levels can go up and down rapidly in plants. It accumulates only in the vegetative parts of plants, not in the grain or fruit. Highest levels are found in the lowest part of the stalk. Cool season grasses such as fescue, orchard grass, and timothy are not incriminated in nitrate poisoning, and legumes are seldom a problem. Green chop made from drought stressed crops such as corn grown on highly fertile soils is the most dangerous.

Silage loses more than half, in many cases 80- 90%, of the nitrate in the ensiling process. Toxic gases such as nitrogen dioxide (N02) and nitrogen tetroxide (N2O 4) are produced in the ensiling process and may form a brown colored gas on top of the silo. Livestock and people have been killed when this gas, which is heavier than air, floats down a silo chute and into a barn or confined area. Crops that are put in a silo in an extremely dry condition may lose only 20% of the nitrate. An addition of 10 to 20 lbs. of limestone per ton of silage delays the drop in silage pH and increases the amount of nitrate removed during the ensiling process.

Nitrate may be converted to the much more toxic nitrite by bacterial action in wet bales of hay. Excessive soaking with water may result in higher levels of nitrite near the bottom of large bales and stacks.

Nitrate accumulation is usually not excessive unless adequate soil moisture is present. Drought stressed crops that receive rain a few days before harvest can accumulate significant levels of nitrate. Acid soils, low molybdenum, sulfur deficiency, phosphorus deficiency, low environmental temperature (55 degrees), and good soil aeration are conducive to nitrate accumulation. Herbicide damage to plants also can lead to significant nitrate uptake.

The following plants are known to accumulate nitrate, possibly other annual grasses will as well:

Plants that can accumulate nitrates

Crop Plants	Weeds
Oats	Pigweed
Beet	Lamb's quarters
Rape	Canada thistle
Soybean	Jimsonweed
Flax	Wild sunflower
Alfalfa	Fireweed
Rye	Cheeseweed
Sudangrass	Smartweed
Wheat	Dock
Corn	Russian thistle
Sweetclover	Nightshade
	Johnson grass

Symptoms of acute nitrate poisoning in animals are related to the lack of oxygen in the tissues. These include muscular weakness, incoordination, accelerated heart rate, difficult or rapid breathing, cyanosis, coma, and death. Less severely affected animals may be listless and only show rapid respiration when exercised. Drop in milk production, abortion due to lack of oxygen getting to the fetus, poor performance and feed conversion are seen in cases of nitrate toxicosis.

Of the crop plants, drought stressed green chop corn is the most likely to cause nitrate toxicity in Iowa. Sorghum/Sudan harvested or grazed under the same conditions may cause problems. Oat hay harvested from land that has had heavy applications of nitrate fertilizer and a rapid regrowth from rain just prior to harvest has caused a few cases of nitrate poisoning. Several weeds can accumulate nitrates but seldom cause toxicity because livestock usually will not eat them.

A useful rule of thumb is that cattle and sheep can tolerate up to 0.5% nitrate on a dry matter basis. Total nitrate intake, including from drinking water, must be considered. Feeding non-protein nitrogen such as urea does not affect suscepti-bility to nitrate toxicity. Intake of large amounts of nitrate at one feeding is more likely to produce toxicity than intake of the same levels spread out over several hours. Livestock can adapt to higher levels of nitrate intake over a period of several days. Inclusion of grain in the diet speeds up the conversion of ammonia to protein and makes ruminants less susceptible to nitrate toxicity.

Those feeding green chopped drought-stressed corn on highly fertile land may want to consider testing.

Toxicity Potential of Green-Chopped Corn

Condition of Corn	Toxicity Potential
Corn barren, stunted, N supply normal to high	High
Barren to poor grain yield, N supply normal to high	Medium
Poor to moderate grain yield, normal N supply	Low
Corn with moderate to high grain yield	Low

Several private laboratories and the Veterinary Diagnostic Laboratory at Iowa State University can test for nitrates. A practicing veterinarian must submit samples sent to the Veterinary Diagnostic Laboratory. When sampling green chop, collect a total of two pounds from several areas of the field. Tightly pack and freeze the sample in a plastic bag pending delivery to the laboratory. Laboratory results may be reported in several ways such as nitrate, nitrate nitrogen ($N0_3$-N), or potassium nitrate (KN03). When interpreting laboratory values, make sure that interpretation is based on the correct reporting method.

Interpretation of Laboratory Results

Form of Nitrate Reported			Recommendations for Feeding
KN0 3	NOa-N	N03	
0- 1% 0-10,OOOppm	0- 0.15% 0-1500ppm	0 - 0.65% 0-6500ppm	Generally considered safe for livestock.
1 - 1.6% 10,400-16000 ppm	0.15- 0.23% 1495-2300 ppm	0.65-1% 6500-10,000 ppm	Caution: Potentially toxic at this level. **Mix,** dilute, limit feed forages at this level.
>1.6% >16,000 ppm	>0.23% >2300 ppm	>1% >10,000 ppm	DANGER, DO NOT FEED: Potential for toxicity high.

Summary Recommendations:

1. Those who intend to feed drought stressed green-chopped com from high fertility soils should consider testing, especially if a short period of rapid growth has occurred just prior to harvest.
2. Cattle and sheep can tolerate up to 0.5% nitrate on a dry matter basis.
3. Cattle and sheep can tolerate more nitrates if feeding occurs over a period of several hours.
4. Nitrate tolerance is increased if grain is fed.
5. The nitrate levels in the feed and water sources are additive.
6. Drought stressed corn should be cut at 12 to 18 inches above the ground level, as the lower stock has the highest concentration of nitrate.
7. The ensiling process results in the loss of much of the nitrate and greatly reduces the risk of toxicity.
8. Gradually introduce cattle to suspect forages over a period of several days.

To give a perspective on similar recommendations information from surrounding states:

Minnesota (About the same levels as Iowa but 4 categories) NOTE the units are listed as ppm NO_3-N)

ppm NO_3-N in dry matter	Comment
0-1500	Safe level under all conditions
1500-3000	Feeds will generally be safe when introduced into the ration gradually. At upper end (2500-3000), limit nitrate feed to 50% of the total ration DM.
3000-4500	Feeds in this range should be restricted to 25% of the total ration OM.
Over4500	Forages over 4500 are potentially toxic and should not be fed.

Kansas (More conservative on the upper end)

ppm NO_3	"Effect on Animals"
0-3000	Virtually Safe
3000-6000	Moderately safe for most situations, limit use for stressed animals to 50% of the total ration
6000-9000	Potentially toxic to cattle depending on the situation; should not be the only source of feed
9000 and above	Dangerous to cattle and often will cause death

Nebraska (Like Kansas, more conservative on the upper end)

Potentially Lethal Levels	%	ppm
NO_3 - N	> 0.21	2100
NO_3	> 0.9	9000
KNO_3	> 1.5	15,000

Wisconsin and Kentucky

NO_3-N ppm	NO_3-N %	NO_3%	Comment
<1000	0.1	0.44 L.f'ioow	Safe. A 1000 lb cow consuming 20 pounds of dry matter would consume about 9g of NO_3-N or less than 1g per 100 lb of body weight.
1000-2000	0.1-.2	0.44-.88 1..f'i06- Jtsoo	Generally safe when fed balanced rations. Best to limit to half of the total dry ration for pregnant animals and also be sure water is low in nitrate.
2000-4000	0.2-0.4	0.88-1.5 tstsoo • IS-000	Limit amount to less than half of total ration (KY to %). Be sure ration is well fortified with energy, minerals, and vitamin A.
Over4000	>0.4	>1.5 / $'00D	Potentially toxic - do not feed.

File: Animal Science 11

Revised and updated by Steve Ensley and Doug Snider, Veterinary Diagnostic Laboratory, Stephen K. Barnhart, Extension Agronomist-Forages, and Sherry Hoyer, Iowa Beef Center. Originally prepared by Nolan Hartwig, extension veterinarian, and Stephen K. Barnhart, Iowa State University, Ames, Iowa.

IOWA STATE UNIVERSITY
Extension and Outreach

Bilag 2 til besvarelsen 'Vurdering af Kommissionens forslag til vejledende grænseværdier for nitrit og nitrat i foder' sendt fra DCA, AU til FVST den 3. februar 2017. Kommissionens forslag om vejledende grænseværdier for nitrit og nitrat i foder og tilhørende principper for GMP

Recommendation on good practices to prevent /reduce presence of nitrates/nitrites in feed

Elements to consider in such a Commission Recommendation (individual points to be further elaborated)

I. Nitrates

1) Feed materials containing high levels of nitrates (not exhaustive)

- (Sorghum), maize, rye, (soybean), wheat, barley as forages

- rape, lucerne, turnip tops, sugar beet tops

2) susceptibility animal species

- within ruminants: sheep has the highest tolerance to nitrates, cattle are at greatest risk.

3) factors affecting the nitrate content in plants

a) agricultural aspects

- high nitrogen fertilisation

- low soil sulphur and molybdenum

- herbicide application

- annual forage crops tend to accumulate greater amounts of nitrates than perennial forages

b) amount of nitrate in plant tissues depends on

- plant species

- stage of maturity: higher in young plants and decreases as plants mature

- part of the plant : most plant nitrate located in bottom third part of the stalk, leaves contain less nitrate, and flowers or grain contain little or no nitrate

c) factors causing nitrate accumulation in plants

-drought

- rain after drought period :nitrates are high for several days after rain

-cloudy or cold weather

- herbicide application

-wilting

d) hay/silage

- hays made from nitrate rich materials contain as much nitrate as the original materials, unless some nitrate is converted to nitrite by heating or mould

- silage contains less nitrate than the parent crop due to fermentation process. Forages high in nitrate can lose 40%-60% of their nitrate content during fermentation.

4) prevention (of poisoning) / management

-Having feeds and forages analysed for nitrate when in doubt of high levels such as drought stressed, small grain forages

- check water as a source of nitrates

- not grazing on forages that are potentially dangerous

- feeding of hungry animals on dry hay or mature grass before allowing free access to immature cereal crops or root-crop tops

- not grazing high-nitrate pastures or crops for 7 days after periods of rainfall, cloudy days, frosts or high temperatures that cause wilting

- feed high nitrate forages as silage (silage reduces nitrate levels by the fermentation process)

- harvesting close to maturity (although this means reduced digestibility of te feed)

- leave drought –damaged feeds in the field as long as practical since nitrate will diminish as plants mature

- raising the cutter head to selectively avoid stalk bases reduces the risk of poisoning

- avoid using drought –stricken forages for 3-5 days after a rain

-control weeds closely to avoid nitrate from weed sources

5) Guidance levels

- determination of nitrates can be done through screening followed in case of suspicion by quantitative analysis

- methods of expression of nitrate and nitrite contents in feeds and conversion factor

Nitrogenous substance	**Chemical formula**	**Atomic/molecular or ionic weight**	**Multiplication factor**
Nitrate nitrogen	NO3-N	14	4.4
Nitrite nitrogen	NO2-N	14	4.4
Nitrite	NO2	46	1.3
Nitrate	NO3	62	1
Sodium nitrate	NaNO3	85	0.73
Potassium nitrate	KNO3	101	0.61

Guidelines for nitrate /nitrate –nitrogen in feed (**expressed in ppm on dry matter basis**)

Nitrate nitrogen	**Nitrate**	**Comment**
0-1000	0-4400	This level is considered safe to feed under all conditions
1000-1500	4400-6600	This level should be safe to feed to non-pregnant animals under all conditions. It may be best to limit its use to pregnant animals to 50 percent of the total ration on a dry basis.
1500-2000	6600-8800	Feeds are fed safely if limited to 50 percent of ration's total dry matter
2000-3500	8800-15400	Feeds should be limited to 35 to 40 percent of total dry matter in the ration. Feeds containing over 2000 ppm nitrate nitrogen **should not be used for pregnant animals.**
3500-4000	15400-17600	Feeds should be limited to 25 percent of total dry matter in ration. **Do not use for pregnant animals.**
> 4000	> 17600	Feeds containing over 4000 ppm nitrate nitrogen are potentially toxic. **DO NOT FEED.**

(alternative guidelines/simplified)

Guidelines for nitrate /nitrate –nitrogen/potassium nitrate in feed (**expressed in ppm on dry matter basis**)

Nitrate nitrogen	**Nitrate**	**Potassium nitrate**	**Comment**
0-1200	0-5000	0-8100	Generally safe
1200-2300	5000-10000	8100-16300	Caution (subclinical symptoms may appear).
>2300	>10000	>16300	High nitrate problems (death losses and abortions can occur)

II. Nitrites

1) Feed materials containing high levels of nitrites (not exhaustive)

2) susceptibility animal species

- pigs most susceptible then cattle, then sheep and then horses

3) factors affecting the nitrite content in plants

a) agricultural aspects

b) amount of nitrite in plant tissues depends on

c) factors causing nitrite accumulation in plants

d) hay/silage

4) prevention (of poisoning) / management

- avoid mould formation in high nitrate forages that can convert nitrates to nitrites

5) Guidance levels (from Dir 2002/32/EC)

		ppm
Nitrite	Feed materials	15
	with the exception of:	
	— fishmeal;	30
	— silage;	—
	— products and by-products from sugar beet and sugarcane and from starch and alcoholic drink production.	—
	Complete feed	15
	with the exception of:	
	— complete feed for dogs and cats with a moisture content exceeding 20 %.	—