Water Quality for Beef Cattle

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As one of the six classes of essential nutrients, water is often overlooked, even though it is the most important nutrient for all living beings. An adequate supply of high-quality drinking water should always be available to promote cattle health and production status.

Importance of Understanding Water Quality

Much like one can utilize forage and feed analysis to ensure that animals are receiving correct and proper nutrients, water analysis can provide useful information as well. Cattle consuming low-quality water containing contaminants such as debris, microbes and toxoids could have inhibited performance and negative health consequences compared with animals with a supply of clean, fresh drinking water. Although ponds and natural bodies of water are utilized as a drinking water source for livestock, the poor water quality warrants a change. Cattle often drink less contaminated water compared with high-quality water, leading to reduced feed intake and, in hot weather, an increased risk of heat stress. Therefore, it is important that we gain a better understanding of what is present in a water supply.

Assessing Water Quality

Assessing water quality focuses on these areas:

- Physical properties
- Physiochemical properties
- Excess nutrients
- Toxic compounds
- Microbiological agents

Physical Properties

Maintaining drinking water at a proper temperature that is preferred by cattle is one way of ensuring consistent intake and performance. The preferred water temperature for cattle is between 40 degrees F (4.4 degrees C) and 65 degrees F (18.3 degrees C). Cattle intake tends to fluctuate with changes in weather, temperature, dry matter intake and stage in production, so it is important that producers understand what their herd requires so that they can ensure all their needs are being met. Cattle water consumption requirements are listed in Table 1.

Table 1. Cattle water consumption requirements

Temperature (degrees F)	Gal/lbs. DM*	500 lbs. Calf (12 lbs. DMI*)	750 lbs. Calf (16.6 lbs. DMI*)	1,100 lbs. Dry Cow	1,100 lbs. Lactating Cow
40	0.37	4.4	6.1	7.4	8.1
60	0.46	5.5	7.6	9.2	10.1
80	0.62	7.4	10.3	12.4	13.6
90	0.88	10.6	14.6	17.6	19.4

*DM = dry matter; DMI = dry matter intake.
Adapted from Higgins et al., 2008.

Physiochemical Properties

pH

pH is a measure of alkalinity or acidity in a water source. On a scale of 1-14, a pH of less than 7 is considered acidic and a pH greater than 7 is alkaline, while 7 is considered a true neutral. In terms of drinking water, humans prefer water that have a pH of 6.5-8.5, but there is very little knowledge on cattle preference or the result of water sources differing in pH on cattle performance. However, it should be a goal to provide drinking water to cattle with a pH that falls into the range of 5 or 5.5 to 9.

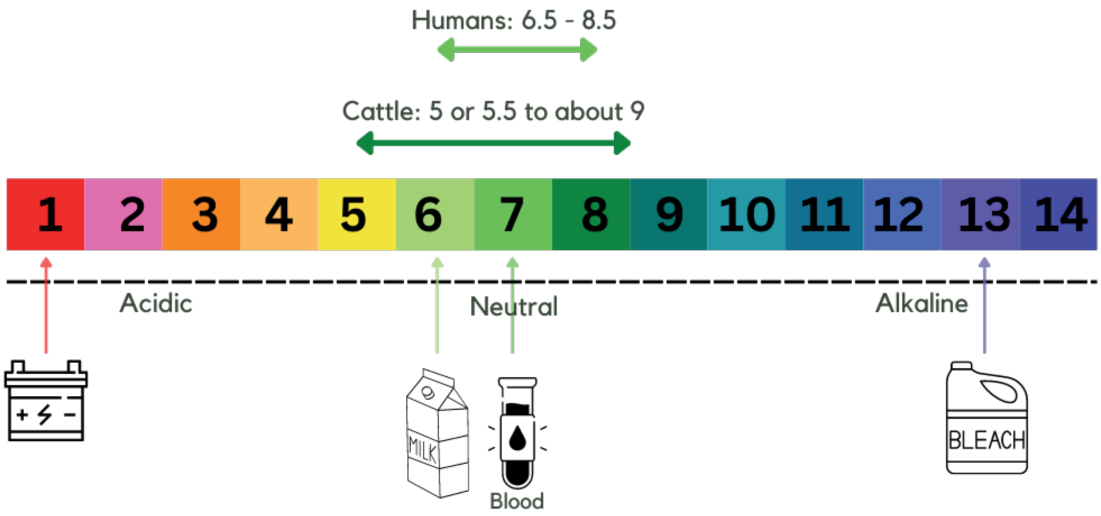

Figure 1. Preferred drinking water pH values. *Adapted from NDSU-VDL.*

Salinity

Salinity has been defined as the amount of dissolved minerals and salts present in water and is determined by measuring total dissolved solids, total soluble salts or electrical conductivity. The most common level of excess nutrients is sodium chloride, or salt, but other compounds such as calcium, magnesium, silica and sulfate may also have significant levels contributing to the salinity of water. Additionally, noticeable concentrations of boron, fluoride, nitrite, potassium, phosphorus and strontium can contribute to salinity as well. Various salinity categories are listed in Table 2.

Table 2. Salinity guidelines

Total Soluble Salts (mg/L)	Quality	Comments
Less than 1,000	Excellent	Safe to drink; should pose no threat to health
1,000-2,999	Good	Mildly safe to drink; could cause mild cases of diarrhea
3,000-4,999	Fair	Cattle may refuse; lowered intake will cause a reduction in performance; diarrhea is common
5,000-6,999	Poor	Should only be offered if maximizing performance is not a goal; do not offer to pregnant or lactating cattle
7,000-10,000	Limit	Avoid providing for drinking water; will cause variety of health problems
More than 10,000	Unsafe	Unsafe to consume; do not use

Adapted from Higgins et al., 2008.

Hardness

Water hardness is the amount of naturally occurring positive ions in water or the amount of dissolved magnesium and calcium present expressed as equivalents of calcium carbonate. Iron and manganese can also contribute to water hardness but are typically found in much lower concentrations. These minerals accumulate as water flows through rocks and other substances in soil. Hardness mostly influences water delivery. Hard water tends to build up scale, or residue, on the inside of pipes that effects water pressure and flow. It can also encrust exterior pipes and valves and prevent proper movement.

As far as cattle are concerned, hardness does not affect the palatability or daily intake of water. It does, however, affect performance. High levels of dietary calcium (more than 12.5g calcium/kg diet) have also shown to limit selenium absorption in cattle. Hard water with high concentrations of iron has also been found to influence zinc and copper absorption. Table 3 lists water hardness guidelines.

Table 3. Water hardness scale

Hardness (mg/L)	Category
0-60	Soft
61-120	Moderately Hard
121-180	Hard
181-350	Very Hard
More than 350	Brackish

Adapted from Higgins et al., 2008.

Excess Nutrients

Nitrates and Nitrites

High levels of nitrates in the water most commonly occur during extreme weather conditions such as drought-like conditions or when the ground is frozen. Increases in nitrates in the water typically are only for a short period of time, so short that you may not notice cattle differences until after it normalizes. However, excess nitrates accumulate in the rumen where rumen microorganisms convert nitrate to nitrite. Nitrites absorb into the bloodstream and interfere with respiration by preventing hemoglobin's ability to transport oxygen throughout the body. In severe cases, asphyxiation may occur. Symptoms of nitrate poisoning include poor growth and development, infertility, abortions, poor physical appearance, and vitamin and mineral deficiencies. Acute symptoms include troubled or difficulty breathing, blue coloration of the face, increased heart rate and frothing at the mouth. Chronic symptoms are harder to detect but include a weakened immune system, poor performance, decreased milk production and decreased appetite. Nitrate concentration guidelines are shown in Table 4.

Table 4. Nitrate and nitrite guidelines

Nitrites (mg/L)	Nitrates (mg/L)	Comments
0-44	0-10	Safe drinking water, no restrictions
45-132	11-20	Safe when offered with feeds low in nitrates and a balanced diet
133-220	21-40	Could be harmful if consumed long term
221-660	21-100	Cattle death is likely
More than 661	More than 101	Unsafe for consumption; do not use

Adapted from Higgins et al., 2008.

Sulfates

Sulfates are present in most water supplies regardless of source. Sulfates can most commonly be detected by the distinct, bitter smell. Unlike other contaminants, sulfates do affect the palatability of water when presented to cattle, and most will refrain from drinking it even if it is the only water source. Sulfates bind to calcium, iron, sodium and magnesium salts and act as a strong laxative when ingested at heightened levels. Additionally, excess amounts of sulfates can cause polioencephelomalacia (PEM), a muscle disorder with symptoms of weakness, lethargy and muscle tremors. PEM can also lead to paralysis and death in worst case scenarios. Research has shown cattle can tolerate sulfates in water at 500 ppm in calves and 1,000 ppm for adult cattle (Table 5).

Table 5. Sulfate and sulfate sulfur maximum levels guidelines

Sulfate (mg/L)	Sulfate Sulfur (mg/L)	Cow Type
Less than 500	Less than 167	Calves
Less than 1,000	Less than 333	Adults

Adapted from Higgins et al., 2008.

Toxic Compounds

There are other compounds commonly and uncommonly found in water that could have an effect on cattle performance (Table 6). An understanding of uncommon behaviors and symptoms could help identify causes from water sources. Producers with water containing concentrations exceeding recommended levels should seek other water sources or treatment for the original source.

Table 6. Maximum recommended levels of potentially toxic compounds

Substance	Maximum Recommended Level (mg/L)
Aluminum (Al)	5.0
Arsenic (As)	0.2
Boron (B)	5.0
Cadmium (Cd)	0.1
Chromium (Total) (Cr)	1.0
Cobalt (Co)	1.0
Copper (Cu)	0.5
Fluorine (F)	2.0
Lead (pb)	0.1
Manganese (Mn)	0.05
Mercury (Hg)	0.01
Selenium (Se)	0.05
Vanadium (V)	0.1
Zinc (Zn)	24.0

Adapted from Higgins et al., 2008.

Microbial Agents

Fecal Coliforms

Fecal coliforms are essentially indicators that fecal matter is present. Most suggest that drinking water for livestock contain less than 1 colony forming unit per 100mL for calves and 10 colony forming unit per 100mL for adult cattle. Although ponds are a resourceful way of providing water to cattle, this is where fecal coliforms are most commonly found. By blocking out water access completely or limiting it so that cattle cannot submerge themselves is one simple solution for resolving this issue.

Figure 2. Cattle loafing in ponds can create water quality issues.

Cyanobacteria

Water sources can become stagnant and still in drought periods. With limited movement, high temperatures and nutrient overload, it is the ideal environment for algae blooms to develop. These algae blooms may contain cyanobacteria, or blue-green algae, and contaminated water is most commonly identified by having a blue-green color. The toxin in this type of contaminated water is released by the blue-green algae and is called microcystins. Waters contaminated with microcystins often have elevated total dissolved solids, phosphorus and nitrogen concentrations as well. After consuming water containing cyanobacteria, there is documentation that many cattle have become sick or died. Nevertheless, management practices with a focus on providing fresh drinking water and cleaning watering equipment is a simple way of preventing sickness caused by water sources.

Collecting Water Samples

To have a better understanding of the quality of water sources, it is important to test water regularly. There are several water testing options and producers can submit samples to commercial or university labs for complete analysis of the samples, or at home kits can be purchased for fewer contaminant identification.

One of the most important steps in collecting water samples is to do it according to the testing protocol from the lab or sampling kit (Table 7). Doing this ensures that the sample is best fit for that test analysis. After collecting the sample, proper handling and submission is necessary for the most accurate read. Samples not submitted within the proper time frame or not maintained at the correct temperature, for example, lose validity after a certain period of time and the samples are essentially useless.

Table 7. Sample collection and handling guidelines

Category	Comments
Location	Samples should be a quality representation of the water that animals consistently drink from. Samples taken from flowing water sources such as a stream should be taken mid-channel and mid-depth. Water lines should be flushed for 3-5 minutes before samples are taken from spouts or spigots.
Container	Containers should be clean. No contaminants or other particles should be present. Containers should only be opened to collect the sample.
Label	Label should contain your name, date, time collected, and sample location.
Holding Time	Confer with laboratory or manufacturer for suggested holding times, as this varies by test method and contaminant. pH must be analyzed in field at water location.
Holding Temperature	Store at 4 degrees C (39 degrees F).
Volume	Fill container completely full for organic compound determination; space for aeration and mixing should be left for inorganic and microbiological determinations. Be sure to collect enough sample matter to conduct all tests.
Preservation	Confer with laboratory or manufacturer for suggested care as this varies by test method and contaminant.
Safety	Samples should be collected, handled, stored and transported with care. Personal protective equipment could be required and samples should not be stored near food for human consumption.

Adapted from Higgins et al., 2008.

Procedures are often different for mineral versus bacterial samples. Bacterial samples often must be kept cool once collected and overnighted to the lab. Various labs have different forms and procedures to follow. Some labs provide (for a fee) ice chests, sample tubes, whirl-pak bags, cool packs, etc. Check with the lab you are using to ensure proper protocol is followed. The Tennessee Department of Environment and Conservation maintains a list of laboratories approved for drinking water analysis (https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/drinking-water-redirect/lab-certification-program.html).

Overall, it is important to ensure adequate accessibility and quality of drinking water for beef cattle. Understand that there are many factors and properties of water quality that can impact palatability and animal performance.

References

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