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CLEAN
WATER

You Can Make A Difference

Water Quality for Livestock and Poultry

by
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MINNESOTA EXTENSION SERVICE
UNIVERSITY OF MINNESOTA

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Water Quality for Livestock and Poultry

An adequate and safe water supply is essential to the production of healthy livestock and poultry. Water that adversely affects the growth, reproduction, or productivity of livestock and poultry cannot be considered suitable. Farm water supplies, either surface or ground, should be protected against contamination from microorganisms, chemicals, and other pollutants. Finally, the water supply must not affect the acceptability or safety of any animal products for human consumption.

When water is suspected of causing health problems in livestock, veterinary assistance should be sought in order to determine the actual disease. Laboratory diagnostic examination of both animals and the water supply may be necessary to adequately evaluate the problem. Temporarily changing to a known safe water supply is a useful test to determine if the health problems can be solved. Remember, however, that water is too often blamed for production or disease problems. Thus, the importance of an accurate diagnosis must be emphasized.

It is important to stress that the water quality recommendations in this publication pertain only to livestock and poultry, and not to human drinking water. Human drinking water standards are the responsibility of the U.S. Environmental Protection Agency. For more information on the human consumption of water, refer to Agricultural Extension Service Folder 547 *Drinking Water Quality in Minnesota.*

This folder will discuss those water quality factors that have been shown to cause livestock health or production problems and are likely to occur in Minnesota. Additional information about the effects of water quality on livestock and poultry is available from the faculty and departments listed at the end of this publication.

NITRATES

Sources and Movement of Nitrates in Water

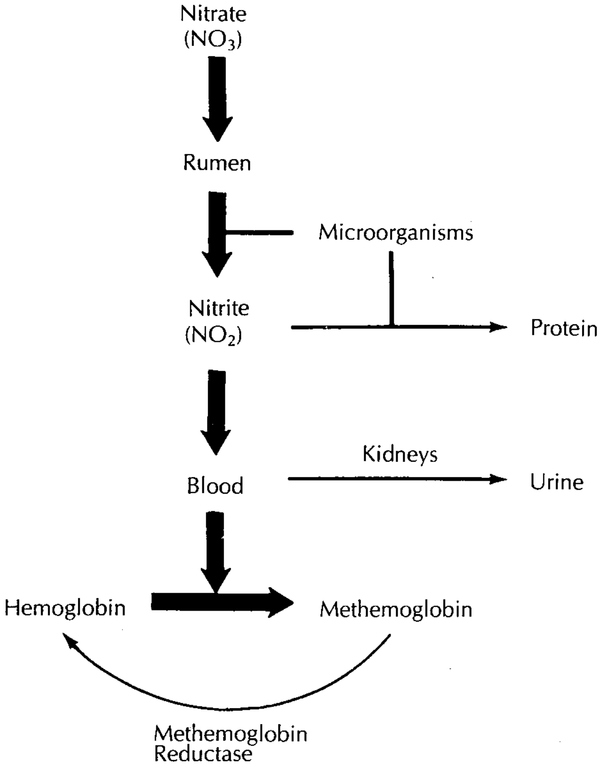
Nitrates are soluble and move with percolating water. Nitrates added to or produced within the soil profile may be washed away by surface runoff or leached to the ground water by percolation. Ground water pumped from a well may contain nitrates even if their source is a considerable distance from the well. Sources of nitrates in ground waters include nitrogen fertilizers, animal manure or wastes, crop residues, human wastes, and in some cases industrial wastes.

As nitrates percolate downward, they may reach a shallow ground water table. The nitrate concentration will be the greatest in the upper 5 feet of a shallow ground water table and wells which just penetrate into the table may remove water relatively high in nitrates. Waters from shallow wells normally contain more nitrates than waters from deeper wells because the shallow ground water table is easily polluted with leached nitrates.

While deep wells are usually nitrate free in Minnesota, an improperly located or improperly constructed deep well can be polluted with surface or ground water. Pollutants can enter deep aquifers through abandoned wells which have not been adequately sealed. A rusted or perforated well casing from an old well may allow ground water from a shallow contaminated formation to reach a deep aquifer. In some cases, old wells have been carelessly used for sewage or waste disposal allowing contaminants to enter directly into the ground water.

In the karst topography of southeastern Minnesota, sink holes allow direct contamination of fractured rock aquifers. Some of these aquifers have acquired relatively high nitrate levels. In some areas of Minnesota, particularly the southwest, relatively high levels of nitrate exist naturally in the ground water.

Figure 1. A simplified pathway for nitrates in ruminants.



How Nitrates Poison (Cattle, Goats and Sheep)

Nitrates by themselves are not very toxic. However, in the rumen of the cow or sheep, microorganisms change nitrates to nitrites, which are quite toxic (see **figure 1**).

Nitrites may be further acted upon by microorganisms converting nitrite-nitrogen into protein. In cows or sheep that consume large amounts of nitrates in short periods of time, however, nitrites accumulate faster than they can be built into protein. Note that water is only one source of nitrates for animals. Feedstuffs may contribute far more nitrates than those ingested by drinking water. For example, corn silage which is made during drought periods may be particularly high in nitrates.

From the animal's stomach, the excess nitrites are absorbed into the blood stream. While a small portion of the nitrites will be excreted in the urine, most of them will react with the hemoglobin (the red, oxygen-carrying pigment of the blood) to form methemoglobin, which precludes the blood from carrying oxygen (the blood turns chocolate brown). If a large portion of the hemoglobin has been converted to methemoglobin, the animal shows symptoms of asphyxiation including labored breathing, a blue muzzle and a bluish tint to the whites of the eyes, trembling, lack of coordination, inability to stand, and often death. Animals that recover will, except as in instances as noted below, show no after effects. Milk from animals displaying symptoms of nitrate poisoning should not be consumed as it may contain nitrites. However, healthy animals consuming nitrates have not been found to have nitrites in milk they secrete. Recovery is usually quite rapid since the enzyme (methemoglobin reductase) which converts methemoglobin back to hemoglobin is present in the blood. Exception to complete recovery concerns pregnant animals that have received so near a fatal dose that the fetus they carry dies and is later aborted.

How Nitrates Poison (Swine, Poultry and Horses)

In the simple-stomached animals such as swine and poultry, there is no fermentation vat similar to the rumen to aid in the digestion of roughages and to change nitrate to nitrite. Some nitrites may be

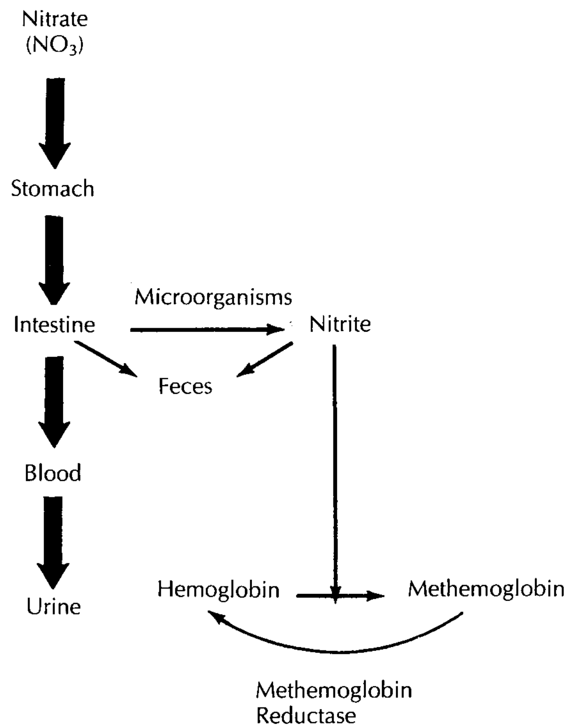


Figure 2. A simplified pathway for nitrates in swine and poultry.

formed in the intestinal tract (see **figure 2**), but this is so small an amount that it is of no consequence to animal health.

Most of the nitrates or nitrites pass unchanged from the intestines into the blood and then are eliminated by the kidneys. While nitrates themselves have some physiological effects, they are small when compared to those of nitrites, and it is unlikely that nitrites ever occur high enough naturally in water to harm swine and poultry. Horses are also simple stomached, but they have a large cecum (appendix), and this acts much like the rumen in digesting roughages. Nitrite formation can take place in the cecum, and horses are susceptible to nitrate poisoning because of this.

Dangerous Levels

At what level are nitrates in drinking water dangerous to livestock? A number of factors must be taken into account to arrive at such a value. These factors include the kind of animal, quantity of intake, the kind of feed, and the nitrate content of the feed. Taking these into account and allowing for a reasonable margin of safety, the guide shown in **table 1** was developed by South Dakota State University staff based on published data and years of observation.

The National Academy of Science has found that livestock and poultry studied under controlled experimental conditions can tolerate the continued ingestion of waters containing up to 300 ppm of nitrates or 100 ppm of nitrites. Their recommendation is, "in order to provide a reasonable margin of safety to allow for unusual situations...nitrates should be limited to 100 ppm or less and nitrite content alone be limited to 10 ppm or less."

Research results in southeastern Minnesota suggest that the South Dakota nitrate standards are probably relevant in Minnesota. Water supplies containing sufficient nitrate to cause livestock poisoning are seldom found in Minnesota. If a ground water supply is found to be high in nitrate, it is wise to test for the possible presence of coliform organisms.

It should be pointed out that there are a number of ways in which chemists have reported the nitrate contents of waters, and this has led to mistaken interpretations. Factors for converting other methods of reporting to a nitrate-nitrogen basis are shown in the footnotes for **table 1**.

It is also important to stress here that the recommendations in **table 1** pertain only to livestock.

Nitrites in Water

Nitrites are occasionally found in water but usually only at very low levels. Rarely are they found at a concentration of over 1 or 2 ppm (part

Table 1. A guide to the use of waters containing nitrates for livestock.

Nitrate content* as parts per million (ppm) of nitrate nitrogen (NO3N)+	Comments
Less than 100	Experimental evidence indicates this water should not harm livestock or poultry.
100 to 300	This water should not by itself harm livestock or poultry. If hays, forages or silages contain high levels of nitrate this water may contribute significantly to a nitrate problem in cattle, sheep, or horses.
Over 300	This water could cause typical nitrate poisoning in cattle, sheep, or horses, and its use for these animals is not recommended. Because this level of nitrate contributes to the salts content in a significant amount, the use of this water for swine or poultry should be avoided.

** The values shown include nitrate nitrogen. In no case should the waters contain more than 50 ppm nitrite nitrogen (NO_2N) because of the greater toxicity of the nitrite form.*

+ 1 ppm of nitrate nitrogen is equivalent to:
4.4 ppm of nitrate (NO_3)
6.1 ppm of sodium nitrate ($NaNO_3$)
7.2 ppm of potasium nitrate (KNO_3)
1 milliequivalent (meq) per liter of nitrate nitrogen is equivalent to 14 ppm.

Young stock in loose housing drink from common waters.

per million) of nitrite-nitrogen, and this amount is far below toxic levels for livestock and poultry. It is true that microbial growth in dirty troughs is able to change nitrate to nitrite, but the extent of this change has been found to be small. It has been suggested that the zinc in galvanized tanks or troughs causes nitrates to be changed to nitrites, but evidence for this is lacking and there is no sound theoretical basis for assuming that this conversion should happen. In short, nitrite amounts in most water supplies seem to offer no problems to livestock.

Chlorination

Chlorination of water does not destroy nitrates! Why then has chlorination been recommended by some as a remedy for high nitrate waters? The recommendation is likely based upon two facts: (1) that chlorine can convert nitrites back to nitrates, and (2) that chlorine can kill microorganisms that might cause nitrates to be changed to nitrites, or that might form nitrates in the first place.

However, some additional facts must be considered to evaluate the chlorination recommendation. Since nitrites do not occur naturally at dangerous levels in water, chlorination is not necessary to change nitrites back to nitrates. While chlorination will destroy microorganisms, the introduction of filth or contaminants into the water at the waterer destroys the effectiveness of the chlorination. Chlorine will first oxidize the organic materials and insufficient chlorine concentration may remain to destroy microorganisms. In order for nitrites to be formed from nitrates in water troughs, organic matter must be present to provide for growth of the microorganisms.

In addition, chlorine in the drinking water cannot prevent the change of nitrates to nitrites in the rumen of the cow or sheep or the cecum of the horse unless the chlorine level is so high that it would cause physical damage to the animal.

Chlorination can be useful to control a nuisance bacteria population, such as iron bacteria, and along with a proper filter is also used to remove iron and odors from water. But chlorination by itself is not a remedy for high nitrate waters. Chlorination procedures are discussed in M-156 *Chlorination of Private Water Supplies.*

Solving the Problem

What can be done about water that contains nitrates at a concentration which makes it unsuitable for use by livestock?

Nitrates are not removed by filters, water softeners, additive softening compounds, and they are not destroyed by standing or boiling. They can be removed or reduced in concentration by some ion exchange resins, reverse osmosis, electrodialysis, or distillation. The cost of these practices may make them impractical for treating the volume of water required for a livestock unit. Usually water unsuitable for farm animals because of its high nitrate content should be replaced by an uncontaminated source. A deeper water supply well may provide water which is low in nitrates. Well drilling techniques have been improved considerably since many of the older and shallower wells were constructed. Consult with a local well driller to determine if a deeper water bearing aquifer is likely to be present and inquire about the cost of the well.

Small ponds can be used for a farm water supply where a controlled watershed is available. The watershed should be of adequate size and should be protected against erosion, high applications of manure or chemicals, etc., in order to provide high quality water. If protective measures are taken and the watershed is controlled, a farm pond can deliver low nitrate water for a livestock enterprise. Surface water also is usually low in dissolved minerals. Consult with the Soil Conservation Service on technical assistance for the construction of a farm pond.

SULFATES

Sulfates are one of the dissolved solids that appear in Minnesota water and are usually either magnesium sulfate (Epsom salt) or calcium sulfate. Both of these salts will cause a cathartic (laxative) effect and Epsom salt is a commonly used laxative. These salts appear in the water because they have been dissolved as the recharge water moves down through soil and rock formations. Man's activities have little effect upon the concentration of sulfates in ground water supplies.

Problem Levels

The U.S. Public Health Service recommends that waters containing more than 250 ppm of chlorides or sulfates and 500 ppm of dissolved solids not be used for human consumption if other less mineralized supplies are available. These levels, however, are recommended primarily by consideration of taste. Excessive concentrations of sulfates cause a laxative effect in animals, which is more pronounced in the young than the mature animal. In young animals, sulfate concentrations in excess of 350 to 600 ppm may be associated with severe, chronic diarrhea, electrolyte imbalance, and in a few instances death.

Solving the Problem

As with humans, animals tend to become acclimated to the sulfates in water. If a severe cathartic effect is experienced by newly purchased animals, they will likely become acclimated to the high sulfate water after a period of time. To reduce the cathartic effect, consider diluting the high sulfate water with water containing no sulfates. A dilution of three to four to one may be necessary to minimize the cathartic effect. Gradually increase the amount of high sulfate water in the mixture. This same procedure may be effective with young pigs at weaning time. This process requires additional management and a tank to haul and contain the water supply. However, this procedure is the most inexpensive method of reducing the cathartic effect of high sulfate water.

If the animals do not become acclimated to the high sulfate water then sulfates will need to be removed from all of the water used by the livestock production unit. Techniques such as distillation, reverse osmosis, electrodialysis, and demineralization are all available but require relatively high levels of management and may not be economically feasible for the livestock producer.

The use of a home water softener does not remove sulfates. The softener merely changes the magnesium or calcium sulfate into sodium sulfate which is somewhat more laxative.

Your local water well contractor may have information on aquifers at different depths which are likely to contain water low in sulfates. If water of suitable quality can be obtained from a new well, this would likely be the most cost effective solution to the problem. A small pond as explained in the section on nitrates, may provide low sulfate water.

TOTAL DISSOLVED SOLIDS

The term Total Dissolved Solids (TDS) includes all the minerals which have been dissolved as the recharge water percolates downward through the soil and rock formations. There is little that man's activities can do to change the amount of total dissolved solids in an aquifer.

Problem Levels

Most domestic animals can tolerate a total dissolved solid concentration in the range of 15,000 to 17,000 ppm. However, these concentrations will likely affect production. Some investigators have found that concentrations as high as 15,000 ppm are safe for a limited period but dangerous for continued use. Livestock specialists in Colorado and Montana classify water as good when it contains less than 2,500 ppm of dissolved solids. In South Dakota, the "good" water category extends to 4,000 ppm. The National Academy of Science recommendation is 3,000 ppm.

Australian agriculturists recommend safe upper limits according to species as follows:

Table 2. Upper Limit of TDS Concentrations

Animal	Threshold* TDS concentration, ppm
Poultry	2,860
Swine	4,290
Horses	6,435
Cattle, dairy	7,150
Cattle, beef	10,000
Sheep, adult dry	12,900

* *Threshold: The point where a psysiological effect may be produced.*

Salt water toxicity resembles the symptoms of simple dehydration and will upset the electrolyte balance. Levels over 10,000 ppm affect palatability for animals and, if consumed, will produce weight loss and diarrhea.

Solving the Problem

Total dissolved solids are difficult and expensive to remove from a water supply. The proposed solutions are the same as for sulfates.

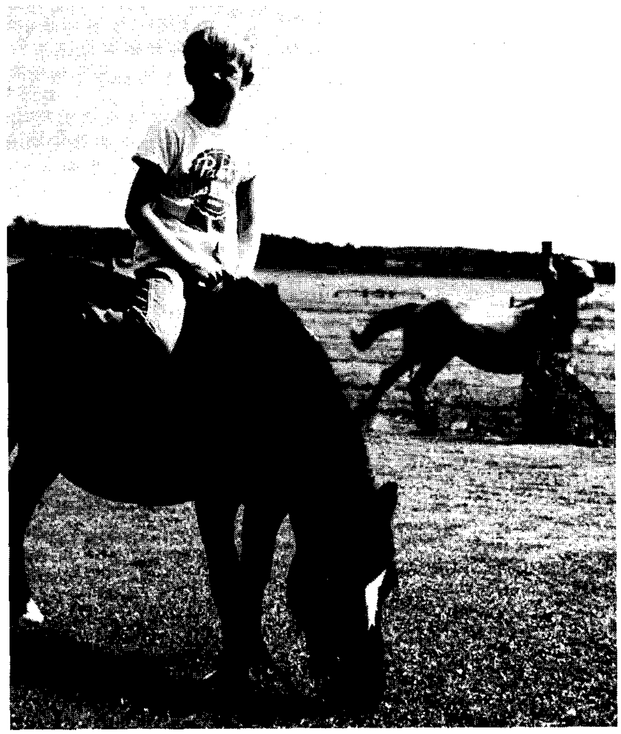
MICROORGANISMS

Coliform bacteria are nearly everywhere and may be of plant, animal, or soil origin. The term fecal coliform bacteria refers to normal organisms found in the gastrointestinal tract of livestock, humans, and birds. While these bacteria may not be harmful, their presence often indicates that other disease-causing bacteria may also be present.

Harmful microorganisms can readily enter a well having improper surface protection. Wells with cracked casings or wells situated so as to receive drainage from a feed lot or a well pit may result in bacteria to entering the water supply. Bacteria such as *Salmonellas* can cause disease, especially in young animals, and also can indirectly get into the milk supply from dairy herds. Although waterborne illness in livestock due to microorganisms is not often reported in Minnesota, the potential exists for problems to occur, especially where large concentrated animal populations exist and where wells are poorly protected from surface run-off as experienced during spring and with heavy rainfall.

There are no legal limits for microorganisms or chemicals in water used for livestock production except if the farm is a dairy operation. In this case, the water must be from a supply which has been microbiologically tested safe by an approved water testing laboratory before milk can be sold from that farm. Grade A dairy farm water supplies must meet the Minnesota Water Well Construction Code established by the Department of Health which requires testing every three years or any time repairs or modifications are made on the water supply system. Manufacturing Grade dairy farms must have their water supply tested safe each year if their well does not meet the Minnesota Water Well Construction Code.

It is possible that microorganisms can contaminate a water supply at the drinking point. Bacteria and other organisms can develop rapidly in the waterers for turkeys and chickens raised under floor and range production systems.



Healthy horses require an adequate supply of high-quality water at all times.

Nipple-type waterers minimize the chances of a sick animal infecting others. With no standing water present, bacterial numbers will usually be insufficient to cause infection.

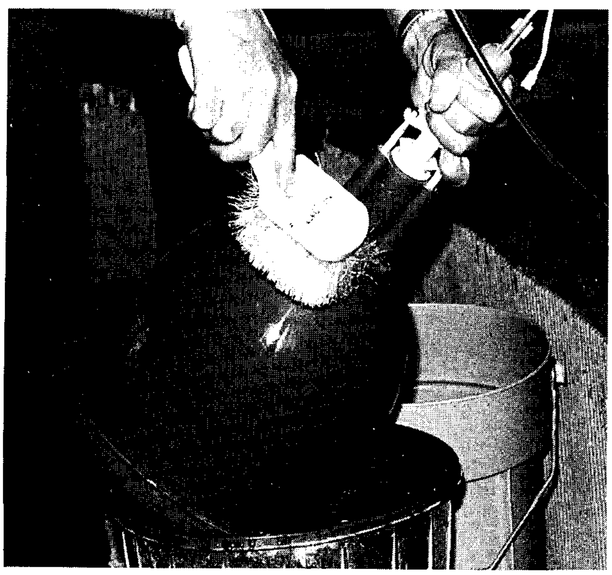
Occasionally, a water tank is located directly under the ventilation exhaust from a livestock building in order to provide a heat source to keep the water from freezing. Consider, however, that the water surface will be directly exposed to microorganisms which are carried out of the structure with the exhausted air. Thus, the watering tank could serve as a source of contamination by water even though the remainder of the water supply system is free of microorganisms. The exhausted air may contain microorganisms and also serve as a source of infection when an animal is drinking from a water tank located near an exhaust fan.

Solving the Problem

If the water test results indicate the presence of coliform organisms, the water supply system should be checked to determine possible sources of entry. The most common sources for entry of coliform organisms into a water supply are near the immediate area of the well itself or into the water storage container, such as a cistern.

Cisterns are usually masonry which is susceptible to cracking. Thus, microorganisms can enter the cistern as the liquid level goes up and down.

Dug wells commonly have a very poor surface cover and are inadequately protected against the direct entrance of coliform organisms from small animals or from surface run-off which accumulates in the vicinity of the well. Drilled wells which terminate in a well pit are also commonly contaminated by drainage into the pit. If the well is drilled and cased, a pitless underground discharge can be used to replace the well pit. The well pit should be filled with a compacted loam or clay soil and all surface water should be directed away from the well location.



A recommended daily procedure is to thoroughly scrub and rinse poultry waterers with a disinfectant.

The first requirement of a water supply well is to deliver water free of coliform organisms. It is not sound practice to use chlorine to keep a continuing supply of pathogens in a contaminated well under control. Any failure of the chlorination equipment will immediately expose the livestock and poultry to the pathogens. If the source of contamination in a well cannot be eliminated, the only recourse may be to drill a new well.

Where the possibility exists that animals can transfer pathogens at the drinking point, a chlorine residual of 5 ppm may be helpful. However, in order for the chlorine residual to remain and destroy whatever microorganisms may enter the water, the watering device must be kept clean.

Troughs should be sited and elevated such that contamination for fecal material is virtually impossible. The "nipple-type" waterer helps to eliminate a source of water contamination between animals. Do not locate an outside water tank directly under a ventilation exhaust fan.

Proper cleaning of poultry waterers on a daily basis is an important part of flock management. A recommended procedure is to scrub water pans or troughs thoroughly with a brush, empty, and then rinse with a disinfectant. Studies have shown that bacteria counts in waterers properly cleaned daily can be kept relatively low. Poor practices in cleaning waterers can result in subjecting birds to water containing millions of bacteria per milliliter.

IRON

According to Report No. 26 of the Council for Agricultural Science and Technology, "Under usual conditions, water supplies only a small percentage of the iron available to animals. Because iron from natural sources is absorbed with efficiency less than 10%, the iron in water should not pose a hazard to animals. Under these circumstances, a 'no limit' recommendation is reasonable. High doses of the more available forms of iron, however, are toxic."

There is no evidence to show that iron will cause any problems with livestock or poultry products. An exception might be the so-called "white veal" trade which tries to develop a pale product based on milk, darkness, and a diet low in iron.

Solving the Problem

Iron can be removed from drinking water with a water softener or with an iron filter. Iron problems and removal techniques are discussed in M-154 *Iron in Drinking Water.*

PESTICIDES

Pesticides can enter a groundwater or surface water supply from run-off, drift, rainfall, direct application, accidental spills (immediately notify the Minnesota Department of Agriculture, or call the statewide 24 hour emergency number for the duty officer from the Emergency Management Division, Minnesota Department of Public Safety (non-metro—1-800-424-0798, metro—1612-649-5451)), faulty storage facilities, and faulty waste disposal techniques. Pesticides should be used only when necessary. When pesticides are used all label directions should be strictly followed, together with approved application techniques. The Minnesota Extension Service provides pesticide applicator's training.

There have been no reported cases of domestic livestock deaths resulting from pesticides contained in livestock drinking water. Many pesticides are readily broken down and eliminated by livestock with no obvious ill effects, but there is a possibility that some could be excreted in milk or accumulate in meat. Of the pesticides currently in use, the organophosphates are the most dangerous for livestock. It should be noted that fish are much more sensitive to pesticides than are livestock or poultry.

The National Academy of Sciences recommends that "the maximum levels for public water supplies for individual pesticides are recommended for farm animal water supplies." In Minnesota, pesticide levels in ground and surface waters have not been shown to be a problem for livestock production.

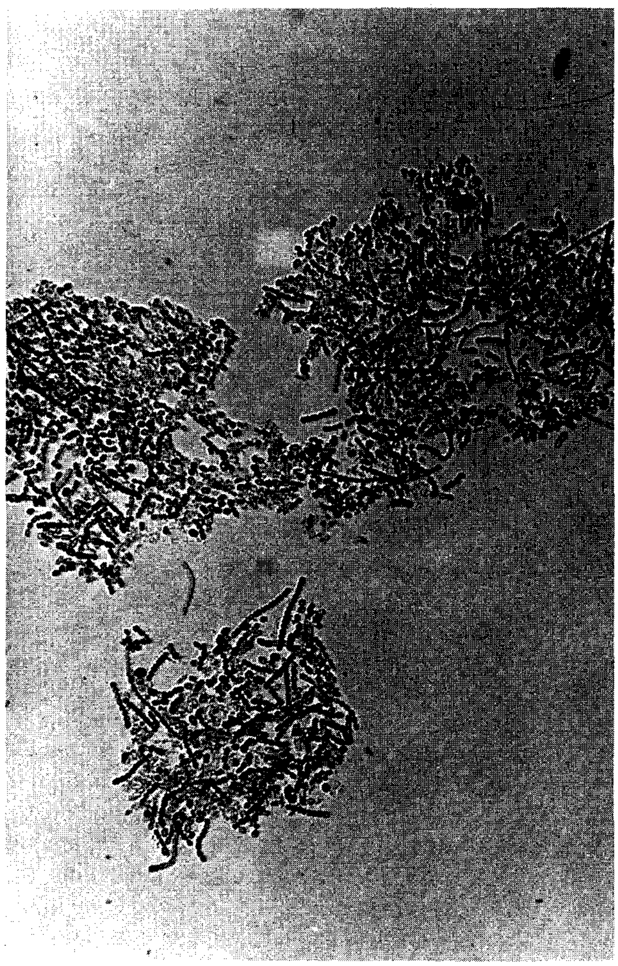
Solving the Problem

It is extremely difficult and expensive to test for unknown pesticides or suspected chemicals in water. If the chemical can be identified, a test can be performed to determine if that chemical is present in the water supply. If a general chemical pollution is suspected, it will be extremely expensive to determine which pesticide or which chemicals may be present in the water.

The best solution is to prevent the problem from occurring. Be sure that there is adequate drainage around any water supply well. The well should be located on elevated ground where surface run-off will not reach the well.

If a surface water supply which as an excavated pond or impoundment is used, the design should include waterways which prevent uncontrolled surface runoff from entering the water supply.

Microcystis aeruginosa

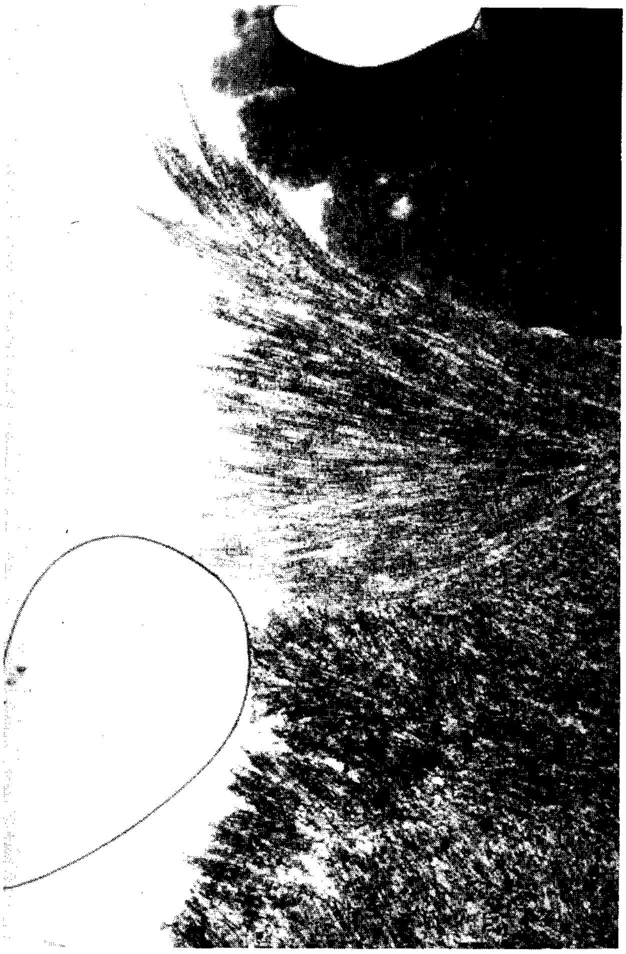


Anabena flos-aquae

BLUE-GREEN ALGAE

For over 100 years, toxic blue-green algae or toxic water blooms have been recognized as a problem in Minnesota, particularly in the relatively shallow lakes of southern and central Minnesota. Algae grow and multiply because of favorable nutrient and temperature conditions. Water with a high level of algal nutrients will experience algal blooms with lower water temperatures than less nutritious water. Surface waters and ponds will have algal blooms whenever nutrient and temperature conditions are favorable. Algal blooms occur in Minnesota between May and early November; their growth is favored by hot, dry weather, usually in mid-summer. Wind causes the algae to accumulate along the downwind shores of lakes, ponds, and streams. Algal blooms can appear almost overnight, continue for several days to a week, and then rapidly recede with the advent of cooler weather and rain. Some lakes or ponds frequently have several algal blooms during a summer. Farm ponds and stock tanks can also be affected.

The three different types of toxic blue-green algae found in Minnesota are *Microcystis aeruginosa, Anabena flos-aquae,* and*Aphanizomenon flos-aquae.* The first two are most commonly encountered and are quite readily identified by microscopic examination of the water. Blue-green algae poisoning is quite common in grazing livestock causing muscle tremors, diarrhea, lack of coordination, collapse, labored breathing, liver damage and death. Effects can occur from within a few minutes to a day, and animals that recover often shed large sections of the unpigmented (white) areas of their hides. All species are affected.



Aphanizomenon flos-aquae

Other Water Borne Problems

Botulism affects livestock, dogs and birds especially waterfowl. The organisms, *Clostridium botulinum* is found in most soils but especially in lakes when high temperatures and receding shorelines result in conditions conducive for their multiplication. Signs in cattle include loss of appetite, severe depression, and reduced milk yield, while in birds, neck paralysis is the major sign. A laboratory diagnosis is necessary to confirm the disease. Vaccination, dispersal of animals and birds and provision of alternate water supplies are options for prevention.

Leptospirosis. This disease is caused by Leptospira bacteria which thrive in moist areas and surface water. Livestock exposed to these organisms may pass red urine, abort, or show a sudden drop in milk production. Vaccines are available to prevent leptospirosis.

Solving the Problem

Water containing a bloom of blue-green algae should not be used for watering livestock. There is no specific antidote to algae poisoning. The best thing to do is administer large quantities of medicinal-grade charcoal and mineral oil. Animals must be denied access to the algae-contaminated water and provided with a supply of suitable water.

Algae can be controlled with copper sulfate in concentrations of about 1.0 ppm. This is equivalent to 3 pounds of copper sulfate per acre-foot of water. To keep algae under control several applications may need to be made to a body of water during a summer. It is recommended that livestock not drink the treated water. Also remember that algal blooms can occur in a very short period of time and it may be extremely difficult to control all blooms in a body of water that is high in algal nutrients.

Algal blooms can also occur in stock tanks if nutrients and temperature conditions are favorable. Periodically cleaning the stock tank to remove the nutrient source is the best way of preventing algal blooms there. In real problem situations, adding 3 ounces of chlorine for every 50 gallons every 10 to 14 days will help control algal bloom in stock tanks.

OTHER FACTORS

Stray Voltage

This problem has been more widely identified and is steadily increasing on Minnesota dairy farms. If stray voltage is a problem, animals may curtail their water intake resulting in production losses. Water consumption problems which are related to stray voltage may be incorrectly interpreted as a water quality problem. A complete discussion of the stray voltage problem is presented in AG-BU-1359, *Stray Voltage Problems with Dairy Cows.*

Water Temperature

There is little evidence to show that livestock production is affected by drinking water temperature in the range from above freezing to summer ambient temperatures. Lactating dairy cows have been shown to produce the most milk when offered water between 50 and 65 degrees F. Water temperature above 75 degrees F decreases water intake and milk production. Poultry have been shown to decrease their intake of water when the water is warm, especially in hot weather. Warm water also is subject to more bacterial growth than cold water.

WATER TESTING

Contact your community or county health service, county extension agent or veterinarian for information where water samples can be examined and what tests may be required. Remember that tests for microorganisms require that the water faucet run for several minutes before the sample is collected in a sterile container, sealed, and dispatched to the testing laboratory to arrive within 24 hours. It is recommended that tests be made by laboratories that have been approved by the Minnesota Department of Health. If the results of water tests indicate that problems may exist, field officers of the Minnesota Department of Health Well Managementl Unit are available for advice and recommendations by contacting the main office at 717 Delaware Street SE, Minneapolis, MN 55440. District offices of the Minnesota Department of Health are located at Bemidji, Duluth, Fergus Falls, Sauk Rapids, Marshall, Mankato, and Rochester.

OBTAINING A NEW WATER SOURCE

If it is determined that an existing water supply is either unsatisfactory in terms of chemical or microbial contamination, or if the supply is inadequate for the existing or expanding livestock operation, a new well may have to be drilled. The services of a licensed water well contractor should be obtained and the well should be constructed according to the provisions of the Minnesota Water Well Construction Code. Further information on water well construction can be obtained from the Well Management Unit, Division of Environmental Health, Minnesota Department of Health, 717 Delaware Street SE, Minneapolis, MN 55440. The district offices listed above also have water source information.

ADDITIONAL SOURCES OF INFORMATION

The following faculty of the University of Minnesota have contributed to this publication and may be contacted through your local county extension office for additional information:

Veterinary Medicine	Dr. Ashley Robinson
Veterinary Medicine	Dr. Larry Stowe
Dairy Cattle	Dr. James Linn
Beef	Dr. Jay Meiske
Swine	Dr. Jerry Hawton
Horses and Sheep	Dr. Robert Jordan
Poultry	Dr. Mel Hamre

WATER QUALITY GUIDELINES FOR BEEF AND DAIRY CATTLE

Water is the nutrient required in the largest quantity by beef and dairy cattle. Daily intakes of water can range from 5% of body weight for a beef cow to 20% of body weight for a high producing dairy cow. A lack of water intake will have a rapid and dramatic effect on animal health and productivity. The following guidelines are based on limited research and field observations, and are not standards. They are presented as an aid in evaluating water quality tests and trouble shooting water intake problems on farms.

WATER ANALYSIS	ACCEPTABLE
pH	6.0-8.0
Total Dissolved Solids (TDs)	0-3000 ppm
Hardness	Generally no problem
Nitrate nitrogen	0-100 ppm
Nitrate nitrogen	0-10 ppm
Sulfate	0-500 ppm
Lead	0-.1 ppm
Mercury	0-.01 ppm
Total bacteria	0-1000/ml
Coliform bacteria	0-50/100 ml

General conversions

ppm = parts per million

10,000 ppm = 1%

1 ppm = 1 milligram/liter (mg/1) or 1 milligram/1000 milliliters

1 grain/gallon = 17.1 ppm or 17.1 mg/1

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This publication is based on an original publication written by Roger Machmeier, Emeritus Extension Agricultural Engineer.