Manitoba

Agriculture

Evaluating Water Quality for Livestock

Water is the single most important nutrient for livestock. Animals, as well as humans, can live for long periods of time without food. Without water, however, death can occur in a matter of days. Unfortunately, both the quality and quantity of the water provided for livestock is often overlooked.

Water is involved either directly or indirectly in virtually every physiological process. Water is a medium for transporting nutrients, waste material, hormones and other chemical messengers, as well as food along the gastrointestinal tract. It also plays an important role in regulating body temperature, acts as a lubricant for skeletal joints and is a component of many basic chemical reactions.

Water quality is determined by analyses of water samples. A bacterial analysis indicates if water contains microorganisms, such as bacteria, which may be harmful. A chemical analysis determines the levels of various minerals present in water.

Evaluating the content of water is relatively straightforward. The major difficulty is establishing levels at which animal health, welfare and productivity may be impaired.

This factsheet outlines recommended levels and potential problems found during water analysis. Table 1 summarizes the water quality guidelines established by the 1987 Canadian Task Force on Water Quality.

Interpretation of Chemical Analysis pH

The hydrogen ion concentration in water determines the pH level. A pH value of 7 indicates "neutral" water. Values less than 7 are increasingly acidic and values greater than 7 are increasingly alkaline. Most water falls within an acceptable range of 6.5 to 8.5. If the pH is lower than 5.5, acidosis and reduced feed intake may occur in cattle. A low water pH is unlikely to have any direct effect on swine because of the already acidic conditions of the stomach.

Water pH is an important factor in determining the effectiveness of various water treatments. Chlorination efficiency is reduced at a high pH. A low pH may cause precipitation of some antibacterial agents delivered through the water system. For example, sulphonamides are a particular concern as precipitated medication may leak back into the water after treatment has ended, contributing to potential sulpha residues in carcasses.

Table 1. Canadian Water Quality Guidelines for Livestock

Item	Maximum Recommended Limit(mg/L)
Major Ions	
Calcium	1,000.0

Nitrate and nitrite	100.0
Nitrite alone	10.0
Sulphate	1,000.0
TDS	3,000.0
Heavy Metals and Trace Ions	
Aluminum	5.0
Arsenic	0.5*
Beryllium	0.1**
Boron	5.0
Cadmium	0.02
Chromium	1.0
Cobalt	1.0
Copper (swine)	5.0
Fluoride	2.0***
Iron	no guideline
Lead	0.1
Manganese	no guideline
Mercury	0.003
Molybdenum	0.5
Nickel	1.0
Selenium	0.05
Uranium	0.2
Vanadium	0.1
Zinc	50.0

* 5.0 if not added to feed

** Tentative guideline

*** 1.0 if fluoride present in feed

Source: Task Force on Water Quality Guidelines. 1987.

A Guide to the Use of Poor Quality Water for Livestock

Total Dissolved Solids (mg/L)

- Fewer than 1,000: Relatively low level of salinity with no serious burden on any class of livestock
- 1000-2999: Satisfactory for all classes of livestock; the water may cause temporary and mild diarrhea in livestock not accustomed to it, but should not affect health or performance; individual mineral levels should be checked

- 3000-4999: Satisfactory for livestock, although it may cause temporary diarrhea or refusal at first by animals not accustomed to it
- 5000-6999: Reasonably safe for dairy and beef cattle, sheep, swine and horses; avoid using water with higher levels for pregnant or lactating animals
- 7000-10,000: Probably unfit for swine; considerable risk may exist in using this water for pregnant or lactating cows, horses, sheep, the young of these species or for any animal subjected to heavy heat stress or water loss; in general, use of this water should be avoided, although older ruminants, horses and even swine may subsist on it for long periods under conditions of low stress
- More than 10,000: the risks with these highly saline waters are so great that they cannot be recommended for use under any circumstances

Reprinted from *Nutrients and Toxic Substances in Water for Livestock and Poultry,* 1974, National Academy of Sciences.

Filterable Residue (mg/L)

Filterable residue or Total Dissolved Solids (TDS) is the main indicator of water quality. If the TDS is acceptable, it is unlikely that mineral levels will be a problem. Water with a TDS of less than 1,000 mg/L is acceptable for all classes of livestock. Between 1,000 and 7,000 mg/L the effects of TDS are less clear cut and may range from no noticeable effect to temporary diarrhea to decreased productivity. If TDS falls in this range, an evaluation of the mineral levels that make up TDS is needed. Any number of minerals can elevate TDS; for example, calcium and magnesium contribute to TDS, but have very different physiological effects compared to sulphate, another contributor to TDS.

If the TDS is between 7,000 and 10,000 mg/L, serious health problems can develop and water refusal by livestock can occur. Water with a TDS over 10,000 mg/L should not be used for animal consumption.

Alkalinity Total (mg/L as $CaC0_3$)

Alkalinity measures water's ability to neutralize an acid. Alkalinity levels in excess of 500 mg/L can have a laxative effect. While alkalinity levels usually do not exceed the recommended limit of 500 mg/L, lower levels can increase the laxative effects caused by a high sulphate level. As the level of alkalinity increases, the level at which sulphates will cause scouring decreases.

Copper (Cu in mg/L)

As little as 0. 1 mg/L of copper may cause an oxidized flavour in cows milk. There is some suggestion that copper levels above 0.6 mg/L can result in liver damage in dairy cows, although this is well below the level considered toxic in the diet. For swine, the Canadian Task Force on Water Quality has set a maximum recommended level of 5 mg copper/L of water.

Hardness (mg/L as $CaCO_3$)

Although hardness has no effect on water safety, it can result in the accumulation of scale (mostly magnesium, manganese, iron and calcium carbonates) in water delivery equipment. The clogging of pipes and drinkers can lead to reduced water consumption and its associated problems. Water with more than 121 mg/L as $CaCO_3$ is considered hard.

Iron (Fe in mg/L)

Low levels of iron can be troublesome in water. Levels over 0. 1 mg/L have been reported to cause red meat in veal calves. Iron levels in excess of 0.3 mg/L can stain clothes. It can also support the growth of iron bacteria, which result in foul odours and plugging of water systems. Levels over 0.3 mg/L might also reduce water intake and production in dairy cows. As little as 0. 1 mg/L may cause oxidized flavour of the milk.

Magnesium (Mg in mg/L)

Magnesium sulphate, also known as Epsom salts, is undesirable in water because of its laxative effect. An upper limit of 300 to 400 mg/L has been suggested for dairy cows. Magnesium levels in water are usually considerably lower than this.

Nitrates (NO_3-NO_2-N [diss] as mg/L)

Nitrates and nitrites in water are serious potential hazards. They react with hemoglobin in the blood making it incapable of transporting oxygen. Infants are at serious risk from this problem. Among livestock, ruminants are most susceptible because bacteria in the rumen convert nitrate to the much more dangerous nitrite. Pigs are less susceptible because this conversion doesn't occur to the same extent.

Most water nitrates come from organic material and runoff from heavily fertilized fields. Nitrates have been found to move through moist soil at a rate of up to one metre per day. They can rapidly contaminate shallow wells, especially those located in or around current or abandoned livestock yards.

Nitrates are reported as nitrate and nitrite-nitrogen combined, as nitrite is unstable and converts to nitrate before the analysis is done. Water containing over 100 mg/L of nitrates, or 23 mg NO_3-NO_2-N/L, is potentially dangerous. High nitrates in feed can contribute to toxicity if the supply in the water is also high.

Pigs are very resistant to nitrate poisoning and levels well above what is normally found are necessary before average daily gain decreases (nitrate levels greater than 750 mg/L).

Sodium (Na in mg/L)

Sodium sulphate, also known as Glauber's salts, is a well known laxative. By themselves, magnesium and sodium normally pose little risk to livestock, but their association with sulphate is a major concern. Water with over 800 mg sodium/L can cause diarrhea and a drop in milk production in dairy cows. High levels of sodium, a major component of salt, may necessitate adjustments to rations. Care should be taken when removing or reducing salt from swine and dairy rations to ensure a chlorine deficiency does not result. Salt may be reduced in swine diets if the sodium in the water exceeds 400 mg/L.

Sulphates (SO_4 in mg/L)

Sulphate levels in excess of 150 mg/L can cause a noticeable taste that may or may not affect water intake. Water with sulphate levels above 500 mg/L can have a laxative effect until an adjustment to the water is made. The effect of sulphates depends largely on the body mass of an animal - the smaller the animal, the greater the effect. Weanling pigs can, therefore, be affected by relatively low levels of sulphates. Because of an interaction between sulphates and alkalinity, the laxative effects of a high sulphate water will be more pronounced as the alkalinity level nears its limit of 500 mg/L.

Depending on alkalinity levels, sulphate levels of 1,000 to 1,500 mg/L can cause chronic diarrhea in weanling pigs. Sulphate levels greater than 2,000 mg/L can cause diarrhea and reduced milk production in dairy cows. High levels of sulphates can also contribute to copper deficiencies in beef and dairy cattle.

Microbiology

Water may contain a variety of microorganisms, including bacteria, viruses, protozoa and parasite eggs. A coliform bacteria count of over 1/100 ml can cause scours in calves. A count of over 20/100 ml can result in diarrhea in cows and cows going off feed. Water chlorination will remove harmful bacteria and other microorganisms. Protozoa and enteroviruses are more resistant to chlorination than bacteria.

Water analysis

Producers wanting information on how to take water samples and where to send samples should contact their local agricultural representative office.

Sources:

- National Academy of Sciences, 1974 *Nutrients and Toxic Substances in Water for Livestock and Poultry* (Washington, D.C.)
- Patience, J.F., J. McLeese and M.L. Tremblay, 1989. *Water Quality - Implications for Pork Production* (Proceedings of the Tenth Western Nutrition Conference, Saskatoon, Saskatchewan.)

- Smart, M.E., D. McLean and D.A. Christensen, 1989. *The Dietary Impact of Water Quality* (Proceedings of the Tenth Western Nutrition Conference, Saskatoon, Saskatchewan.)

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