

Water – The Forgotten Nutrient

“If there is magic on this planet, it is contained in water” – Loren Eiseley. “Water is Life’s matter & Matrix, mother and medium. There is no life without water” – Albert Szent-Gyorgyi



Picture 1

Water is one of the most important & most voluminous nutrients ingested by chicken but most neglected one. Adequate availability of safe drinking water to birds is critical for normal life, health and performance.

- Water is an inorganic, transparent, tasteless, odorless & nearly colorless chemical substance.
- Water has the important ability to dissolve many other substances, this versatility as a solvent is essential to living organisms.
- A broiler chicken drinks 10 litres of water in their short life and a layer chicken drinks almost 160 litres in 80 weeks; these much water is passing through the gut epithelium of chicken.
- Gut epithelial surface area is much higher than the external body surface, and hence drinking water must be safe, free from any chemical & microbial contamination, have good taste & helps digestive process. Hippocrates quote on medical science, “**All Diseases begins in the gut**” is again remembered here and the gut is exposed to high volume of water daily.
- Water consumed in greater quantity than any of the other nutrient (5 times of Maize)
- Chicken may die rapidly from lack of water than lack of any of the other nutrients.
- Almost 70% of chicken body is made of water

WATER CONTENT (%) OF CHICKEN MEAT		
PRODUCT NAME	RAW	COOKED
Whole Chicken	66%	60%
White Meat Chicken with Skin	69%	61%
Dark Meat Chicken with Skin	66%	59%
Egg	76%	

Functions & Importance of Water

- Major component of blood to carry Oxygen & Nutrients to cell and carrying waste away
- Directly related to all physiological functions like digestion, respiration, excretion, production, movement, thermoregulations, etc.
- For normal living, optimum growth & production chick need free & easy access of safe drinking water
- 80% of disease incidence can be prevented through supply of safe drinking water to chicks

In Poultry farming, water consumption depends on

- Age & Productivity level of chicken
- Environment; Temperature & Humidity
- Drinking water quality
- Feed form & feed composition
- Gut Health
- Stress factors like Disease, Litter Ammonia, etc

Environmental Temperature °C/°F	Feed vs Water Intake in Broiler chicken
4°C /39°F	1:1.7
20°C/68°F	1:2.0
26°C/79°F	1:2.5
30°C/86°F	1:3.0
37°C/99°F	1:4.5

In Poultry farming, water deprivation results

- Reduced feed intake, low body weight & low egg production; low productivity
- Dehydration & Immuno-suppression
- Thermoregulatory failure to maintain body temperature leading to enlarged heart resulting to multi organ failure & death
- Chemical imbalance leading to disturbance in all body processes from joint movement to brain function due to thickening of different body fluid

- Reduce digestive capacity, resulting poor growth & production because of dehydration effect on Villi height & crypts depth
- *Today's chicken is less tolerant to Stress, with a significant stress from poor drinking water quality; which might have had no impact on chicken 15 years ago, could be devastating for birds today.*

Drinking Water Quality Parameters for Chicken:

- Physical: shall be colourless & odourless and have no turbidity
- Contamination: shall be free from Chemical & Microbial contamination
- Hardness & TDS: around 100
- pH: 6.2 – 6.6 in broiler and 6.8 – 7.2 in layer & breeder
- Taste: Pleasant

Effect of Chemical Contamination or Excess Minerals in water:

Poultry performance affected by even 10 ppm Nitrates from sewage or fertilizer contamination of water or 5 ppm Iron in ground water. Seven signs in poultry that indicates poor water quality without producing specific infections:

- High Nitrate (>1mg/litre) level Lowers O₂ uptake in the blood, resulting in lethargic birds, reduced fertility in breeders and bluish comb, lobes & head
- Very high Nitrate (>200mg/Litre) level may attribute respiratory problems
- High Potassium (>300mg/Litre) level may cause Enteritis & Diarrhoea
- High Na (>200mg/Litre) may result Cerebral symptoms, torticollis & lameness
- High Sulfide (>250mg/Litre) level converted to sulfate under the influence of bacteria may block nerve conduction, smell of rotten eggs
- High level of Iron (>5mg/Litre) causes Intestinal Dysfunction
- Mycotoxins produced by moulds causes Weaker Immune Response & Loose Drop

Effect of Microbial Contamination of drinking water:

- Poultry producers are critical about Feed quality all the time, but the quality of drinking water often not receive the attention it deserves although volume is 2 - 3 times



Picture 2



Picture 3

In poultry house environment, there is always chance of contamination of water from litter, dust & discharges of birds; 1 mg faeces dust may contain 1000 *E coli*

Hardness & TDS as water quality parameter:

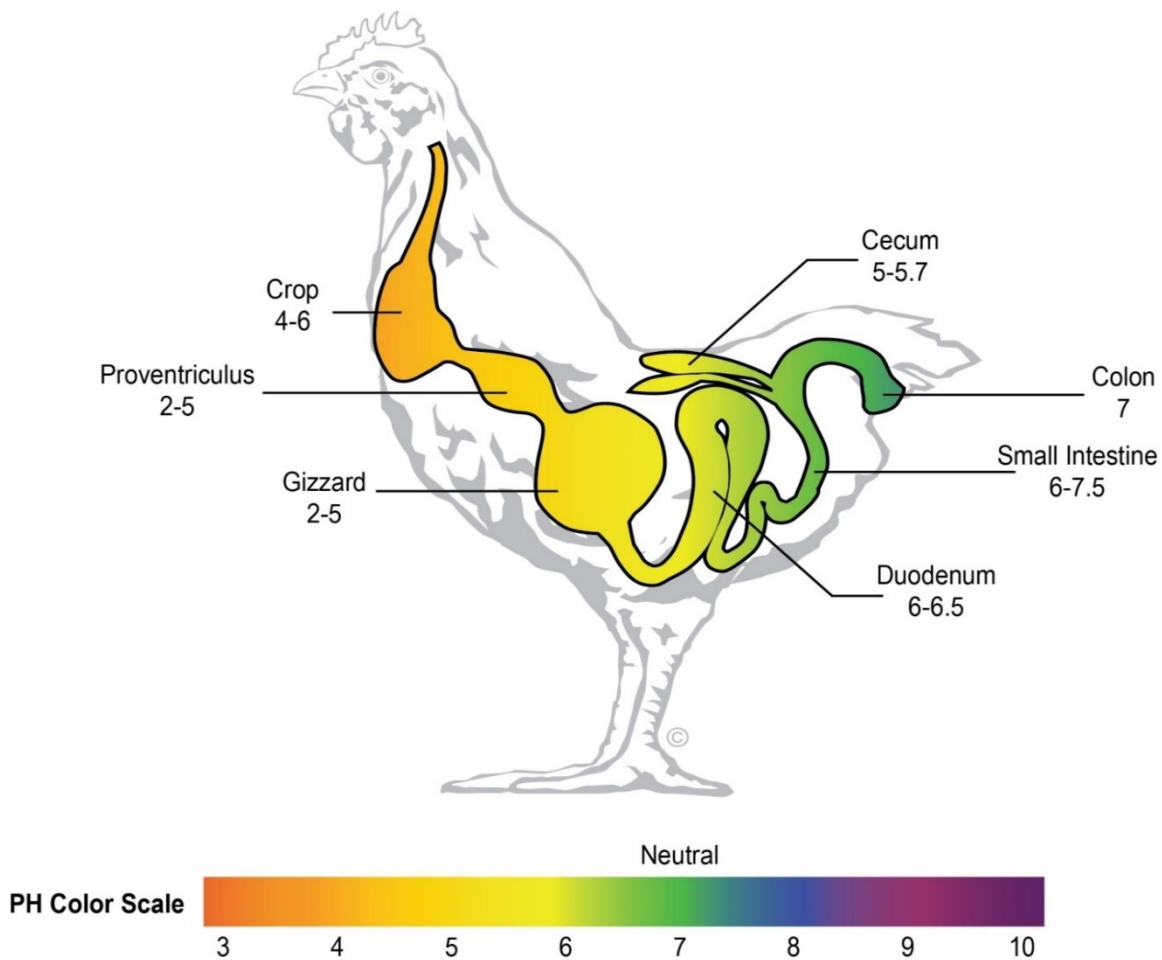
- Hardness is the amount of dissolved mineral, Ca & Mg in the water as carbonate, sulfate & chloride; Hard water has high level of Ca & Mg ions.
- Hardness causes the build-up of hardness scale; dissolved Ca & Mg salts are responsible for scale formation in poultry watering system
- Total Dissolved Solids (TDS), a measure of all inorganic & Organic Solids dissolved in water
- The main difference between TDS and Hardness is that TDS include inorganic and organic substances that cannot be filtered through a filter paper

Water Hardness Scale	
Mg/litre & ppm as CaCO₃	Classification
0 – 75	Soft
75 – 150	Slightly Hard
150 – 300	Hard
300 +	Very Hard

- Hardness & TDS of water are directly proportional to each other, higher the TDS more will be Hardness of the water
- Hardness reduces efficacy of Sanitizer/disinfectant, interferes with activity of many Medicines & can affect Vaccine Efficacy
- Hard Water can clog pipes & Nipples, Scale builds up around nozzles/outlets, drinkers
- Water Hardness can be removed by Water Softener through Reverse Osmosis (RO), which replaces Ca & Mg Ion by Na ion and water become soft with TDS @ desired level.

Water pH and Drinking Water quality:

- pH means **potential hydrogen or Power of Hydrogen**; how much hydrogen is in the water and how active the hydrogen ion is?
- pH is a scale used to specify the acidity or alkalinity of any liquid, in our case the drinking water



Picture 4

- Hardness & pH are not always directly associated, but generally, hard water has a higher pH
- pH heavily impacts water quality & efficacy of disinfectants

Table - 1: pH Standards for poultry drinking water

pH Level	Consideration	Indication
< 5	Poor	Performance issues, metal corrosion of equipment and water lines
6.0 to 6.8	Satisfactory	Recommended for poultry
> 8	Unsatisfactory	Impacts on water sanitizers and results in "bitter" taste
5 to 8	Tolerable	Maximum acceptable levels

- Gut Microbiome and digestive enzyme activity are sensitive to pH
- Coliforms, including *E. coli* and *Salmonella*, grow best at alkaline pH. In contrast, beneficial bacteria like Lactobacilli thrive at more **acidic pH**

Water pH & Drinking Water Vaccination in Poultry

Drinking Water is the easiest & common Route of Vaccination in Poultry. Vaccine Efficacy Issue & Vaccination Failure are very common in this subcontinent and Drinking water quality heavily impacts the same

There is a publication on “Role of water chemistry and stabilizers on the Vero-cells-based infectivity of Newcastle disease virus live vaccine - October 2017” [The Journal of Applied Poultry Research](#) 27(1)

- *Minimum reduction in virus infectivity was recorded in the water with neutral or slightly alkaline pH*, while the virus was relatively less stable at extreme pH conditions
- *Maximum reduction of infectivity was observed in the water with pH 9.00* in which the virus was completely inactivated within 3 hours
- Minimum reduction in infectivity was observed in the water with neutral pH, followed by the ones with a pH of 8.00, 6.00, 5.00, and 9.00
- In all water samples, T-90 values (time required for 90% reduction in virus infectivity) were highest (485 minutes) at neutral pH (pH 7.00) and lowest (102 to 134 min) at an extreme alkaline condition (pH 9.00)
- Results indicate that water with a pH range of 7.00 to 8.00 is suitable for administration of NDV live vaccines

Water pH & Common Water sanitizer, Chlorine in Poultry

www.poultrysite.com – 25 September 2019 by Aviagen

- Chlorination is an effective way to achieve water sanitation, as it provides residual protection against recontamination, is easy to use and cost effective
- Chlorination requires an acid application to adjust water pH to 5 - 7. The effectiveness of chlorination depends on the water pH, which should be between 5 – 7.
- When chlorine is added to water it forms Hypochlorous acid (HOCl) which is the active sanitizing agent, and OCl⁻ which is not an effective sanitizer
- When the water pH exceeds 7, more OCl⁻ and less HOCl is formed and so the effectiveness of the chlorination is significantly reduced

Poor Water Quality Effect on Chicken Gut Health

Poor Quality Drinking Water > Gut Health Compromise > i) Excess Production of Toxic Gas CO₂, NH₃ & H₂S, ii) Excess Production of Toxic Amines which irritates Gut, iii) Reduced Bile Production leading to further disturbance in fat digestion > Excessive Immune Reaction leading to LEAKY GUT > Further Disruption & Damage to Gut Mucosa > Deviation in Gut Microbiota > Malabsorption of Nutrients > Passage of Fat, Carbohydrate & Protein towards hind gut > Microbes (e.g. Clostridium) gets necessary nutrition to multiply > Dysbacteriosis > Enteritis

Poor Drinking Water quality with high pH & high TDS leads to Enteritis, diarrhoea & Pasty Vent condition in chicks. Continuation of the issue may cause mal-absorption of protein leads to



Picture 5



Picture 6



Picture 7

undigested protein in hind gut resulting development of Necrotic Enteritis. Maggot development is a common outcome of persistent NE in broiler

Monsoon Effect on Drinking Water Quality and subsequently on Chicken Gut Health

- Effect of Monsoon on underground Drinking Water Quality parameters like Taste, pH, TDS, Hardness, Alkalinity, Dissolved Oxygen & Microbial Contamination varies widely depending on the Nature of the Soil, Land Proximity to River, Presence of Organic matter & Rain volume, etc.
- Poultry in this subcontinent is in between agricultural land and Monsoon is cultivation time when Nitrate contamination in Drinking water is a concern
- Due to Flood & water logging condition of many areas, Microbial contamination reaches its peak in monsoon and Enteritis with Diarrhoea is very common in poultry
- pH & dissolved Oxygen were found maximum in monsoon – Published by H V Vyas & V A Sawant – “Seasonal Variation in Drinking water quality of some Borewell water in urban area of Kohlapur City” - in *Nature Environment and Pollution Technology, Vol VII, No 2 in 2008*
- *The total Hardness, the Total Dissolved Solids (TDS), the Alkalinity and Electrical Conductivity are higher in post monsoon water samples than the pre monsoon samples – Published by K Karthik, R Mayildurai & S Karthikeyan – A Research on Pre-Monsoon and Post-Monsoon Physio-Chemical Parameters of Groundwater of Velliangadu Vill, Coimbatore, TN, India.*

How to make Borewell water into Safe Drinking water for Poultry farming

- Borewell shall be away from agricultural land to avoid fertilizer contamination
- Avoid any open drain or drain water pipeline beside Drinking water line to avoid Microbial contamination
- Avoid 90° degrees bend in pipeline to avoid biofilm development in pipeline.
- The borewell shall be as near as possible to main water tank to avoid long water travel through pipeline
- Main water tank needs to be cleaned thoroughly after every flock to remove scales & biofilm
- Water Pipeline to be cleaned and disinfected after every flock and then every fortnight during rearing
- Installation of RO plant is best & economic way of serving the birds a safe drinking water where TDS & pH can easily be controlled
- In small farms where RO is not feasible, Double water tank is advisable; 1st one for Chlorine treatment and the second one for sanitization & medication
- To make the water pH at desired level use Water Acidifier first and after 10 minutes, use Sanitizer of your choice; wait for 40 minutes and then give the water to the birds
- Sanitizer include Iodine salt, DDAC, Chlorine Tablet, Chlorine + Bromine tablet, etc