ANIMAL SCIENCE FACTS

Extension Swine Husbandry

Publication Number ANS00-811S

Guidelines for Water Quality in Pigs

Eric van Heugten, Ph.D.
Swine Nutrition Extension Specialist
Department of Animal Science
North Carolina State University

High quality drinking water is an essential component for the health and efficient production of pigs. If there is any doubt concerning the quality of the drinking water, samples need to be collected to analyze the water and verify that it is acceptable for animals. Many factors can affect the quality of water, including microbiological, physical and chemical factors. These factors will be described in this fact sheet. In addition, water quality recommendations and potential water treatment options will be discussed.

Microbiology

There are a variety of microorganisms that can be contained in water. Bacteria using inorganic ferrous iron as an energy source can be particularly problematic, because they produce a reddish slime that can block water lines and nipple waterers. Pathogenic protozoa (coccidia) and eggs of intestinal worms could also be encountered. A high level of microbial counts in water can be a sign of contamination from outside sources, for example surface runoff that enters poorly constructed wells. High levels of coliform bacteria are an indication of fecal contamination of the water source. As a guideline, drinking water for animals should contain fewer than 100 total bacteria per milliliter and fewer than 50 coliforms per milliliter. If levels of contamination greatly exceed these guidelines, the source of contamination needs to be eliminated or a new well needs to be constructed. Low levels of contamination can be managed by using disinfectants (shock treatment with chlorox for example).

Physical Measures

Physical measures include color, odor, flavor and clarity. Water should be clear and odorless. If the water appears cloudy, frothy, colored, or has an odd smell or taste further testing needs to be conducted because a potential problem with quality may exist.

Chemical Measures

A variety of chemical tests are available to determine the quality of water. Of these, Total Dissolved Solids (TDS), pH, iron, hardness, and nitrates/nitrites are a good initial screening. If any of these tests prove unsatisfactory, further analysis needs to be conducted to specify the nature of the contamination.

Table 1. Evaluation of water quality for pigs based on total dissolved solids

Total Dissolved Solids (mg/L)	*Comments*
< 1,000	No risk to pigs.
1,000 - 2,999	Satisfactory for pigs. Mild diarrhea may occur in pigs not adapted to it.
3,000 - 4,999	Satisfactory for pigs. May cause temporary refusal of water and temporary diarrhea
5,000 - 6,999	Reasonably safe for pigs. Higher levels should be avoided by pregnant or lactating pigs.
7,000 - 10,000	Unfit for pigs. Risky for pregnant, lactating or young pigs, or those exposed to heat stress or water loss.
> 10,000	Not recommended for use.

Adapted from NRC (1974).

TDS

The TDS is a measure of the total concentration of inorganic matter dissolved in the water. It is also referred to as salinity and commonly involves calcium, magnesium and sodium in the bicarbonate, chloride or sulfate form, with traces of iron, manganese and other substances. If TDS concentrations are high, further tests need to be conducted to determine specific contaminants. Table 1 provides recommendations for acceptable levels of TDS.

pH

The acceptable range in pH for groundwater is from 6.5 to 8.5. A pH of less than 6.5 (acidic) or greater than 8.5 (basic) can cause corrosion of the water system leading to contamination of water with metals such as iron, copper, lead, and cadmium. In addition, pH can have an effect on certain water treatments. For example, chlorination of water is impaired at a high pH and some drugs (for example sulfonamides) delivered through the water may not be soluble above or below a certain pH.

Hardness

Water is considered soft if hardness is less than 60 ppm, hard between 120 and 180 ppm and very hard above 180 ppm. Hard water can cause problems because of accumulation of scale in the water deliv-

Table 2. Water quality standards (ppm)

	Dutch Standards		*Canadian Standards*	*EPA Standards (Human)*
Item	*No Risk*	*Risk*	*Maximum*	*Maximum*
pH	5 - 8	> 9 & < 4		6.5 - 8.5
Ammonia[1]	< 1	> 2		
Nitrite (as N)	< 0.1	> 1	10	1
Nitrate (as N)	< 25	> 100	100	10
Chloride	< 250	> 1,000		250
Salt (via Na)	< 1,000	> 2,000		
Iron	< 0.2			0.3
Manganese	< 1	> 2		0.05
Sulfate	< 100	> 250	1,000	500
Calcium			1,000	
TDS			3,000	500

[1]High levels of ammonia indicate bacterial contamination (manure), which would make the water unsuitable

ery system. In addition, certain drugs (oxytetracycline) can be inactivated by high levels of calcium, magnesium and iron. However, hardness of water is not a problem for pig health and performance.

Chloride

Chloride levels in water above 250 - 500 ppm can cause a brackish taste which may result in low water intake.

Iron

Iron can promote growth of certain bacteria and result in precipitation of iron compounds. Although there is no health risk, iron concentrations of 2 to 3 ppm can block water flow from water nipples. At a concentration of 5 ppm or greater, oxytetracycline added to the water can be inactivated. Water refusal or low water intake may occur at levels of 10 ppm or greater.

Sulfates

Sulfates are laxative agents and can cause diarrhea, particularly in young pigs, at high levels. Levels of 7,000 ppm or greater have been reported to cause diarrhea and reduced growth performance in pigs. However, lower levels (2,650 ppm) did not have an effect. Adaptation to high levels of sulfate appears to occur within a few weeks of exposure.

Nitrates and Nitrites

Pigs are relatively tolerant to nitrates and nitrites. Nitrates in the water often indicate bacterial contamination or contamination with runoff water from land which has received heavy application of fertilizer. These nitrates can be converted to the more toxic nitrites, which can bind to hemoglobin in the blood and impair the oxygen carrying capacity of blood. A level of 300 ppm of nitrate may be sufficient to produce enough nitrite to cause toxicity in swine. A level of 10 ppm of nitrite is of concern for swine.

Table 3. Recommended limits for concentrations of potentially toxic substances in drinking water for livestock (ppm).

Substance	*NAS*	*CAST*	*EPA (Human)*
Arsenic	0.2	0.5	0.05
Boron	NE	10	NE
Cadmium	0.05	0.5	0.005
Chromium	1.0	5.0	0.1
Cobalt	1.0	1.0	NE
Copper	0.5	0.5	1.3
Fluoride	2.0	3.0	4
Iron	NE	NE	NE
Lead	0.1	0.1	0.015
Mercury	0.01	0.01	0.002
Nickel	1.0	NE	0.1
Nitrate	440	300	10
Nitrite	33	33	1
Selenium	NE	0.1	0.05
Vanadium	0.1	1.0	NE
Zinc	25	25	NE

Abbreviation: NE, not established

[a] Recommended by National Academy of Sciences, 1974.

[b] Recommended by the council of Agricultural Science and Technology (CAST). Report No. 26. Quality of Water for Livestock. 1974.

[c] Recommended by the United States Environmental Protection Agency, Office of Water, EPA 822-B-96-002, October, 1996.

Water Quality Recommendations

Some published recommendations for water quality are listed in Table 2. Values in the Dutch guidelines that fall between the “no risk” and “risk” category do not pose a problem if it concerns only one measurement. However, if three or more measurements fall into that area, it may be recommended to not use the water, or to do additional analysis.

Many other chemicals can occur in water. Upper limits for concentrations of potentially toxic substances in drinking water are listed in table 3.

Water Testing

Water testing is available through the North Carolina Department of Agriculture laboratory and a variety of commercial laboratories. Collect samples of water after the water has been allowed to run for a few minutes to obtain a representative sample. If microbiology is to be conducted on the sample, care should be taken not to contaminate the sample. The water outlet should be cleaned and sterilized prior to taking the water sample and samples should be taken in a sterilized container for immediate analysis. Forms and further information can be obtained from your local county extension office.

Improving Poor Water Quality

Some water problems can be resolved by water treatment. The cost effectiveness of the water treatment system needs to be carefully evaluated. Some options for water treatment are summarized in Table 4.

Table 4. Options for treating drinking water (Taken from Carter, T., American College of Poultry Veterinarians and Western Poultry Disease Conference, Sacramento, Ca., March 4, 2000.)

Contaminant	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Bacteria	R	R		R					R	R	R			R
Chloride	R	R	R											
Copper	R	R	R											
Hardness (Ca & Mg)					T									
Hydrogen Sulfide				T		T			T			T		
Iron and Manganese	R	R	T		R				R			R	T	
Lead	R	R	T											
Nitrate	R	R			R									T
PH (Acidity)							T							
Sediment	T	T		T										T
Pesticides & Organics	R	T	R											T

Treatment options:

1. Distillation
2. Reverse Osmosis
3. Activated Carbon
4. Microfiltration
5. Ion Exchange
6. Aeration
7. Neutralizing Filter
8. Activated Alumina
9. Chlorination
10. Ozonation
11. Ultraviolet Radiation
12. Oxidizing Filter
13. Polyphosphate Feeder
14. Improved Well Construction

R Indicates a recognized treatment technique for meeting drinking water regulations (Water Quality Association).

T Indicates a treatment option considered effective in reducing some contaminant levels.

Reviewed by: Dr. Morgan Morrow, *Department of Animal Science, North Carolina State University*
Dr. Todd See, *Department of Animal Science, North Carolina State Univesity*