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How to Collect Your Water Sample and Interpret the Results for the Poultry Analytical Package

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Rapidly growing birds may consume up to twice as much water as feed (Scantling and Watkins 2013), which means a plentiful supply of clean water is crucial for poultry health and productivity. To determine the quality of your poultry's water resources, periodic sampling and analysis is needed. Analyzing water supplies can also be a crucial tool in identifying existing or potential challenges. The Arkansas Water Resources Center (AWRC) in cooperation with the UA Cooperative Extension Service offers several analytical packages to assess the quality of your water resources. This document is intended to provide guidance to poultry producers on collecting water samples for analysis and understanding the "Poultry Water Report Form" provided by the AWRC's Water Quality Laboratory (Lab). The information contained within this fact sheet should be used as general guidance, and the reader is encouraged to seek advice from Extension specialists regarding the interpretation of individual reports and water testing results that may be of concern.

Why Should You Have Your Poultry's Water Tested?

- To test your water resource for contamination from agricultural application of fertilizers and pesticides and by runoff from confined animal feeding operations and failed septic systems (Gadberry 2013, Watkins 2008).
- Installation of new resources, such as drilling a new well for groundwater.
- Noticeable changes in odor, color, or taste of water.
- Noticeably decreased water consumption by flock.
- Following maintenance of water supply system.
- If animals become sick with waterborne disease.

If you have poorly performing flocks, poor water quality might be to blame

Where Should You Collect Water For Analysis?

For routine testing of the chemical constituents of your water quality, you should collect water from the source (well, pond, or municipal source). In poultry operations, many variables can impact water quality after it leaves the source resulting in a change in the quality of the water birds actually consume at the drinkers. For this reason you may want to also test the water quality from the drinkers within the barns. If bacterial contamination is of concern both the water source and distribution lines should be tested, as naturally occurring nutrients and added electrolytes and vitamins may promote the growth of bacterial biofilms throughout your water distribution system (Scantling and Watkins 2013).

Collection Of Water For Analysis

The AWRC Water Quality Lab requires 0.5 liters (roughly half a quart) to measure all of the physical and chemical parameters included in the poultry analytical package. If you are requesting the analysis of E. coli and total coliforms also, an additional 0.12 liters of water collected in a sterile container is needed. Both sample bottles and sterile containers should be properly labeled with your site information; clean bottles and sterile containers can be obtained from the AWRC Water Quality Lab, if needed. Prior to sample collection, the sample bottle should be field-rinsed three times. To do this, fill the sample bottle approximately ¼ full, cap and shake, and then discard the rinse water away from the location that the sample will be collected. Samples should be pulled directly from a faucet and never from water hoses. When collecting samples for bacterial analysis, wipe the faucet with alcohol and flame metal faucets to sterilize. Let the water run for 30 seconds to a minute and then capture the sample.

If multiple water sources are used for your poultry barns, each source should be tested also test this so it can be determined what the birds are drinking. When submitting multiple samples, make sure to properly label each sample bottle so that they can be distinguished from one another. Water samples should be kept cool, preferably on ice and out of the sun, and submitted along with a completed AGRI-422 form to the AWRC Water Quality Lab as soon as possible. Reduce delays during shipping by avoiding submitting samples at times when they will reach the Lab on a holiday or weekend, as the concentrations of the variables in this analysis package may change over time in unpreserved water samples.

For the most reliable results, water samples should be kept cool, in the dark, and delivered to the AWRC Water Quality Lab as soon as possible.

Interpreting Test Results

Table 1 provides a list of average values and maximum acceptable concentrations for each of the parameters analyzed in the poultry water quality analytical package. In the descriptions below, specific holding times are listed for each parameter. Many of the parameters are stable for 14 days to 6 months once they have been filtered and preserved by the Water Quality Lab, a list of holding times is provided in Table 1. It is recommended that you submit your water samples to the Water Quality Lab as soon as possible, and keeping them stored on ice until delivery will help ensure accuracy of the variables measured. The AWRC Water Quality Lab generally completes the analysis of your water sample(s) within two weeks, returning results to clients within three to four weeks. If a quicker turnaround time is needed, please contact the lab to facilitate this process.

Table 1: Poultry water quality standards along with preservation and maximum holding time for accurate determination of the parameters analyzed by the AWRC Water Quality Lab for the poultry water quality report.

Parameter	Levels Considered Average	Maximum Acceptable Level	Sample Preservation	Holding Time (days)
Total Coliforms (CFU/mL)	0.0	50	Iced/cooled	1
E. coli (CFU/mL)	0.0	0.0	Iced/cooled	1
pH	6.5 - 7.8	5 - 8	None	2
Alkalinity (mg/L as $CaCO_3$)	100	300	None	14
Bicarbonate (mg/L as $CaCO_3$)	NA	NA	None	14
Hardness (mg/L as $CaCO_3$)	60 - 180	110	Acidified	180
Chloride (mg/L)	50	150	None	28
Sulfate (mg/L)	15 - 40	200	None	28
Nitrate-nitrogen (mg/L)	1 - 5	25	None	2
Calcium (mg/L)	60	110	Acidified	180
Magnesium (mg/L)	14	125	Acidified	180
Sodium (mg/L)	50	150	Acidified	180
Manganese (mg/L)	0.01	0.05	Acidified	180
Iron (mg/L)	0.2	0.3	Acidified	180
Copper (mg/L)	0.002	0.6	Acidified	180
Lead (mg/L)	0	0.014	Acidified	180
Zinc (mg/L)	0	1.5	Acidified	180

Data for modern production birds is limited on how combinations of minerals can create health or production challenges. It is possible that combinations of minerals such as sodium, sulfate and magnesium could create issues when present in amounts below the ranges generally found acceptable for the individual minerals.

1 **pH:** This is a measure of how acidic (values less than 7) or basic (values greater than 7) a water sample is. The acceptable range for poultry is between 6.5 and 7.8, with a maximum range of 5 to 8 (Table 1). A multitude of problems may arise when the pH is outside of this range. Excessively low pH may corrode metal components in water delivery systems leading to contamination of the water with metals such as iron, copper, and lead. PVC pipes are not affected by pH but components such as water flow sensors can be damaged by pH below 5.5. Additionally, abnormally high (>8.0) or low pH (<4.0 pH) can decrease the effectiveness of disinfectant products such as chlorine, as well as decrease the effectiveness of chemicals that may be administered through the water. Waters with a pH outside of the desirable range may also result in digestive upset, diarrhea, and decreased feed and water intake. There is no standard method for the preservation of samples for pH analysis but samples should be analyzed within 48 hours of collection for the most accurate results.

2 **Alkalinity**: Alkalinity is a measure of how well water prevents large rapid changes in pH. This is measured in mg/L of calcium carbonate ($CaCO_3$), and the desirable range for sufficient buffering capacity is from 50 – 100 mg/L $CaCO_3$ (Table 1). Values greater than 100 mg/L $CaCO_3$ can give the water a bitter taste which is undesirable to the birds. For the most reliable results your water should be analyzed within 14 days of collection.

3 **Bicarbonate:** Bicarbonate is a component of total alkalinity, which is a measure of how well your water is buffered against extreme pH fluctuations. Bicarbonate has units expressed in mg/L or parts per million (ppm) of $CaCO_3$, and total alkalinity and pH are used to estimate its concentrations (APHA, 2012), so for the most reliable estimation of bicarbonate your water sample should be analyzed within 48 hours of collection.

4 **Hardness:** is related to the calcium and magnesium content of your water and generally ranges between 60 – 180 mg/L. However, levels greater than 110 mg/L may cause scale to develop within the pipes of your water distribution system reducing pipe volume and causing drinkers to be difficult to trigger. Once your sample is processed and preserved in the Lab it is stable for 6 months.

5 **Chloride (Cl):** Chloride should not be confused with chlorine (Cl_2) which is a highly reactive compound, often used by drinking water treatment plants as a disinfectant. Chloride is part of common salt (sodium chloride) and occurs naturally in surface and ground water sources due to the dissolving of rock. The maximum acceptable concentration of chloride is 150 mg/L and when combined with similar or higher concentrations of sodium, this can produce a laxative effect causing flushing. Chloride concentrations are stable in water samples for up to 28 days after collection.

6 **Sulfate (SO_4):** Sulfate is a naturally occurring compound in surface and ground waters ranging in concentration from 15 – 40 mg/L. High sulfate concentrations (above 200 mg/L) can cause flushing in birds. Sulfate concentrations are stable in water samples for up to 28 days after collection.

7 Nitrate-nitrogen (NO_3-N): Nitrate is not in itself very toxic to animals; however, excessively high nitrate concentrations (>300 mg/L NO_3) tend to co-occur with an accumulation of nitrite (NO_2) which is toxic. The maximum acceptable nitrate concentration for poultry drinking water is 25 mg/L and values greater than this may result in poor growth and feed conversion. High nitrate concentrations may also be an indicator of fecal contamination, so you should also test for bacteria. Nitrate should be analyzed within 48 hours of water sample(s) being collected.

8 Calcium (Ca): Calcium is naturally occurring in most water sources and it is from dissolved rock such as limestone and gypsum. Birds are very tolerant of calcium, thus higher concentrations do not pose health concerns. However, high concentrations of calcium (greater than 110 mg/L) along with magnesium relate to "hard water" which can result in scale formation in your water delivery system, thereby decreasing function. Once your water sample is processed and preserved in the Lab it is stable for 6 months.

9 Magnesium (Mg): Similar to calcium, magnesium is naturally occurring in most water sources and comes from dissolved rock such as dolomite. Magnesium also relates to "hard water" which can result in scale formation in water delivery systems. Concentrations less than 125 mg/L are generally safe for your poultry; however, concentrations as low as 50 mg/L may cause diarrhea if sulfate is high. Once your sample is processed and preserved in the Lab it is stable for 6 months.

10 Sodium (Na): Usually found in association with chloride, sodium occurs in water from the dissolving of rock and salts. Concentrations of less than 150 mg/L are acceptable for poultry production (Table 1). However, lower concentrations may be needed if both chloride and sulfate are also present in higher concentrations as this may result in a laxative effect in birds. Once your sample is processed and preserved in the Lab it is stable for 6 months.

11 Manganese (Mn): The maximum acceptable level for manganese in poultry drinking water is 0.05 mg/L. Higher concentrations may result in the formation of a black grainy residue forming on filters and drinkers, which may reduce water flow. Once the water sample is processed and preserved by the Lab, it is stable for 6 months.

12 Iron (Fe): Birds are tolerant of the metallic taste associated with higher iron concentrations (Table 1); however, high iron concentrations cause drinkers to leak and promote the growth of bacteria that may be harmful to the health of birds. Once the water sample is processed and preserved by the Lab, it is stable for 6 months.

13 Copper (Cu): The maximum acceptable concentration for copper in the water supply for poultry is 0.6 mg/L. Higher concentrations may produce a bitter flavor which can reduce water intake and decrease animal production. One potential source of elevated copper is from the water delivery system if copper pipe is used and the water source has a low pH, this may cause copper to dissolve into the water. Once your sample is processed and preserved in the Lab it is stable for 6 months.

14 Lead (Pb): The maximum acceptable concentration for lead in the water supply for poultry is 0.014 mg/L. Long term exposure to higher concentrations can cause weak bones and fertility problems in breeders. Once your sample is processed and preserved in the Lab it is stable for 6 months.

15 Zinc (Zn): The maximum acceptable concentration for zinc in the water supply for poultry is 1.5 mg/L, higher concentrations are toxic. Once your sample is processed and preserved in the Lab it is stable for 6 months.

Bacteria

Water delivery systems provide ideal conditions for bacteria to grow and reproduce resulting in the formation of biofilms (Scantling and Watkins 2013). These biofilms can reduce the flow of water through the delivery system; portions of the biofilms can slough off and clog drinkers, and can harbor harmful bacteria that result in bird health issues. There are several chemical constituents from the standard water quality analysis that may indicate the presence of bacteria in the water supply. Elevated sodium and chloride can promote the growth of *Enterococci* and high iron may promote the growth of *E. coli* and *Pseudomonas*; while, high nitrate concentrations may be an indicator of fecal contamination of the water supply (Watkins 2008). If there is concern of bacterial contamination, the AWRC Water Quality Lab can also analyze your water for *E. coli* and total coliforms. *E. coli* should not be detectable in your water sample, while the maximum acceptable level for total coliforms is 50 CFU/100 ml (Table 1; CFU stands for colony forming units).

The AWRC Water Quality Lab is only able to measure the concentration of total coliforms and *E. coli* in the water. However, just measuring the bacteria in the water may not accurately reflect the contamination load (Scantling and Watkins 2013). Collecting swabs of the inside of your water distribution lines and having them tested for bacteria may provide a better indication of bacterial contamination than testing the water alone. Detailed methods for collecting bacterial swabs can be found in the University of Arkansas Division of Agriculture publication "Identify Poultry Water System Contamination Challenges" (Scantling and Watkins 2013, FSA publication no. 8011). Swab kits can be obtained from and tested through the Watkins lab at the Poultry Science Center of Excellence; contact the lab at 479-575-8428.

Water delivery systems provide ideal growing conditions for bacteria, so it is important to also test for bacteria.

Summary

Having a reliable water source with good water quality is integral for poultry health and production. Testing water resources regularly can help ensure that you are providing your poultry with clean water and can help detect problems before they negatively impact your animals. This fact sheet is intended to provide information on acceptable concentrations of various elements and compounds for poultry consumption. If the water is being used for additional purposes, such as crop irrigation, it is important to take into consideration the recommended concentrations for the other intended purposes when managing your water resources. If you have specific questions regarding how your water quality may influence your poultry production please contact either Dr. Mike Daniels with the University Of Arkansas Cooperative Extension Service (mdaniels@uada.edu).

Literature Cited

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