



**TO
WEBINAR
ON
THE BLUE STRATETEGY
FOR
FARM WATER QUALITY MANAGEMENT**

16-09-2021

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PRACTICAL APPROACH

TOWARDS

CLEAN AND SAFE DRINKING WATER

CHALLENGES AND SOLUTIONS

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WATER IS LIFE



- Water is an inorganic, transparent, tasteless, odorless & nearly colorless chemical substance
- Liquid at room temperature
- Has the important ability to dissolve many other substances, this versatility as a solvent is essential to living organisms



"Water is life's matter and matrix, mother and medium. There is no life without water."

Albert Szent-Gyorgyi

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WHY DISCUSSION ABOUT WATER IN POULTRY??



Broiler Chick Drinks 10 Litres Water in 5 Weeks

Gut Epithelial Surface is much higher than external body Surface

High Volume of Water passing through Gut Epithelial Everyday

"All Diseases begins in the gut" - Hippocrates



Layer Chick Drinks 160 Litres Water in 80 Weeks

Safe Drinking Water is Essential for Normal Health & Production

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IMPORTANCE OF WATER IN THE BODY

➤ Water, the 'forgotten' nutrient; safe water intake is as important as feeding birds a healthy feed

➤ 70% of Chicken Body Wt is Water



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➤ Water consumed in greater quantity (5 x Maize) than any of the other nutrient

➤ Birds may die rapidly from lack of water than lack of any of the other nutrients.

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FUNCTIONS OF WATER IN THE BODY

- As major component of blood Water helps transporting Nutrients & O2 to the cells and carrying waste away
- Directly related with all physiological activities; Digestion, Respiration, Excretion, Production, Movement & Thermoregulation, etc
- For optimal Growth & Production, Chick needs free & easy access to safe water

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



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WATER & FEED CONSUMPTION RATIO

Ambient Temperature °C/°F	Feed vs Water Intake in Broiler
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

Water Consumption depends on

- Drinking Water Quality
- Feed Composition & Feed Form
- Gut Health
- Existing Stress Factors like Climate, Disease, Litter Ammonia



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EFFECT OF DRINKING WATER DEPRIVATION

- Deprivation results POOR PERFORMANCE - reduced Feed Intake, Low Body Weight & Egg Production and Poor FCR
- Causes Dehydration & Immuno-suppression
- Causes Failure to maintain Body Temperature (Thermoregulation) with enlarged heart followed by multi organ failure & death
- Results Chemical Imbalance with all body processes from joints to brain function get disturbed due to thickening of blood (concentrated)
- Effects Intestinal Villi Height & Crypt Depth - reduces digestive capacity resulting Poor Growth & Production



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COMMON MISTAKES - WATER DEPRIVATION

- Too few no of Drinker
- Height & Size of Drinker in Chicks
- Water Pipeline – Bending issue, Narrow Angle type fitting
- Clogging of Nipple – Hardness, Supplements

- Size of Farm Water Tank – shall have the capacity of 24 hours water to maintain Water supply in case of Electrical or any mechanical failure



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DRINKING WATER QUALITY REQUIREMENT

Where we are today?

Broiler:
Very High growth & Feed efficiency
AND

Layer:
High Hen-house & Hen-day Production

Today's chicken became less Tolerant to Stress; with a significant stress from Poor Drinking Water Quality

Water Samples

Contaminants, Minerals & Ions

	Average Level	Maximum Acceptable Level		Average Level	Maximum Acceptable Level
Total Bacteria	0 CFU/ml	100 CFU/ml	Iron (Fe)	0.3 mg/l	0.3 mg/l
Coliform Bacteria	0 CFU/ml	100 CFU/ml	Lead (Pb)	0	0.02 mg/l
PH	6.5 - 7.5	6.5 - 8.5	Magnesium (Mg)	14 mg/l	120 mg/l
Total Hardness	50 - 100 ppm	170 ppm	Nitrate	10 mg/l	70 mg/l
Calcium (Ca)	40 mg/l	400 mg/l	Sulfate	120 mg/l	200 mg/l
Chloride (Cl)	14 mg/l	200 mg/l	Zinc (Zn)	N/A	1.0 mg/l
Copper (Cu)	0.02 mg/l	0.05 mg/l	Sodium (Na)	30 mg/l	50 mg/l

N/A = Not Applicable

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What might have had No Impact on birds 15 years ago, could be Devastating for the bird of today

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CHALLENGES ON WATER QUALITY IN POULTRY

Artificial & Avoidable; can be controlled or Minimized

- Tank & Pipeline Design
- Dry & Dusty Litter Material
- Unnecessary Bird Movement
- Feed Spillage
- Supplement through Water
- Cleaning

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Natural & Un-avoidable, need systematic approach to handle

- Hardness & TDS
- pH
- Color, Taste & Smell
- Water Source
- Minerals
- Dissolved Organic matter
- Climate; Rainfall

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DRINKING WATER QUALITY PARAMETERS

- Physical : Colourless & Odourless
- Contamination: Free from unwanted Chemical & Microbes
- Hardness/ TDS: 110
- pH : 6.0 – 6.8
- Taste : Pleasant

➤ In Poultry, Borewell water or groundwater is the most common source of water

➤ Largely, Borewell water is the rainwater that seeps deep into the ground and gets trapped between the rock layers



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DRINKING WATER PARAMETER – PHYSICAL APPEARENCE

Drinking Water must be Clear without any Turbidity, Colourless & Odourless



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DRINKING WATER – CHEMICAL CONTAMINATION

- Water must be Free from any unwanted Chemical Contamination
- Poultry performance affected by even 10 ppm Nitrates from sewage or fertilizer contamination of water or 5 ppm Iron in ground water

Improve Infrastructure & Husbandry Practice to provide Safe drinking water to avoid Chemical Contamination



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DRINKING WATER – MICROBIAL CONTAMINATION

- Water shall be Free from any Microbial Contamination for Optimum Health & Performance
 - Poultry producers are critical about Feed quality, but the quality of drinking water often not receive the attention it deserves although volume is 3 times
- In poultry house environment, there is always chance of contamination of water from litter, dust & discharges of birds



Water SANITIZER use is a compulsion in poultry throughout the production/life cycle

- To prevent Water borne diseases
- To control horizontal spread of infections
- To get optimum digestive capacity from Intestine

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WATER HARDNESS & DRINKING WATER QUALITY

- Hardness is the amount of dissolved mineral Ca & Mg in the water; Hard water has high level of Ca & Mg ions
- The term hardness originally applied to waters that were hard to wash in, referring to the soap wasting properties of water



- Hardness prevents soap from lathering by developing an insoluble curdy precipitate
- Hardness typically causes the build-up of hardness scale; dissolved Ca & Mg salts are responsible for scale formation in poultry

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HARDNESS, TDS & DRINKING WATER QUALITY

Total Dissolved Solids (TDS), a measure of all inorganic & Organic Solids dissolved in the water, which can be measured easily

Water Hardness Scale		
mg/L & ppm as CaCO ₃	dH	Classification
0 - 75	0 - 4	Soft
75 -150	4 - 8.5	Slightly Hard
150 - 300	8.5 - 17	Hard
300+	17+	Very Hard

- The main difference between TDS and Hardness is that TDS include inorganic substances that cannot be filtered through a filter paper
- Hardness is due to the presence of Mg and Ca as carbonate, sulfate & chloride

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WATER HARDNESS & DRINKING WATER QUALITY

- Hardness reduces efficacy of Sanitizer /disinfectant
- Interferes with administration of many Medicines & can affect Vaccine Efficacy
- Hard Water can clog pipes & Nipples, Scale build up around nozzles/outlets, drinkers
- Hardness & TDS of water are directly proportional to each other
- The higher the TDS the more will be the Hardness of water



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DRINKING WATER HARDNESS – THINGS TO DO

- Most common way of removing Water Hardness is to install a Water Softener, which replaces the Ca²⁺ & Mg²⁺ with Na ions by Ion Exchange Resin or by Reverse Osmosis (RO)
- RO uses an applied pressure gradient across a semi-permeable membrane to overcome osmotic pressure and remove water molecules from the solution with Hardness ions.



The membrane has pores large enough to admit water molecules to pass; but Ca²⁺ & Mg²⁺ will not fit through the pores



The resulting Soft Water supply is Free of Hardness ions

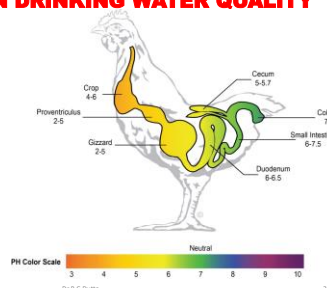
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ROLE OF pH IN DRINKING WATER QUALITY

- pH is a measure of acidity/alkalinity
- pH value < 7 is Acidic, and value > 7 is Alkaline
- Hardness & pH are not always directly associated, but generally, hard water has a higher pH
- pH heavily impacts water quality & efficacy of disinfectants

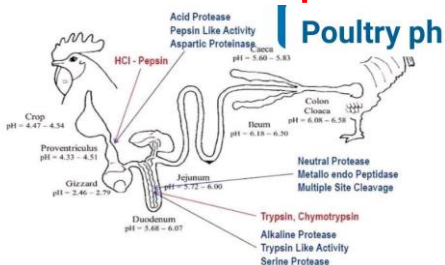


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CHICKEN DIGESTIVE CANAL pH IS ACIDIC



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ROLE OF pH IN DRINKING WATER QUALITY

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

Low pH helps Newly hatched chicks to adapt to dry feed because low pH promotes beneficial microbial growth & aids enzyme production



Liquid Water ACIDIFIER help maintaining Water pH at desired level

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- 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 @ 4.5-5.5 promotes the growth of beneficial bacteria in the gut and discourages the growth of coliforms

WATER pH & DRINKING WATER VACCINATION

Drinking Water is the most easy & common Route of Vaccination in Poultry

Drinking Water Quality (pH & TDS) is very poor in most part of this subcontinent

Vaccine Efficacy Issue & Vaccination Failure are very common

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

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WATER pH & CHLORINE SANITIZATION OF WATER

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

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DRINKING WATER QUALITY ISSUES (Non-Infectious)

7 Signs in Poultry that Indicate Poor Water Quality without producing specific Disease

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

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POOR WATER QUALITY EFFECT ON GUT HEALTH

Poor Drinking Water quality

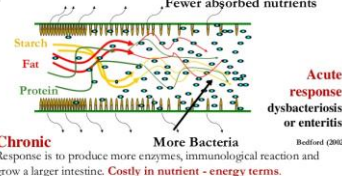
Gut Health Compromise

Deviation in Gut Microbiota

Malabsorption

- Poor absorption of Fats, Protein & Carbohydrate
- More Nutrients available at hind gut (Caeca) for microbes leading to growth & multiplication of pathogenic organisms

Slow digestion by the bird leads to more substrate for bacteria
Fewer absorbed nutrients



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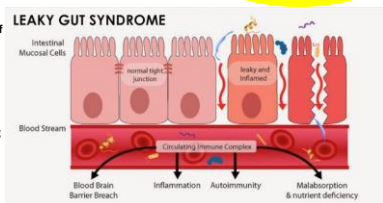
POOR WATER QUALITY LEADS TO GUT HEALTH COMPROMISE

This leads to further Disruption & Damage of intestinal mucosa resulting to many more infections

This is called **Dysbacteriosis**

Unwanted Microbial Overgrowth

- Excess Production of Toxic gas like CO₂, NH₃ & H₂S
- Production of Toxic chemical (Amines); irritates gut
- Inactivation of Bile production affecting Fat absorption
- Excessive Immune reaction leading to Leaky Gut



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POOR WATER QUALITY & PRACTICAL FIELD PROBLEM

- Poor Drinking Water quality with high pH & high TDS leads to Enteritis, diarrhoea & Pasty Vent condition in chicks



- Continuation of the problem may cause mal-absorption of protein leads to undigested protein in hind gut resulting Necrotic Enteritis. Maggot development is a common outcome of persistent NE in broiler



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EFFECT OF MONSOON ON DRINKING WATER QUALITY

- 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 Mayidurai & S Karthikeyan – A Research on Pre-Monsoon and Post-Monsoon Physio-Chemical Parameters of Groundwater of Velliangadu Vill, Coimbatore, TN, India.

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WATER ACIDIFIER EFFECT ON GUT HEALTH

- Organic Acids like Acetic, Formic, Propionic, Citric, Lactic & Butyric acids not only Reduce Drinking Water pH, but also helps maintaining Optimum Gut Health
 - Field experience shows Combination gives better results than any single acid
1. Organic Acid reduces Water pH and thus minimizes microbial load in Drinking Water
 2. Reduce gut pH which is always under threat from feed intake & poor quality water
 3. Helps maintaining Gut Microbiome by favouring the growth of Beneficial Bacteria
 4. Makes the Gut epithelium unfavourable for the pathogenic bacteria like *E coli* & *Salmonella* for adhesion & colonization
 5. Enhances Villi Height (VH) & Crypts Depth (CD); improves digestion & absorption capacity
 6. Reduce unwanted abdominal Fat content in chicken
 7. **Bactericidal Action:** Butyric acid enters the bacterial cell wall through diffusion (Clark and Cronan, 1996) which causes toxicity inside the bacterial cell (Warnecke and Gill, 2005), the reduction in the cytoplasmic pH of the bacterial cell (Choi et al., 2000) leading to the death of bacteria

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DRINKING WATER SANITIZING AGENTS

- Chlorine Dioxide (ClO₂) – NADCC (Na Dichloro/Dihalo Carbonate) release HOCl & OCl which hydrolyses bacterial Peptide chain
- Bromo-Chloro molecules (BCDMH, Bromo-Chloro Dimethylhydantoin) –
 - a) Dual action, releasing both Bromine & Chlorine
 - b) Bromine is slow releasing & has sustained action
 - c) Effective @ much higher pH
 - d) Effective in Presence of Organic matter
 - e) It is effective against some Viruses & fungi
- Ozone – The nascent O₂ molecule of Ozone destroy bacterial cell wall by progressive oxidation. Useful for Hatchery, Processing units



- IODINE Salt – i) Act against Bacteria, Fungi & Virus
ii) Effective in Hard Water & have Quick action
- DDAC (Di-Decyl Dimethyl Ammonium Chloride) –
 - a) Effective against Bacteria, Fungi, Algae & Virus
 - b) Effective against antibiotic resistant bacteria
 - c) Safe @ higher dosage
 - d) Broad-spectrum & Bactericidal
 - e) Causes disruption of intermolecular interactions & dissociation of lipid bilayers

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WHAT I NEED TO DO TO USE BOREWELL WATER IN MY FARM?

1. Installation of Water Treatment Unit (RO) to get desired water pH & TDS

OR

ACIDIFICATION & SANITIZATION

- from 1st water of 1st Day to Lifting/ Culling
- Use Good Liquid combination of Organic Acids to Reduce water pH to desired level
 - Use Sanitizer after 10 minutes, e.g Bromo-Chloro Salt, Iodine salt, DDAC or Chlorine Dioxide Tablet.
2. Maintain Drinking Water HYGIENE through CLEANING of Watering System regularly
 - Tank – after every batch with Bleaching Pow
 - Pipeline – Every fortnight with H₂O₂ preparation
 - Drinker – Everyday for Manual & Bel (Auto) Drinker and Nipple Cups Weekly



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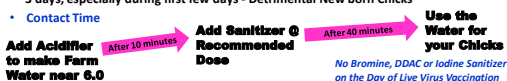
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WATER SANITIZATION - COMMON MISTAKES AT FARMS

- Use of Water Acidifier alone for Farm water Sanitization
- Use of Sanitizer alone in Farm Water with high Hardness
- Mixing of Acidifier & Sanitizer or Simultaneous Application
- Dose of Acidifier – depends on Farm Borewell Water pH
- Overdosing of Chlorine or Iodine Sanitizer
- No Sanitizer on First day of Chick's Life
- No Acidifier Use on 1st Day & the day of Vaccination
- No Acidifier and/or Sanitizer Use during Medication
- Filling the overhead Tank full capacity & adding Acidifier and/or Sanitizer, may be for 3 days, especially during first few days - Detrimental New born Chicks
- Contact Time

Chick don't like Any Available Water

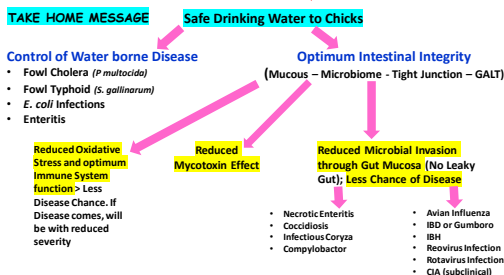


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DISEASE CONTROL - FARM WATER QUALITY MANAGEMENT



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