Water Quality Critical to Broiler Performance

MISSISSIPPI STATE UNIVERSITY EXTENSION

Water is the most important nutrient for poultry. Although the necessity of providing a plentiful supply and sufficient access is well understood, the importance of **water quality** on performance is often misunderstood or neglected. Providing a clean and safe water supply is critical to ensuring that broilers perform at their best. Water quality takes on an increasingly valuable role as public concern over antibiotic use in animal feed shifts the poultry industry away from the use of antibiotics. Numerous factors, including equipment, management practices, house environment, and housing type play a role in broiler performance, but water quality may be one of the most critical and least appreciated.

Bacteria, molds, fungi, minerals, and water additives interact in the water source and within piping and drinkers to complicate management practices necessary to guarantee the best quality water for optimum performance (Oviedo, 2006). Even though 1,000 bacteria per milliliter is the acceptable standard for poultry drinking water, up to 1 million bacteria per milliliter have been found in contaminated water (Watkins, 2002).

Ideally, bacteria should not be present in drinking water; their presence often indicates contamination by organic materials. Presence of coliform bacteria in drinking water is typically related to fecal contamination resulting from runoff to surface or ground water supplies (Brake and Hess, 2001). **Table 1** lists established guidelines for poultry drinking water quality.

The quality of water will affect water intake by broilers. The **pH, hardness, and total dissolved solids (TDS)** can all have an effect on consumption patterns. Water with a pH of 7 is neutral; a pH greater than 7 indicates alkalinity, while a pH less than 7 indicates acidity. Water with a low pH can be unpalatable, while high pH water can clog watering systems because of excessive mineral levels, especially calcium and magnesium. Water outside maximum acceptable levels for both high and low pH can negatively impact performance.

The degree of **water hardness** is not usually harmful to poultry, but is typically associated with deposit buildups and scale formation in water system components. Calcium and magnesium are the source of the scale. When water pH is above 7 and either of these minerals is present at more than 60 parts per million, there is likely scale in the water system. This will have to be removed with an acid-type cleaner designed for nipple drinker systems (Watkins, 2006).

High levels of TDS cause the most harmful effects in poultry production (Brake and Hess, 2001). Calcium, magnesium, and sodium salts are the primary components that contribute to TDS. **Table 2** gives guidelines suggested by the National Research Council (1974) for the suitability for poultry of water with different concentrations of TDS. In addition to TDS, many wells are affected by high levels of iron, which can lead to increased growth of iron bacteria.

Dissolved iron in water that causes stained filters and plumbing fixtures is different from iron bacteria, and the two should not be confused. Iron bacteria do not cause disease but can be a major nuisance and challenge to poultry growers because they do form a reddish-brown slime that coats the inside of pipes, affects pump action, and plugs drinkers.

Daily water intake patterns can be an important indicator of flock performance. Growers often ask, “Should I be concerned if water intake flatlines or does not increase every day?” To address this question, the daily water consumption for 12 flocks of broilers on the same farm was analyzed (**Table 3**). Daily mortality was removed from the next day’s bird count so that water consumption reflected the actual bird number and not placement number. Overall, daily water consumption steadily increased, but there were days when usage dropped or remained similar to the previous day’s usage (Watkins and Tabler, 2009).

Therefore, growers should not be overly concerned if, on occasion, water intake declines slightly from one day to the next. However, if the decline lasts for more than one day, it’s time to start looking for the cause. The **water intake pattern should be a steady, gradual increase in consumption** from placement to harvest, with perhaps an occasional small decrease or plateau. If intake declines for more than a day, check for the following:

- Drinker line height (too high or too low)
- Air locks in the water system

- Water line pressure incorrect for age of birds
- Clogged water filters or drinkers
- Dramatic changes in light intensity
- Frequent changes in day length
- Feed changes or feed outages
- Water treatments/additives
- Sick birds/too many birds per drinker (result of migration or bird placement numbers)

Water quality can change with the seasons, depending on location and water source. In addition, the warm environment inside a broiler house can lead to a rapid replication of microorganisms within the water system. This can result in formation of a **biofilm** slime in water lines and regulators. Biofilms are composed of many types of bacteria and other organisms that live together in a sticky film inside water lines, regulators, and nipple drinkers (Hancock et al., 2007). Chlorine and acidifiers such as citric acid have a difficult time removing the biofilm because it protects itself by secreting a thick mucous that is not easily penetrated.

To combat this situation, many growers use **sanitation and acidification practices** to maintain water quality for their birds. Sanitation and acidification are two very different approaches that work well as part of a farm's overall water quality program. However, products used for sanitation and acidification SHOULD NEVER be mixed together. When mixed, the different chemicals react to form dangerous gases.

Chlorine may be the most popular sanitizer, but there are others that work well, including hydrogen peroxide, chlorine dioxide, and ozone. Acidifiers are used to maintain pH of the water supply at less than 7 to improve the effectiveness of the sanitizer and reduce bacterial growth. Many integrators have specific water quality programs in place for growers to follow, so visit with your service technician before changing the water treatment program on your farm.

The initial microbial content, mineral content, and buffering capacity will determine the type and concentration of sanitizers and acidifiers needed for the water to be treated. A valuable tool to assist with this determination is the **oxidation-reduction potential (ORP)**. The ORP is one method used to evaluate the ability of a sanitizer to be a strong oxidizer for destroying bacteria, viruses, and other organic material present in water or for reacting with harmful minerals such as iron and manganese. An ORP value in the range of 650 millivolts or greater indicates good quality water that can be effectively sanitized by as little as 2–4 parts per million free chlorine (Oviedo, 2006).

Naturally occurring oxidizing elements in water, such as oxygen and sulfur, along with chlorine and chromate, can give increased ORP readings, but it is usually only a good sanitizing residual at a favorable pH of 5–7 that gives the most desirable ORP readings of 700–750 (Watkins, 2008). A good-quality ORP meter can be purchased for $100–150.

Drinking water quality is often an afterthought on many poultry farms. However, a clean, safe water supply can have a huge impact on flock performance. Water quality requires constant monitoring, instead of looking for answers only when bird performance is lacking. A regular water sanitation program on the farm will assist growers in preventing unhealthy environments in their water systems that could result in poor flock performance. If you are having performance issues in your flocks and have ruled out other possibilities, have your water tested for bacterial content and mineral levels. Contaminants in the water supply could be the cause of poor flock performance.

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Table 1. Poultry water quality standards and treatment options.[1]

Water Quality Indicator	Levels Considered Average	Maximum Acceptable Level	Maximum Acceptable Levels Indicate	Treatment Options/Comments
Total bacteria (TPC) Total coliforms Fecal coliforms	0 CFU/ml 0 CFU/ml 0 CFU/ml	1,000 CFU/ml 50 CFU/ml 0 CFU/ml	Dirty system, may taste bad and could have pathogens in the water system. Water with >50 total coliforms or any fecal coliform has been in contact with feces.	Clean the system between flocks with approved sanitizing cleaners, and establish a daily water sanitation system when birds are present. Shock chlorinate, as well.
pH	6.5–7.8	5–8	Below 5—metal corrosion. Above 8—water sanitizers work poorly; "bitter" taste.	Raise pH with soda ash, lime, or sodium hydroxide. Lower pH with phosphoric acid, sulfuric acid, and hydrochloric acid (strong alkalinity); citric acid or vinegar (weak alkalinity).
Alkalinity	100 mg/l	300 mg/l	Associated with bicarbonate, sulfates, and calcium carbonate. Can give water a bitter taste that is undesirable to the birds. Difficult to lower pH at high levels. Can be corrosive to cool cell pads.	Acidification. Anion exchange dealkalizer. Can be reduced by removing free carbon dioxide through aeration.
Total hardness	Soft 0–75mg/l CaCO2 Somewhat hard 76–150 Hard 151–300 Very hard >300		Hardness causes scale, which reduces pipe volume and makes drinkers hard to trigger or leak (main factors are calcium and magnesium, but iron and manganese contribute a small amount).	If water is high in sodium, do not use water softener unless potassium chloride is used instead of sodium chloride. Polyphosphates will tie up hardness and keep in solution. Water acidification to pH below 6.5.
Calcium (Cal]	60 mg/l		No upper limit; if values are above 110 mg/l, may cause scaling.	Treatment same as for hardness.
Magnesium (Mg)	14 mg/l	125 mg/l	May cause flushing because of laxative effect if high sulfate is present.	Treatment same as for hardness.
Iron (Fe)	0.2 mg/l	0.3 mg/l	Birds tolerant of metallic taste. Drinkers may leak from Fe deposit. Can promote bacteria growth (*E. coli* and *Pseudomonas*).	Treatment: addition of chlorine, chlorine dioxide, or ozone, then filtration removal with proper sized mechanical filtration.
Manganese (Mn)	0.01 mg/l	0.05 mg/l	Can result in black grainy residue on filters and in drinkers.	Similar to iron; can be more difficult to remove due to slow reaction time. Chlorination followed by filtration most effective in 8.5 pH range; needs extended contact time with chlorine before filtration unless using Iron X media.
Chloride (Cl)	50 mg/l	150 mg/l	Combined with high NA levels, can cause flushing and enteric issues. Can promote Enteroccoci bacterial growth.	Reverse osmosis; mix with non-saline water, keep water clean, and use daily sanitizers such as hydrogen peroxide or iodine to prevent microbial growth.
Sodium (Na)	50 mg/l	150 mg/l	Can cause flushing in combination with high Cl levels. Can promote Enteroccoci bacterial growth.	Treatment same as chloride.
Sulfates	15–40 mg/l	200 mg/l	Can cause flushing. Hydrogen sulfide (rotten egg smell) indicates sulfur-loving bacterial growth; can cause flushing and air locks in water system. Sulfides can gas off, so test results may underestimate actual levels present.	Aerate water into holding tank to gas off sulfur Anion exchange (chloride based). Treat with oxidizing sanitizers, then filtration. If rotten smell is present, shock chlorination of well is recommended, plus daily water sanitation while birds are present.
Nitrates	1–5 mg/l	25 mg/l	Poor growth and feed conversion. May indicate fecal contamination; test for coliform bacteria.	Reverse osmosis. Anion exchange.
Lead (Pb)	0 mg/l	0.05 mg/l	Can cause weak bones and fertility problems in broiler and turkey breeders.	Not naturally occurring. Check for pipes, fittings, or solder that contain lead. Can be reduced by water softeners and activated carbon.
Copper (Cu)	0.002 mg/l	0.6 mg/l	High levels may cause oral lesions or gizzard erosion.	Most likely results from corrosion of pipes or fittings.
Zinc (Zn)		1.5 mg/l	Growth may be reduced at high levels.	Water softener and activated carbon will reduce adsorption.

[1]Adapted from Watkins (2008).

Table 2. Guidelines for poultry for the suitability of water with different concentrations of total dissolved solids (TDS).

TDS (ppm)	Comments
less than 1,000	These waters should present no serious burden to any class of poultry.
1,000–2,999	These waters should be satisfactory for all classes of poultry. They may cause watery droppings (especially at the higher levels) but should not affect health or performance.
3,000–4,999	These are poor waters for poultry, often causing watery droppings, increased mortality, and decreased growth (especially in turkeys).
5,000–6,999	These are not acceptable waters for poultry and almost always cause some type of problem, especially at the upper limits, where decreased growth and production or increased mortality probably will occur.
7,000–10,000	These waters are unfit for poultry but may be suitable for other livestock.
more than 10,000	These waters should not be used for any livestock or poultry.

SOURCE: National Research Council. 1974. Nutrients and Toxic Substances in Water for Livestock and Poultry. Washington, D.C. National Academy of Sciences.

Table 3. Daily water usage for 12 flocks of broilers on the same farm.

	gallons/1,000 birds				gallons/1,000 birds				gallons/1,000 birds		
Age (days)	Minumum Usage	Maximum Usage	Average Usage	Age (days)	Minumum Usage	Maximum Usage	Average Usage	Age (days)	Minumum Usage	Maximum Usage	Average Usage
1	0.0	0.0	0.0	19	34.8	51.8	43.1	37	55.6	87.5	74.4
2	3.8	7.9	5.4	20	37.2	54.6	44.1	38	56.5	92.3	77.2
3	5.6	11.3	7.7	21	38.7	56.1	46.2	39	62.0	91.8	78.6
4	9.4	14.2	11.0	22	35.6	54.7	47.2	40	67.2	96.0	78.9
5	10.7	16.6	12.8	23	39.1	59.4	49.6	41	65.1	99.3	80.8
6	11.9	17.0	10.0	24	38.0	62.9	53.3	42	66.2	96.4	82.3
7	13.3	19.4	16.0	25	43.3	65.6	54.6	43	59.0	92.6	81.0
8	14.5	21.7	17.7	26	42.3	64.8	54.3	44	65.6	90.7	80.2
9	12.6	23.2	19.5	27	46.3	69.4	57.6	45	69.4	91.8	81.2
10	19.4	29.2	22.5	28	49.1	71.7	60.0	46	66.2	97.4	83.4
11	19.4	30.1	25.7	29	53.3	75.8	63.1	47	69.1	91.2	81.8
12	23.0	31.4	27.8	30	52.9	76.8	63.1	48	71.7	97.0	82.3
13	26.0	36.3	30.2	31	47.8	79.3	65.7	49	67.2	97.7	85.9
14	28.4	37.9	32.8	32	56.2	78.8	68.3	50	72.7	93.2	85.4
15	29.9	40.6	34.8	33	59.6	84.5	70.1	51	77.1	100.0	85.3
16	29.7	40.6	35.7	34	55.3	88.1	70.2	52	74.9	98.1	86.7
17	30.7	46.1	38.9	35	59.1	85.5	72.6	53	76.7	98.2	87.8
18	32.5	49.1	41.4	36	56.2	87.4	73.2	54	76.5	98.8	87.5

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By **Tom Tabler**, PhD, Extension Professor, Poultry Science; **Jessica Wells**, Extension Instructor, Poultry Science; and **Wei Zhai**, PhD, Assistant Professor, Poultry Science.

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