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EVALUATING WATER QUALITY

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Drinking water is the least expensive nutrient we can provide to poultry, yet high quality water is often taken for granted. Water is also the most important nutrient. It is critical for many biological functions including the regulation of body temperature, aiding digestion, metabolism, and the transport and elimination of wastes.

On a daily basis water is consumed in large quantities. Poultry normally drink about two times the weight of feed consumed on a daily basis. Consumption is influenced, however, by the age of the bird, strain, rate of production, environmental temperature, type of feed etc. Depending on the age and sex of a bird, 55 to 75 percent of its body is water. The egg at 65 percent is mostly water as well.

Water is a natural solvent containing salts of calcium, magnesium, sodium chloride, sulfates, and bicarbonates. Water quality is characterized by its taste, acidity, alkalinity, odor, color, turbidity, salinity, pH, hardness, anions, cations, herbicides, and pesticides. A definition I find especially good for poultry says that high quality water contains inclusions which promote vitality, and lacks those causing morbidity and mortality.

In recent times researchers have attempted to correlate poultry performance with water inclusions. A study from Arkansas looked at more than 300 commercial broiler flocks and correlated bird performance with the concentration of various water inclusions (Barton et al., 1986). The significant results suggested body weight was positively influenced by water calcium, magnesium, hardness, bicarbonate, and dissolved oxygen. Water nitrate (NO_3) levels had a negative effect on body weight.

Mortality was increased with increasing calcium and potassium levels. Higher calcium and nitrate levels increased condemnation rate. Feed conversion (feed/gain) was improved with higher calcium levels and made worse with greater magnesium. While the results of this work were all highly significant for those flocks in Arkansas, similar evaluations in other regions of the country have resulted in different findings.

Therefore, many experts now feel regional water quality differences will have enormous effects, and simple, single inclusions may not mean a great deal when it comes to poultry performance. Rather, multiple-inclusions may be acting together to influence flock performance.

Work by Zimmerman in 1998 on the Delmarva Peninsula suggested broiler performance could be influenced by multi-element type inclusions. Taken together bird age, and water hardness, pH and dissolved oxygen had a significant positive effect on body weight (correlation coefficient = 0.91), along with low total bacteria counts. Feed conversion was improved when total bacteria counts were low, potassium levels were elevated and when the birds were at a younger age (correlation coefficient = 0.65). Mortality and condemnation rates were lower among younger birds, and when their drinking water had low levels of nitrates, bicarbonate, and total bacteria. Mortality rate was also reduced when water potassium levels were elevated.

While many of us are comfortable reading a water meter to determine if water consumption is normal, most are less sure of themselves interpreting a water analysis. For many, the sheer number of inclusions or contaminants to analyze for is daunting. The units may be unfamiliar. Most inclusions are expressed in milligrams per liter (mg/L), which is equal to parts per million (ppm). Some toxic substances may be expressed in smaller units such as parts per billion (ppb). Others have unique units of measure such as radon (pica curries per liter = pCi/L), or bacteria, pH, hardness, conductance or turbidity.

The EPA has established maximum contaminant levels (MCL) as being harmful to human life. Compounds in this group include atrazine, benzene, lead, and radon. But one concern to both humans and poultry are nitrate levels. Water nitrates can come from natural sources, and are a soil by-product of agricultural fertilization or human or animal waste. The primary concern with young babies is blue baby syndrome caused by a reduced ability of the blood to carry oxygen.

Nitrate is converted to toxic nitrite (NO_2) by GI tract bacteria. The toxic nitrite binds blood hemoglobin displacing oxygen that might otherwise supply oxygen to the tissues. The MCL for humans is 10 mg/L nitrate-N.

Early research in the 1960s suggested that chicks, turkey poults, and hens could handle much higher levels of nitrate and nitrite than humans under controlled research conditions when not confounded with other contaminants. Chicks could consume water with up to 200 and 300 ppm nitrite and nitrate with little effect on hemoglobin, mortality, or feed or water intake. However, growth and liver vitamin A levels were depressed with 200 ppm nitrite. Poults appeared to be more sensitive; when given 100 to 200 ppm nitrites, they showed a reduced intake and growth with depleted liver vitamin A and beta-carotene stores. Hens could handle up to 200 and 300 ppm nitrite and nitrate with no effect on rate of lay, egg quality, intakes, or liver vitamin A or beta-carotene levels.

However, more recent work by Grizzle et al., (1996, 1997a,b) suggests that when nitrates are taken together with other common water contaminants they can have profound effects at much lower levels. In one study with broilers given water with only 5.2 mg/L nitrate-N and low pH (5.75), feed and water consumption, body weight, spleen, liver and thymus weights were all reduced compared to control birds. In another study with broilers given nitrate water plus E. coli or Enterobacteria (500 and 100 colony forming units (CFU)/mL), body weight was depressed along with elevated thymus and bursa weights, suggesting the birds were mounting an immune response to the bacteria. In a third study, broiler breeders were given water with 10.4 mg/L nitrate-N along with 100 CFU/mL E. coli. This combination of contaminants resulted in reduced egg production, while nitrate alone reduced egg hatchability and vitamin A stores. These pieces of evidence would suggest that poultry are sensitive to low nitrate levels when taken together with contaminating bacteria or low pH levels.

Secondary MCL listed by the EPA are general indicators of water quality. These include pH, which should be in the normal range of 6.5 to 8.5. Outside this range the water may be so corrosive that other contaminants will be solubilized and carried to your birds. Total coliform bacteria should be less than 1 organism per 100 mL, with any counts suggesting some form of either human or animal fecal contamination of the water supply. Total dissolved solids should be no more than 500 mg/L, as this is indicative of greater hardness and dissolved iron, manganese and other unnecessary inclusions. Sulfate levels should be less than 250 mg/L as they can impart a rotten egg taste and laxative effect to the water. Nuisance contaminants include chlorides, copper, iron, manganese and iron bacteria. They can impart either salty or bitter taste, or black, blue/green or orange stains to your sinks and other fixtures.

Other concerns with water inclusions in the poultry house are:

• Chloride, pH, and hardness having a negative impact on your ability to deliver vaccine effectively

• Hardness and salts reducing the foaming and cleaning ability or soaps and detergents

Significant inclusions that can impact the nutrient requirements of your birds, including sodium, chloride, calcium, anions and cations.

In summary, water quality varies greatly by region of the country and season of the year. Sample your water quarterly until you have an understanding of seasonal variation, then sample at least annually thereafter. Consider primary MCLs first (nitrate-N = 10 mg/L). Then consider general indicators of water quality including: pH range 6.6 to 8.5; coliforms and total bacteria <1/100 mL; Total dissolved solids <500mg/L and Sulfate <250 mg/L.

Penn State University has numerous publications available from the Publications Distribution Center (814-865-6713) to help evaluate and protect your water supply:

• EC345 Safeguarding Wells and Springs from Bacterial Conta-

(Turn to Page D8)