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Feeds Forages Mycotoxins Soils Plant Tissues Manure Fertilizers Lime Water

Water Analysis is Important

Water is consumed in greater quantity than any other nutrient. Water loss or deprivation causes death faster than lack of any other nutrient. Yet quality of water, even though extremely variable, is often taken for granted. A comprehensive water analysis can tell many things about the suitability of a water supply for household or livestock use.

Interpreting Your Water Analysis Report

Sodium

In most cases, the amount of sodium in water is extremely small by comparison with the amount of sodium consumed in food or livestock feed. However, when a high level of sodium is present, either naturally or as a result of water softening, the amount of salt in the diet may need to be adjusted. This is especially important for persons whose medical conditions make it necessary to restrict sodium intake.

Calcium & Magnesium Hardness

Water containing excessive levels of calcium and magnesium is referred to as "hard". These elements react with soap to form an insoluble, curd-like material which leaves rings in sinks and bath tubs and gives clothes a dull "tattletale gray" cast. When heated, the calcium and magnesium precipitate to form a hard scale in coffee pots, water heaters, pipes, an boilers. This scale, usually referred to as lime, serves as an insulator around electric heating elements which wastes energy and decreases heating capacity.

Soft water, in contrast, leaves no deposits and lathers well with soap. When hard water is passed through a water softener, the calcium and magnesium ions are replaced by sodium ions from salt (sodium chloride).

pH

Acidity is measured as pH, with values below 7.0 being acid and values above 7.0 being alkaline. Most water supplies have a pH value between 6.5 and 8.0. Within this range, there should be no problems due to pH, although water with an acid pH may cause some corrosion of metal. Municipal water supplies are usually adjusted to a pH between 8.0 and 10.0.

Alkalinity

To measure alkalinity, water with a pH greater than 7.0 is neutralized with acid. The amount of acid required is expressed as the amount needed to neutralize an equivalent amount of calcium carbonate. Water with high levels of calcium, bicarbonate, and / or carbonate will usually have a high alkalinity.

Nitrate

Nitrite, an anion (NO3-), is negatively charged and therefore is not absorbed by the soil and moves with infiltrating water. Of the inorganic contaminants found in water, nitrate receives the most attention. This is due to the fact that it is easy to detect and many natural sources are present in the environment.

Nitrate levels in ground water can be affected by a variety of conditions. Rainfall, soil texture, nitrogen fertilization, location of feedlots and septic fields and the depth and location of wells are all factors which can interact to raise water nitrate levels. While natural nitrate originating from soil occurs in water, (0.2 to 0.3 ppm NO3-N), high levels of nitrate in well water indicate surface contamination. These sources include septic fields, manure pits and lagoons, and fertilizer and sludge application.

A large amount of confusion exists over the way nitrate data is presented. For example, a nitrate (NO3) reading of 44.0 ppm is equivalent to a nitrate

nitrogen (NO3-N) reading of 10.00 ppm. You should note the nitrogen value used in the test report for your water.

Levels in excess of 44 ppm NO3 or 10 ppm NO3-N my cause infant cyanosis (blue-baby syndrome) in children under the age of six months. Infant Cyanosis can be fatal to both infants and small animals. The water should not be given to infants either directly or used in formulas. It is also recommended that children and adults should avoid long-term consumption of water with over 10.0 ppm NO3-N. Table 1 provides guidelines for using nitrate-contaminated water for livestock.

Table 1. A Guide For Using Water Containing Nitrates for Livestock

NO3-N ppm Content	Comments
< 100	This water should not harm livestock or poultry.
100 – 300	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.
> 300	Could cause typical nitrate poisoning in cattle, sheep or horses. Do not use the water for these animals. This level of nitrate significantly contributes to the salts content. Avoid the use of this water for swine or poultry.

From: WQ-9, Water Quality for Animals, Dr. K.B. Meyer, Purdue University Extension Publications, 1990.

Nitrites

Nitrate (NO2) in water is several times more toxic than nitrate (NO3). Fortunately, nitrite is not commonly found at significant concentration in drinking water.

Sulfate

Water which is high in sulfate can cause some degree of diarrhea in both humans and animals. The effect varies with the level of sulfate, the age and general health of the person or animal, and the other elements associated with the sulfate. High sulfate associated which high sodium is in effect a solution of "Glauber's Salt" (sodium sulfate), and when associated with high magnesium it is "Epsom Salt (magnesium sulfate), both of which are laxatives. Water with excessive sulfate usually has an objectionable taste, and high levels of sodium sulfate are corrosive to metal.

Total Dissolved Solids (TDS)

The amount of dissolved minerals in a water sample is reported as Total Dissolved Solids (TDS) or Soluble Salts. Dissolved solids consist of a variety of salts such as chlorides, sulfates, and bicarbonates of calcium, magnesium and sodium. When dissolved in water these minerals cause it to conduct electricity. By measuring this conductivity, the total amount of dissolved solids can be determined. Water containing high levels of dissolved solids is often called saline. TDS or salinity is expressed in parts per million of dissolved solids and can be used as a general measure of water quality, although it does not by itself reveal anything about which minerals are present.

Problems with dissolved solids in water can occur at any time in some locations. However, periods of drought can cause problems in areas ordinarily without any problem. The level of dissolved solids can rise due to evaporation or lowering of the water table. For human consumption, levels greater than 500 ppm are not recommended.

TDS or Salinity in Livestock Water

If animals are offered two sources of water, one highly saline and the other not, they will not drink the highly saline water.
Animals can consume water of very high salinity for a few days without being harmed if they are then given water of low soluble salt content.

Saline water is frequently associated with some degree of diarrhea, especially when animals are first introduced to the saline water after transport or weaning. The duration and severity of the diarrhea can vary, depending on age and health of the animal, ration composition, and the elements in the water contributing tot the salinity. Total dissolved solids as low as 1500 ppm have been associated with this problem.

As the soluble salt content of the water increases, intake may increase, except for water of extremely high saline content that the animals refuse to drink. However, in some cases, animals have been know to reduce intake of saline water to the extent of becoming constipated.

Depressed water intake is very likely to be accompanied by depressed feed intake. Thus,

animals being fed for a high rate of gain or production may be expected to show more detrimental effects from water of higher soluble salts content than animals fed at a maintenance level.

While water should normally not be relied upon as a source of essential inorganic elements, highly saline water may in some situations furnish enough of these to be considered in calculating mineral additions to the diet. Furthermore, the salt content of the diet may contribute to the toxicity of saline water. This is of particular concern when salt additions to the diet are used to control feed intake.

Water containing up to 3,000 ppm of TDS usually do no cause problems in livestock. Levels above 10,000 ppm are unfit for poultry and probably swine. Some risk may exist in using this water in pregnant animals of other species as well. Table 4 located on page 5 shows some of the effects of high levels of salinity in livestock water.

Purity

When shown on a water report, purity refers to the presence or absence of bacteria presumed to be coliform, these kind of bacteria found in sewage and manure. When the water tests positive for coliforms, the water should not be used for human consumption without boiling or chemical treatment. Drinking water contaminated with coliform bacteria may cause diarrhea, stomach cramps, and nausea and lead to even more serious health problems. The most common sources of contamination are runoff from feedlots, seepage from septic systems, and faulty plumbing.

Iron

Iron is relatively insoluble and is seldom if ever present in water at toxic levels. However, at levels of only 0.5 ppm, it can cause staining and may form an insoluble precipitate with phosphorus. The most accurate test for iron requires a special sampling procedure to acidify the sample immediately after collection. Ask the laboratory for special instructions.

Manganese

Like iron, manganese is more of a nuisance than a health threat. Even at levels below 1.0 ppm, manganese can cause black staining and a black, smelly slime deposit.

Chloride

The effect of high chloride is a salty taste. Chloride is seldom if ever present at a level that could be considered toxic, and at such a high level would taste too salty to drink.

Copper

At levels above 0.5 ppm in water, copper can give a metallic taste to coffee and tea and causes blue-green staining of porcelain. It is seldom if ever present at a toxic level in groundwater.

Elemental Analysis

Table 3 located on page 4 shows elements that can be tested and levels of each which might be expected to cause problems. Note that nitrate is expressed in both NO3 and NO3-N and that sulfate is expressed in both SO4 and SO4-S. Most apparent conflicts among reports from different laboratories are due to differences in which of these units are reported.

Livestock Water Requirements

An adequate supply of fresh water is essential for livestock production. Water intake is related to the amount of dry matter being consumed in the ration. Cattle and sheep normally drink 3 to 4 lbs. of water for each pound of dry matter intake. Pigs, horses and poultry drink 2 to 3 lbs. of water for each pound of dry matter intake. Lactating animals consume additional water to replace the water lost to milk production. Table 2 provides some estimates of livestock water requirements.

Table 2. Estimated Water Intake of Livestock

	Gals per Day @ Air Temperature	
Animal	**50°F**	**90°F**
Dry Cow	7 – 12	10 – 18
Milk Cow	12 – 24	20 – 40
Beef Cattle	7 – 12	10 – 18
Swine < 60#	0.7 – 1	1 – 2
Swine 60-100#	1 – 2	2 – 3
Swine 100-250#	3 – 4	4 – 5
Swine Sows	3 – 6	3 – 7
Swine Boars	3 – 5	5 – 6
Sheep	1 – 3	2 – 5
Horses	7 – 12	10 – 18
Poultry	0.1 – 0.2	0.2 – 0.3

From: Interpretation of Domestic and Livestock Water Analyses, A & L Labs, 1996.

Table 3. Recommended Limits of Concentration of Substances in Water (ppm).

	Domestic Preferred	Domestic Acceptable	Domestic Objectionable	Domestic Maximum	Livestock Maximum
Aluminum	< 0.05	0.05 - 0.20	> 0.20	> 0.20	0.500
Antimony	< 0.006	< 0.006	0.006	> 0.006	*
Arsenic (As)	0	< 0.010	> 0.010	0.010	0.050
Barium (Ba)	0	< 1.000	> 1.000	1.000	1.000
Boron (B)	0	< 1.000	> 1.000	1.000	5.000
Cadmium (Cd)	0	<0.010	> 0.010	0.010	0.005
Calcium (Ca)	< 50.000	50.000 – 80.00	>80.000	150.000	200.000
Chlorine (Cl)	< 20.000	20.000 – 250.000	>250.000	*	300.000
Chromium (Cr)	0	<0.050	>0.050	0.050	0.100
Cobalt (Co)	0			1.000	1.000
Copper (Cu)	< 0.200	< 1.000	> 1.000	0.500	0.500
Fluorine (Fl)	0.800 – 1.700	0.700 – 2.000	> 4.000	4.000	2.000
Hardness	25 – 100	100 – 250	> 25 or > 250	*	3000
Iron (Fe)	< 0.200	0.200 – 0.500	> 0.5000	*	0.500
Lead (Pb)	0	< 0.015	> 0.015	0.015	0.015
Magnesium (Mg)	< 30.000	30.000 – 60.000	> 60.000	90.000	100.000
Manganese (Mn)	< 0.010	< 0.050	> 0.050	*	0.050
Mercury (Hg)	0	< 0.002	> 0.002	0.002	0.010
Molybdenum (Mo)	*	*	*	0.010	1.000
Nickel (Ni)	0	< 0.250	> 0.250	0.700	0.250
Nitrates (NO3)	< 3.300	3.300 – 44.000	> 44.000	44.000	100.000
Nitrates (NO3-N)	< 1.000	1.000 – 10.000	> 10.000	10.000	23.000
Nitrites (NO2)	< 0.660	0.660 – 3.300	> 3.300	3.300	33.000
Nitrites (N)	< 0.200	0.200 – 1.000	> 1.000	1.000	10.000
pH	7.0	6.5 – 10.0	< 6.5 or > 10.0	*	8.5
Selenium (Se)	< 0.010	< 0.010	> 0.010	0.010	0.050
Silver (Ag)	*	*	*	0.050	0.050
Sodium (Na)	< 20.000	20.000 – 250.000	> 250.000	*	300.000
Sulfates (SO4)	< 20.000	20.000 – 250.000	> 250.000	250.000	500.000
Sulfates (SO4-S)	< 7.000	7.000 – 83.333	> 83.333	83.000	300.000
Sulfates, Hydrogen Sulfide					< 0.100
Total Dissolved Solids (TDS)	25 - 100	100 – 250	> 250	*	3,000
Vanadium (Va)	*	*	*	*	0.100
Zinc (Zn)	< 1.000	<5.000	> 5.000	25.000	5.000

Microbioligy	Calves	Adults
Total Coliform (# / 100 ml)	< 1.0	< 15.0
Fecal Coliform (# / 100 ml)	< 1.0	< 10.0
Fecal Streptococci (# / 100ml)	< 3.0	< 30.0
Total Bacteria (# / 100 ml)	< 100.0	< 1,000.0

- Limit Not Established

From: WQ- 5, Interpreting Water Test Reports-Part One, Ron F. Turco, Cheri L Janssen, & Martin R. Risch, Purdue University Extension Publicaions, 1990.

WQ-9, Water Quality for Animals, Dr. K.B. Meyer, Purdue University Extension Publications, 1990.

Understanding Your Drinking Water Sample Results, Michigan Environmental Health Association, 1994.

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Water Compositon Variability may Affect Performance, "M.T. Socha, S.M. Ensley, D.J. Tomlinson, & T. Ward, Feedstuffs", June 9, 2003, Page 10.

Water Intake and Supply for Dairy Cattle, Dean Ross, "Michigan Dairy Review", July 2004, Page 7.

Table 4. A Guide For The Use Of Saline Water For Livestock And Poultry

Total Dissolved Solids Content of Water	Comments
< 1,000 ppm	**Safe.** Does not present a problem to livestock or poultry
1,000 – 2,999 ppm	**Satisfactory.** Satisfactory for all livestock and poultry. May cause temporary and mild diarrhea in livestock or watery droppings in poultry not accustomed to it (especially at higher levels). Should not affect health or performance.
3,000 – 4,999 ppm	**Satisfactory.** Water is satisfactory for livestock. Might possibly cause temporary diarrhea or be refused at first by animals not accustomed to it. Not recommended for poultry. Often causes watery feces (at the higher levels of salinity), increased mortality and reduced growth, especially in turkeys.
5,000 – 6,999 ppm	**Reasonable.** Water is reasonably safe for dairy and beef cattle, sheep, swine, and horses. Avoid using for animals in late gestation or lactating. Not acceptable for poultry. Almost always causes some problem. Near the upper limit reduced growth and production or increased mortality will probably occur.
7,000 – 10,000 ppm	**Unfit.** Water unfit for poultry and probably for swine. Considerable risk for pregnant or lactating cows, horses, sheep, and the young of these species, or for any animals subjected to heavy heat stress or water loss. In general, avoid the water supply. Although, older ruminants, horses and even poultry and swine can subsist on it for long periods of time under low stress conditions.
> 10,000 ppm	Not recommended for use under any condition.

From: Nutrients and Toxic Substances in Water for Livestock, National Academy of Science, 1999.

Useful Conversions

1 mg / Liter	=	1 ppm
1 mg / Kilogram	=	1 ppm
1 ml / Liter	=	1 ppm
1 ml / Kilogram	=	1 ppm
1 µg / Liter	=	1 ppb
1 µg / Kilogram	=	1 ppb
1 µ1 / Liter	=	1 ppb
1 µ1 / Kilogram	=	1 ppb
1 µg / ml	=	1 ppt
1 µg / Gram	=	1 ppt
1 µ1 / ml	=	1 ppt
1 µ1 / Gram	=	1 ppt