Trouble Spots

FUMING SILO

HAY AND PASTURE

SILAGE AND FODDER

DILUTION WITH OTHER FORAGES

HIGH ENERGY FEEDS

VITAMIN A

Learn to live with NITRATES

Preventives

UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
Learn to live with NITRATES

The Problem

FUMING SILOS

Occasionally, yellow, red, and brown gases may be seen on top of silage and at the drain of a silo when crops are ensiled. These yellow to brown gases are formed by a series of chemical reactions which take place during early silage fermentation.

The gases are a mixture of oxides of nitrogen. One of the oxides is nitrogen dioxide which is extremely poisonous for all plants and animals. It is formed from the nitrates in the plant material. First, the nitrates are converted to nitrites. Then, fermentation acids and heat break the nitrites down to give the oxides.

Often a clear gas layer is found above the silage and a yellow cloud above it. When the blower is started this cloud and clear layer become reddish-brown due to the reaction of the oxides of nitrogen with oxygen of the air. Breathing of these gases may result in death or "silo-filler disease."

(Trench silos are open enough that no cases have been reported.)

PRECAUTIONS:
1. Run blower 10 to 20 minutes before entering the silo.
2. Never jump down into a silo. Remove doors as these gases are heavier than air and do not escape through the top.
3. If the red-brown gases flow down the chute, do not attempt to go up or down until they have drained away.
4. Keep children and animals away from the silo for three to four days after filling.

LOSS OF MILK PRODUCTION

The cause of milk production losses in several Missouri dairy herds has been traced to nitrates. These losses usually occur in two conditions, depending on the level of nitrates in the ration. Moderate levels of nitrates may cause a marked drop in milk flow within 4 or 5 days from the time the forage or silage is first fed. This may be accompanied by increased urine production, darkening of the urine, and apparent digestive failure resulting in the appearance of undigested feed particles in the feces.

A low level of nitrates in the ration may lower milk production only slightly for the first 6 to 8 weeks. Usually within the sixth to the eighth week,
milk production declines more rapidly, symptoms of vitamin A deficiency begin to appear and the herd appears hungry and in poor condition.

**REPRODUCTION DIFFICULTY**

When abnormal calf births are encountered, nitrate poisoning can be considered as one of the many possible causes. A veterinarian can best diagnose the trouble. Two types of abnormal births are common in nitrate poisoning. In one type, calves are carried to full term, but are dead or die immediately after birth.

The second type is abortion in the third to the fifth month period. This has occurred in both beef and dairy herds. It may happen in the pasture season, but is more likely to occur during the winter months.

Diseases such as Leptospirosis, Brucellosis and Vibrosis must also be considered as a possible cause of the abortion.

**SUDDEN DEATH**

Nitrate poisoning, oat hay poisoning and some forms of corn stalk poisoning are essentially the same. Sudden losses occur when cattle or sheep ingest nitrates which the rumen bacteria convert to nitrite. The nitrites compete with oxygen, tying up the oxygen-carrying mechanism in the blood, and the animal suffocates. Blood from these animals will be chocolate brown in color. Nitrites are 10 times as toxic as nitrates. Nitrites can cause the loss in milk production and reproductive problems as described for nitrates.

**The Cause**

**DROUGHT**

Nitrates accumulate during times of low soil moisture and high temperature.

**STAGE OF MATURITY OF CROP**

Nitrates are found in greatest concentration in plants during rapid vegetative growth. Forages cut during this stage have higher nitrate content. As seeds begin to form, the nitrate level usually declines unless the plant had excessively high nitrates during the succulent growth.

**IMBALANCE OF SOIL NUTRIENTS OR OVER-FERTILIZATION**

Nitrates may accumulate in the soil from either commercial fertilizer or from manure applications. The risk of nitrate poisoning must be considered when fertilizing for maximum forage yield.

**WATER SUPPLY**

Nitrates reach dangerous levels in some ponds, streams and shallow wells. One form of “blue babies” has been shown to be due to nitrates in drinking water. For ruminant animals, it is often found to be in toxic amounts in ponds which either trap feed lot drainage or surface water from highly fertilized fields, and in streams containing industrial waste.

**CROPS**

Crops known to be the offender under the conditions given above are:

- Corn—As silage and fodder
- Sorghums—As silage
- Oats—As hay and silage
- Sudan—As silage, hay and pasture
- Alfalfa—As hay
Detection

Nitrate test kits are available from several commercial companies. Your county agent and veterinarian will probably have such kits. These kits or test reagents allow the county agent or veterinarian to make an estimate of the nitrate concentration in your silage, hay, or fodder. If he thinks it warrants more careful chemical analysis he can refer you to a testing laboratory.

Quantitative analysis can be no better than the sample. It is essential to have the sample accurately represent your feed. A good sample can be collected by taking four to eight samples at various levels or positions within the silo, loft, or field. Mix these samples thoroughly and then place at least 3 pounds of the feed in a plastic bag and seal tightly before sending it to the laboratory for testing.

From good samples and quantitative analysis the effect on cattle can be fairly well predicted.

<table>
<thead>
<tr>
<th>Level as KNO₃ On Dry Matter Basis</th>
<th>Animal Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>.0 to 0.5%</td>
<td>Normal if on an adequate ration.</td>
</tr>
<tr>
<td>0.6 to 1.0%</td>
<td>Milk production drop. Slow at first, increasing after the 6th to the 8th week.</td>
</tr>
<tr>
<td>1.0 to 1.5%</td>
<td>Milk production loss within 4 or 5 days. Reproduction difficulty over the period fed and may extend over several weeks after the removal of the feed.</td>
</tr>
<tr>
<td>1.5% plus</td>
<td>Death; usually several head and suddenly.</td>
</tr>
</tbody>
</table>
Prevention

High Energy in the ration will offset milk production losses as long as the nitrate concentration does not exceed 0.85 percent. Molasses and ground corn have both been used successfully. The high energy feed must be placed with the part of the ration that contains the nitrate. Molasses is usually easier to apply on dry roughage. At least 2 pounds per head per day should be used. Another rule would be to use 4 percent molasses for every 1 percent nitrate in the ration. A balanced ration should be fed at all times but in case of a toxic substance such as nitrates it becomes extremely important.

Vitamin A or green feed supplementation will help lessen the toxicity of nitrates. Either a stabilized vitamin A supplement or good quality alfalfa, lespedeza, or silage free from nitrate can be used. If you suspect nitrate trouble a vitamin A supplement would be preferred while you are getting the feed tested.

You can dilute the toxic forage by mixing other forages with it, allowing you to use the crop without harmful effects. Results of analysis of the forage should be used as the basis for the dilution.

The nitrate intake for each cow should not exceed 50 gm. per day and amount to not more than 0.5 percent of the ration.
MILK PRODUCTION LOSS

In October, 1955, an Osage county farmer brought silage, hay and fecal samples to the University of Missouri Veterinary Clinic. His cows had been declining in milk production for a period of 30 days and when undigested particles of silage appeared in the feces he suspected that the trouble was caused by either the feed or parasites. No parasites could be found. The silage and hay were referred to the agricultural chemistry department for nitrate analysis, since this area of the state had again experienced a moderate drought. The corn was from a field which had been manured heavily and fertilized and had been side dressed with 60 pounds of nitrogen per acre.

Qualitative tests were positive for nitrates in both the silage and alfalfa hay. Recommendations were made as follows: Reduce the amount of silage fed by one-half, and add to it 3 pounds of molasses per head. Increase the hay and grain supplement along with 2 teaspoons of dried rumen bacteria per head.

Quantitative analysis of this sample failed to indicate sufficient nitrates to cause the trouble reported. The following week, three staff members visited the farm. Milk records, hay samples and silage samples were obtained. The cows were observed and most appeared normal after having been extremely drowsy. Only the older cows failed to respond to the previous recommendations. Rumen fluid samples drawn from these animals were examined microscopically. The rumen fluid was not normal, although no nitrate or nitrite could be found in the fluid.

Quantitative analyses of the samples taken by the staff members were analyzed. The results are shown in the table.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Cutting</th>
<th>% KNO₃ on Dry Matter Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>1</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.46</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>.54</td>
</tr>
<tr>
<td>Corn Silage</td>
<td></td>
<td>2.04</td>
</tr>
</tbody>
</table>

This information showed that the nitrate content of the feed was too high. Upon further investigation we found the farmer had been feeding the second cutting alfalfa along with the silage. Thereafter, the alfalfa cuttings were mixed and oat hay was added so that the amount of nitrate being fed was reduced.

Milk production for the herd was about 811 pounds per day before silage feeding started. Four days after silage feeding the milk production dropped to 625 pounds per day. The production continued to drop slowly until treatment was prescribed.

To check the effects of nitrate on milk production, two experimental cows were given 75 gm. (0.75 percent) KNO₃ and 125 gm. (1.25 percent KNO₃, respectively, in their grain supplement. Milk production dropped in both cases. When molasses (5 percent) was added both animals returned to normal. However, when molasses was removed and the nitrate left in the ration a severe milk loss occurred. The cow receiving 0.75 percent potassium nitrate survived but aborted while the cow which received 1.25 percent died three weeks after the last experimental period.

This case history and experiment lead to several experiments which have been reported elsewhere.
Case Histories

ABORTION DUE TO NITRATE

June 1, 1956, a herd of dairy cattle began to abort. The local veterinarian and a specialist from the College of Veterinary Medicine could not establish a disease pattern. Blood tests for Vibrio, Brucellosis and Leptospirosis were negative.

Near the end of June a sample of green chopped sudan was brought to the laboratory for nitrate analysis. The analysis of this sample and subsequent samples averaged about 1.9 percent potassium nitrate equivalent on a dry matter basis. The field upon which this sudan was growing had been heavily manured and fertilized according to soil test for phosphate and potash. This field was irrigated and in mid-summer, nitrogen was applied at 150 pounds per acre. This practice was started in 1953 and repeated each year. In 1956 the crop grew faster than it could be fed since sufficient moisture was available without any adverse weather conditions.

Milk production did not seem to be affected. This was contrary to our experience with wintering rations.

Blood samples drawn from four cows which had aborted were found to contain higher than normal levels of nitrate, low vitamin A levels and an oversupply of carotene.

When the sudan was removed from the ration, abortions stopped. The sudan was used later by allowing the cows to graze it and an adjacent alfalfa field. A final check showed some 20 cows from this herd of 90 aborted in the six weeks the toxic sudan was fed.

SUDDEN DEATH

A farmer in DeKalb county had sudan hay and alfalfa hay for winter feed early in 1958. He had been feeding some sudan hay and had lost two cows, on different nights in one week. During a snow storm he stopped feeding sudan hay and fed only alfalfa hay. After the snow storm he fed his 42 cows several bales of sudan hay on top of the snow in the afternoon. The following morning eight of the cows were found dead. Three cows aborted and three calves died after birth, following the death loss of the cows.

Chemical analysis of the sudan hay indicated a concentration of 4.9 percent potassium nitrate. This is well above the accepted toxic level. The alfalfa hay contained only 0.26 percent potassium nitrate.

The sudan was grown on a medium to above average fertile soil. The field had been in soybeans the year before and no fertilizer was added. The sudan was cut for hay when it was approximately 5 feet tall. Few heads had emerged from the boot at the time it was cut. The sudan was pastured following the removal of the hay. No ill effect was evidenced from the pasturing.

This case and the many similar ones during the drought of 1954 indicate the drastic loss of production and dramatic death loss that result from high levels of nitrates in forages.

ACKNOWLEDGEMENT

This bulletin was prepared through the cooperation of the Departments of Agricultural Chemistry, Animal Husbandry, and Dairy Husbandry; the dairy and field crops Extension specialists and the School of Veterinary Medicine. It is a report on research project 247, Forage Poisoning.
Summary

Nitrate toxicity is not new, it was known as early as 1850 and has been occurring in semi-arid regions in this and other countries for years. With cheap and plentiful sources of nitrogen designed to obtain higher production goals and with new methods of forage preservation, forages with excessive nitrates have become more common. The Missouri Experiment Station has conclusive proof that nitrate levels of 0.6 percent and above can cause milk production loss and abortion in cattle. Higher levels cause death. Toxic levels of nitrates were formerly thought to be at least 1.5 percent, but this level is too high in view of recent research.

*We can learn to live with nitrates by following these suggestions:*

1. Know when the crop is least likely to contain nitrates. (See page 3)
2. When crop is grown under conditions that cause accumulation (page 3), harvest at lowest concentration of nitrates.
3. Watch for signs of a fuming silo and protect yourself from the toxic gases.
4. Have feed analyzed before feeding, if it was grown under conditions that cause high nitrate content. (See page 3)
5. Feed a ration that will help protect the animal against the effects of high nitrate. (See page 5)
6. Consult with your county agent and local veterinarian if you suspect nitrates are troubling you.

*Sources of help on nitrate problems:*