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## Water as a critical nutrient in maintenance of poultry health and its role in production performance

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### Abstract

The use of drinking water with adequate physical, chemical and microbiological quality in the poultry industry is of fundamental importance. Since many birds have access to the same water source, any quality problems will affect large number of birds. The drinking water plays an important role in the transmission of some bacterial, viral and protozoan diseases that are among the most common poultry diseases. Water is a major component of blood and plays an important role in transporting nutrients to the cells and carrying waste away. Chicken body consists of 70% water; a loss of only 10 percent of that water will result in the bird's death. It plays a pivotal role in body temperature regulation, digestion of food and elimination of waste materials. Numerous factors, like, genetics, feeding, healthcare, management practices, house environment, and housing type play a role in broiler performance, but water quality may be one of the most critical and often ignored. To keep the poultry flocks healthy adequate quality and quantity of potable water should be provided throughout the rearing period.

**Keywords:** Water quality, performance, poultry

### Introduction

Water is the most critical nutrient in poultry production, but often overlooked. The total content of water in a bird averages from 65-70% of its lean body mass <sup>[1]</sup> and water consumed by birds is generally utilized for nutrient transportation, body temperature regulation, joint lubrication and various intra and extracellular biochemical reactions. Water is needed in every aspect of animal metabolism. Water is also a primary constituent in two of the most essential processes of life in chickens digestion and respiration, which is key to thermoregulation. Chickens normally consume twice as much water as feed during normal environmental temperature, which increases linearly as the temperature increases above normal. To keep the poultry flocks healthy adequate quality and quantity of potable water should be provided throughout the rearing period. Numerous factors, like, genetics, feeding, healthcare, management practices, house environment, and housing type play a role in broiler performance, but water quality may be one of the most critical and often ignored. There are many factors that influence water quality, including the colour, taste, and odour of water, as well as the presence of bacteria and other microbes. The levels of different minerals and some other chemical and physical factors are also responsible for determination of water quality.

### Water intake

Generally, water intake of chicken should be about 1.5 to 2 times feed intake when environmental temperature is normal. In poultry water consumption is dependent on several factors including:

- Feed consumption: Reduced feed intake may lead to reduced water intake and vice versa.
- Too hot water: Less consumption
- Contaminated water: Less consumption
- Ambient temperature: Water consumption increases with increase in temperature and vice versa
- Type of drinkers used
- Drinker height
- Water pressure.

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Drinkers should be checked regularly to ensure they are in working condition. Drinker systems should also be cleaned and flushed regularly to remove any microbial or mineral build up in the lines. Water is presumed safe if it has a zero microbial population, provided that mineral content is at safe levels and undesired contaminants are not present. However,

presence of microbes in water is not always correlated with a disease in flocks unless it increases above a certain infectious level. The acceptable levels of bacteria in colony forming units (cfu) per milliliter (ml) in drinking water for poultry operation are given in Table 1.

**Table 1:** Drinking Water Quality Guidelines for Poultry

Contaminants	Ideal level	Max. acceptable level	Remarks
Total Bacteria	0/ml	100/ml	0/ml is desirable
Coliform Bacteria	0/ml	50/ml	0/ml is desirable
Nitrates and Nitrites	--	25mg/l to 45mg/l	Levels from 3 to 20mg/l affects performance
pH	6.8 to 7.5	--	A pH of less than 6.0 is not desirable. Levels below 6.3 may degrade performance
Total Hardness	60 to 180mg/l as CaCO <sub>3</sub>	--	Hardness levels less than 60 are unusually soft; greater than 180 are very hard
Calcium	60mg/l	--	--
Chloride	14mg/l	250mg/l	Levels as low as 14mg/l may be detrimental if the sodium level is higher than 50mg/l
Copper	0.002mg/l	0.6mg/l	Higher levels produce a bad odor and taste
Iron	0.2mg/l	0.3mg/l	Higher levels produce a bad odor and taste
Lead	---	0.2mg/l	Higher levels are toxic
Magnesium	14mg/l	125mg/l	Higher levels have a laxative effect. Levels above 50mg/l may affect performance if magnesium and chloride levels are high
Sodium	32mg/l	---	Levels above 50mg/l may affect performance if sulfate or chloride levels are high
Sulfate	125mg/l	250mg/l	Higher levels have a laxative effect. Levels above 50mg/l may affect performance if magnesium and chloride levels are high
Zinc	---	15mg/l	Higher levels are toxic

Source: Carter and Sneed [2]

There are many factors that influence water quality, including the color, taste, and odour of water, as well as the presence of bacteria and other microbes. The levels of different minerals and some other chemical and physical factors are also responsible for determination of water quality.

### Color, Taste and Odour

It is utmost important that drinking water be clear, tasteless, odourless and colourless. Contaminated water exhibits different characteristics depending on the quantity and type of contaminants.

1. The water will appear to be cloudy in the presence of particles such as mud, clay, silt, or organic material. Such water can interfere with the proper operation of watering equipment/system and can indirectly lead to adverse effects on flock performance.
2. Water which is reddish-brown in colour might contain excess iron.
3. A blue hue to water can be an indication of excess copper.
4. A rotten egg smell is an indication of presence of hydrogen sulfide in water. Hydrogen sulfide sometimes combine with iron to form black water (iron sulfide), which can also indicate the presence of sulfate-reducing bacteria.
5. The taste of water can be affected by the presence of different salts. Presence of ferrous and manganese sulfates will exhibit a bitter taste.

### Bacteria

Presence of bacteria in the water can be an indication of contamination by organic material. Water is normally tested for total bacteria level as well as coliform bacteria level. The presence of coliform bacteria in drinking water is a clear indication of fecal contamination as coliform bacteria are organisms normally found in the digestive tracts of livestock,

humans, and birds. If water has a high bacterial count then it is not advisable to use disinfectants to maintain safe bacterial levels. Disinfectant is likely to fail at some time and expose the birds to high levels of bacteria. The best option is to eliminate the source of the contamination or to locate an alternative water source. Bacteria, molds, fungi, minerals, and water additives interact in the water source and within the pipe line and drinkers to make difficult management practices necessary to guarantee the best quality water for optimum performance [3]. 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 [4]. 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 [5].

Reddy *et al.* [6] considered that the number of microorganisms in the drinking water of birds should be 100 CFU/mL for total bacteria and 50 CFU/mL for coliforms. The mean levels of *Escherichia coli* in the water of a broiler farm that used bell-type drinkers were 104 microorganisms/mL in the first week of life [7], a concerning finding since this is a high fecal contamination associated to young age of the birds. Meza [8] states that there should be a better bacteriological control of the water provided to the birds during the initial phase, since there is a fast bacterial growth and the health risk is increased for the for birds from 1 to 21 days of age.

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 [9].

### **Physical and Chemical Characteristics**

The acidity or alkalinity of water is an indication of pH level. A scale from 0 to 14 is used to measure pH. Neutral water, which is neither acidic nor alkaline, has a pH of 7. Water with pH below 7 is acidic, and water with pH higher than 7 is alkaline. When the pH of drinking water is acidic then it can affect digestion, corrode watering equipment/system, and impair the use of water-soluble vaccines and medications. Poultry prefer water with a pH of 6.0 to 6.8 but can tolerate a pH range of 4 to 8. However, water with a pH less than 6 has been shown to negatively affect chicken performance. When provided water with a pH above 8, chickens might reduce their water consumption. This in turn will affect feed consumption and bird performance.

### **Hardness**

It refers to the amount of dissolved minerals, like calcium and magnesium in water. Hard water has high levels of these minerals and can cause the buildup of sludge in water lines. Hardness reduces the effectiveness of soaps and disinfectants used in cleaning and disinfection of poultry sheds and also interferes with the administration of some medications. Hard water has not been shown to have either a positive or negative direct effect on poultry performance. However, it can cause stains and adversely affect watering equipment/systems.

### **Minerals**

Several minerals occur naturally in drinking water of poultry. They are usually present in small amounts that do not interfere with the metabolism or digestive functions of poultry. When the levels of certain minerals are out of balance or exceed its threshold limit, then performance of poultry can be adversely affected.

### **Nitrates and Nitrites**

Nitrogen contamination of water generally occurs in the form of nitrates and nitrites. Nitrate ( $\text{NO}_3$ ) is produced during process of decomposition of organic matter. Nitrite ( $\text{NO}_2$ ) is produced during intermediate stages of decomposition of organic compounds. The presence of nitrates and/or nitrites in water indicates that the water is contaminated by runoff containing fertilizer or animal wastes. Nitrates are soluble and may move with surface runoff or leach into the groundwater by percolation through the soil. Nitrate itself is nontoxic, but after ingestion, microorganisms present in the digestive tract convert nitrate to nitrite which is more toxic. Once nitrite is absorbed into the bloodstream, it binds strongly with haemoglobin and reduces the oxygen carrying capacity of the blood. Long-term nitrate and/or nitrite toxicity results in poor growth, decreased feed consumption, and poor coordination and ultimately reduces the performances.

### **Sulfate ( $\text{SO}_4$ )**

Presence of high levels of magnesium or sodium sulphates have a laxative effect. Levels as low as 50 mg/L can have a negative effect on flock performance if either the sodium or magnesium level is also 50 mg/L. High levels of sulfate may also interfere with intestinal absorption of other minerals such as copper.

### **Phosphate ( $\text{PO}_4$ )**

High levels of phosphate may indicate water contamination from sewage.

### **Sodium (Na)**

Presence of excessive levels of sodium have a diuretic effect. High levels of sodium also increase water consumption resulting wet litter problem. This can have an adverse effect on air quality in the poultry house. The normal sodium level in water is about 32 mg/L. Levels above 50 mg/L, together with high levels of sulfate or chloride, have been shown to adversely affect flock performance.

### **Chloride (Cl)**

Excessive levels of chloride have been shown to adversely affect metabolism. A normal chloride level is 14 mg/L. Levels of about 14 mg/L, combined with a level of 50 mg/L of sodium, are detrimental to flock performance. Poultry can tolerate chloride levels as high as 25 mg/L as long as the sodium level is in the normal range. High levels of chloride increase water consumption and results in wet litter problem. According to Jeffrey <sup>[10]</sup>, adequate chlorine dosage in drinking water for birds is 3 ppm, although birds may tolerate residual chlorine concentrations of more than 10 ppm. Concentrations of 5 ppm are indicated to control biofilm formation. The presence of organic material rapidly inactivates chlorine, therefore, drinkers should be cleaned daily to avoid accumulation of organic material. Water pH should be lower than 8.5, and optimal pH values are from 6.0 to 8.0. Chlorination should be suspended two days before any vaccination with live bacteria and virus via drinking water. Supply of chlorinated water may be resumed 4 hours after vaccination is completed. Residual chlorine concentrations between 2 and 5 ppm has resulted in no performance impairment and has been suggested as the levels to be added in the water supplied to broilers and laying hens <sup>[11]</sup>. The microbiological quality of water given to broilers improved at 2 ppm of residual chlorine <sup>[12]</sup>.

### **Magnesium (Mg)**

Water containing high levels of magnesium may have loose droppings. Magnesium may interact with sulfate, and it is in the presence of high sulfate levels that magnesium levels are a concern. The normal level of magnesium in water is about 14 mg/L. Levels as high as 68 mg/L have not been shown to adversely affect production when sulfate levels are normal. A level of 50 mg/L of magnesium in combination with a sulfate level of more than 50 mg/L will adversely affect flock performance.

### **Manganese (Mn)**

Excessive levels of manganese can result in an off flavour in drinking water and reducing water consumption.

### **Copper (Cu)**

In combination with phosphorus, copper plays a role in bone development. Too much copper can give the water a bitter taste and might cause liver damage. Problems with copper can occur when dietary molybdenum is either excessive or deficient.

### **Calcium (Ca)**

Calcium does not appear to have a negative effect, even at levels as high as 400 mg/L.

### **Iron (Fe)**

High levels of iron, up to 25 mg/L does not have any adverse effect on poultry, but they will stain watering system. High iron levels in drinking water may encourage the growth of

bacteria that can lead to diarrhoea. When iron in the ferrous form is exposed to air, it is converted to ferric hydroxide giving water the typical rusty colour.

### Sanitization of drinking water

Water can be purified by filtration, sedimentation, chemical treatment, ultraviolet treatment and ozonization, chlorination of water is the cheapest method. Five gram of stabilized bleaching powder, with an available of chlorine level of 35% should be added to 1000 litres of drinking water and allowed to have a minimum contact time of 60 minutes before offering to the birds. Normally the bleaching powder is added at night to the water and allowed to have a longer contact time of overnight. At the collection point the residual chlorine level should be 0.2ppm. a cheaper alternative is 50% hydrogen peroxide solution, used at 1ml/50 litres of water. If water storage facilities are not available the liquid chlorine preparations like Clodox, Vaz etc. may be used at 1ml/10 litres of water. To assure that the water consumed by birds will not pose risk to the flock health, it should be disinfected. The most recommended disinfecting agent is chlorine, due to its efficiency, cost, practical use and innocuity to birds when adequately applied<sup>[13]</sup>.

### Conclusion

Water is the most critical nutrient and is physiologically required by all animals including poultry. The quantity and quality of water should be supplied on a daily basis as per the bird age and breed to keep all physiological functions intact. Potable water should be made available to the birds round the clock for optimum performances. To keep the birds healthy the water should be free from all types of harmful bacteria especially coliform bacteria and other pollutants.

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