Water Management – A key factor in Poultry health & productivity

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Presentation Outline

- What to look for while visiting the farms?
- Water Management
  - Role of water
  - Factors affecting water consumption
- Evaluating water quality for poultry
  - Color, Taste, Odor
  - Bacteria
  - pH
  - Turbidity
  - Total Dissolved Solids
  - Hardness
  - Mineral Contaminants
- Measuring water quality at farm level
- Water treatments
- Summary

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What we need to do when visiting the farm?

Smell –
- How it smells in the shed environment?
- Ammonia levels
- Air in the shed – stuffy?

Taste
- Water
- Feed quality

Hearing
- Listen to sounds – breathing and respiratory
- normal communicating sounds

Sight
- Behavior
- Crop fill
- Feeders and drinkers
- Birds' movement, gait, posture, physical appearance

Touch
- Crop fill
- Footpad
- Body temperature
- Litter

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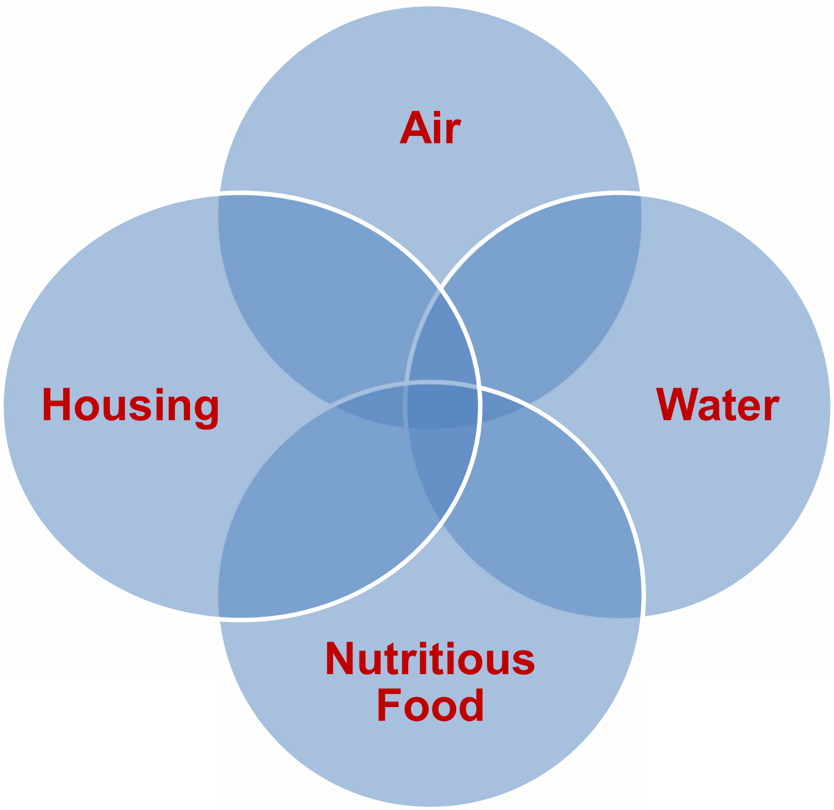
Essentials for Poultry



The overlooked nutrient – drinking water quality in poultry farms

- Poultry consume at least **2.5x to 3x the amount of water** to feed
- Diets, houses, equipment are highly standardized
- Water can be of very different quality, but is hardly ever considered

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Role Of Water In Poultry

- Water is one of the most important nutrients for the poultry
- A chicken body has 70 % water
- A loss of only 10 % will result in death.
- And, a single day without water will cause a layer to stop laying.
- Water quality factors can have either direct or indirect effect on bird's performance

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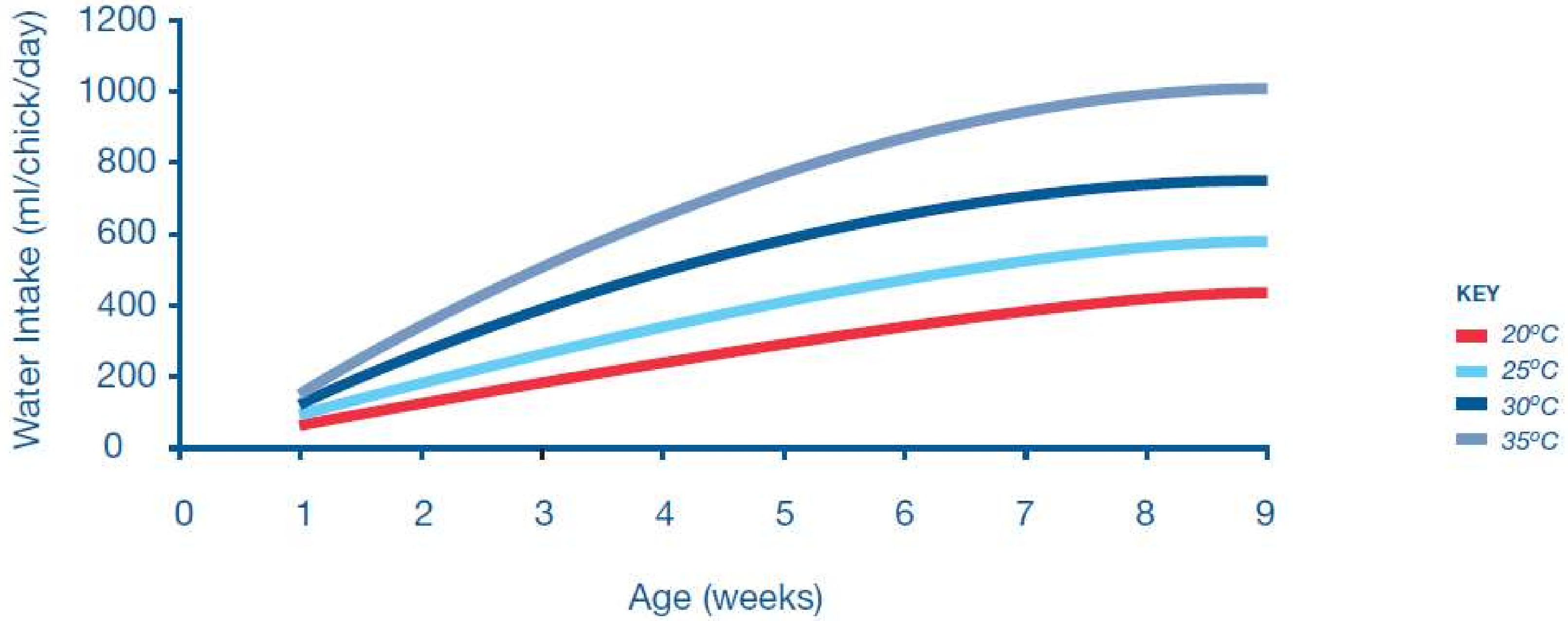
Effect of temperature on water intake



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Ref: Ross Tech

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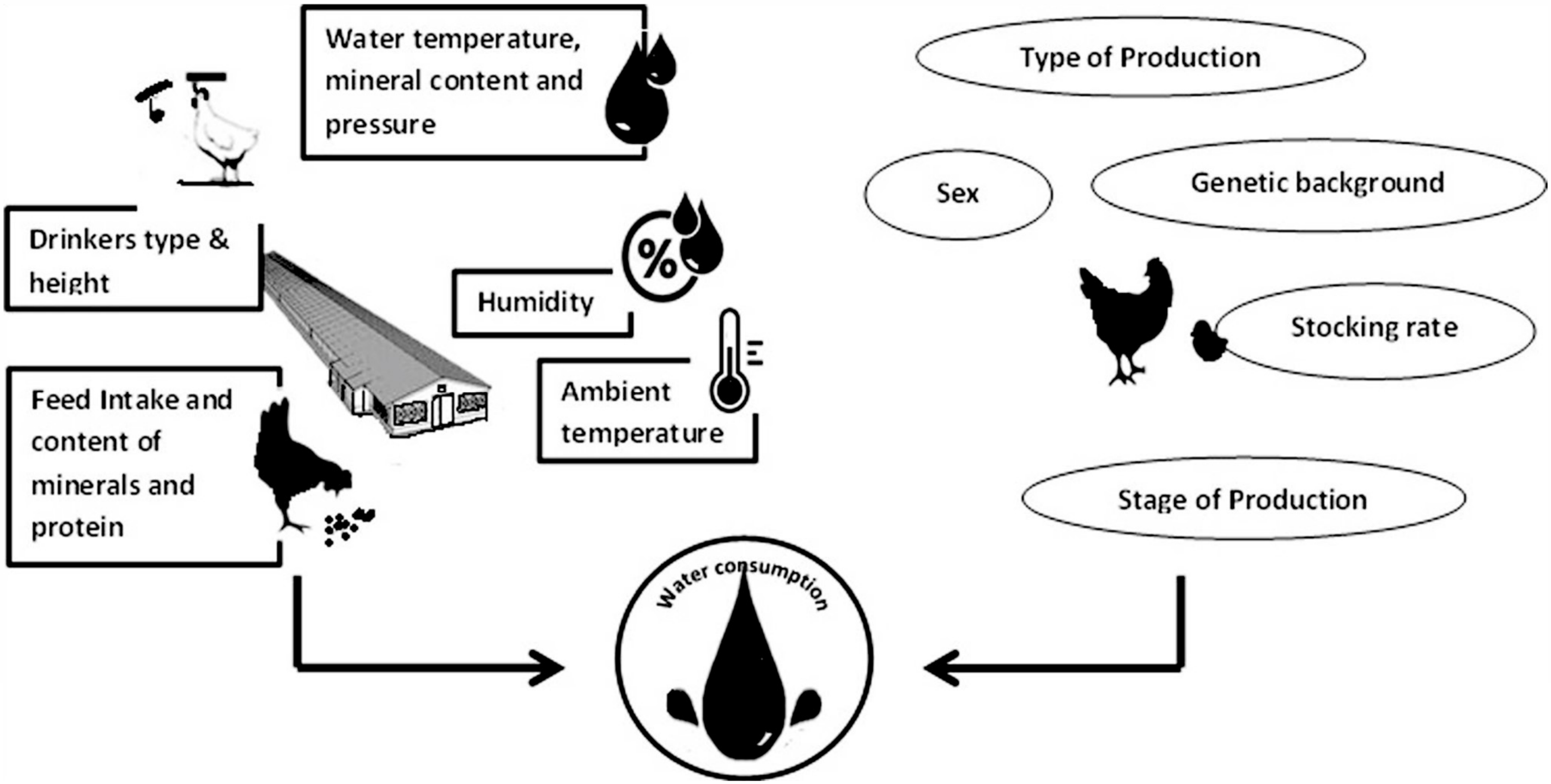
Factors affecting water consumption in chickens



Tropical Animal Health and Production (2023) 55:215

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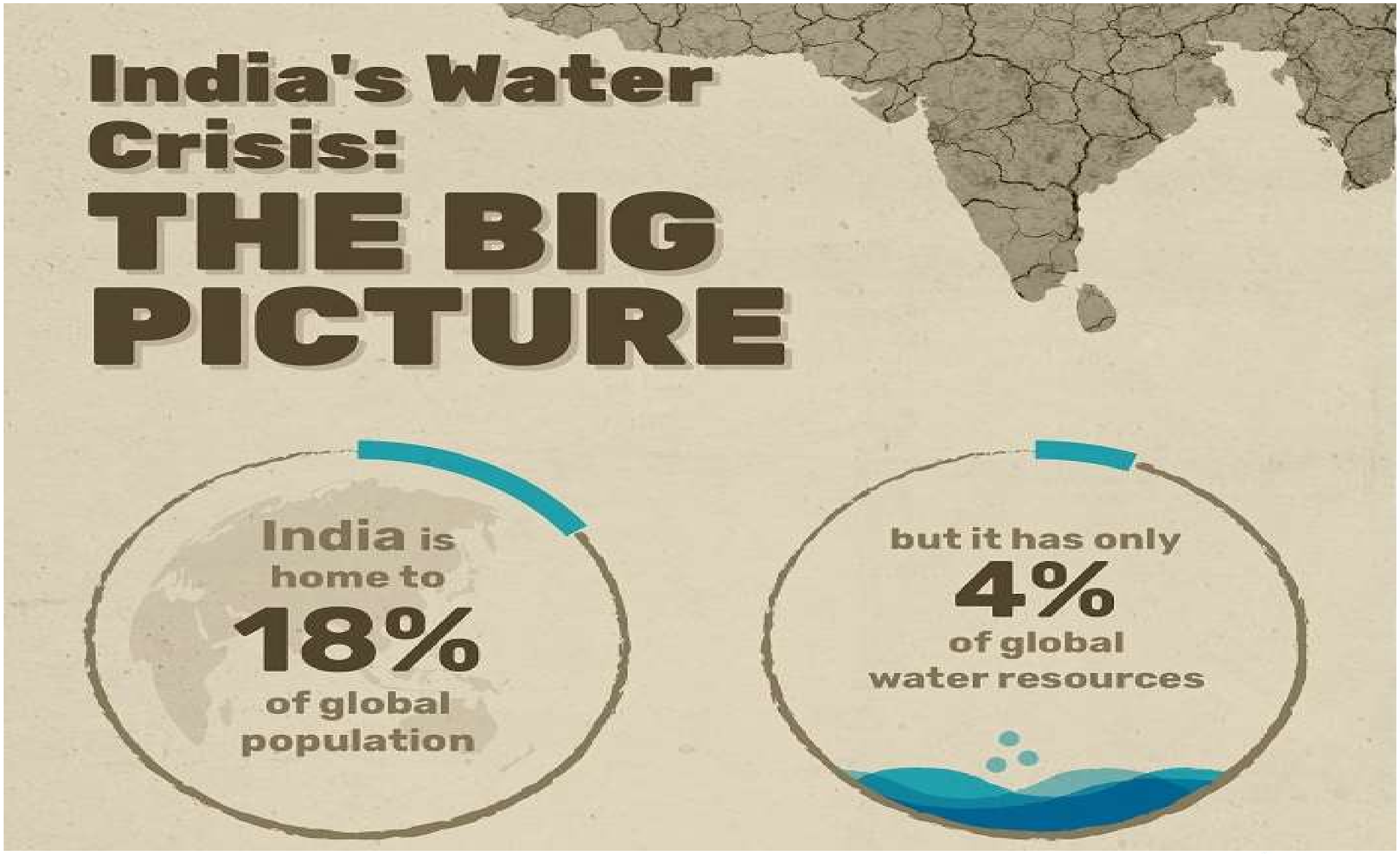
India's Water Crisis:
THE BIG PICTURE
India is home to
18%
of global population
but it has only
4%
of global water resources

Good Quality /Safe Water

- Water is required for proper feed intake
- Water is involved virtually in every physiological process.
- Essential for proper functioning of certain organs like kidneys
- Water is also a good medium for water borne infections to the birds

A safe and adequate water supply is essential for efficient poultry production

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Poor Water Management

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Evaluating Water quality for poultry

- Color, Taste, Odor
- Turbidity
- Bacteria
- pH
- Total Dissolved Solids
- Hardness
- Mineral Contaminants

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Drinking water guidelines for poultry

Contaminant, Characteristic or Mineral	Maximum Acceptable Levels
Bacteria	
Total Heterotrophic Bacteria	100 CFU/100 ml
Coliform Bacteria	50 CFU/100 ml
pH	5.0 – 6.8
Hardness	110 ppm
Naturally Occurring Compounds	
Calcium	500 ppm
Chloride	250 ppm
Copper	0.6 ppm
Iron*	0.3 ppm
Magnesium	125 ppm
Manganese**	0.05 ppm
Nitrate***	25 ppm
Phosphorus	0.1 ppm
Potassium	500 ppm
Sodium	50 ppm
Sulfate	250 ppm

* Iron as high as 600 ppm has been shown to not affect bird health, but will have detrimental effects on water lines and fogging systems (Fairchild et al., 2005).
** Manganese as high as 20 ppm has been reported to not affect bird health, but can have negative effects on water lines and fogging systems (Batal et al., 2005).
*** Nitrates as high as 600 ppm have been shown to not affect bird health (unpublished data).

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T.A. Carter and R.E. Sneed, 1987. Poultry Science and Technology Guide No. 42, North Carolina State University.

1. Physical Quality

Color, Taste & Odor

- **Water for poultry birds must be clear, colorless, tasteless & odorless**
  - **A reddish-brown color -** presence of iron
  - **Blue color -** presence of copper
  - **Rotten egg -** presence of hydrogen sulfide
  - **If there is any taste in water -** presence of salts.
  - **Bitter taste -** certain salts like ferrous and manganese sulfates.

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Turbidity

- Turbid water indicates suspension of materials such as clay, slit, algae or organic materials in water

- Turbid water will clog water lines & nipple drinkers

Bacteriological Quality

- Water is tested for the presence of *E. coli* & other coliform bacteria
- Presence of coliforms in water indicates contamination of fecal matter
- Their level of presence gives indication of the degree of water contamination
- Presence of more coliforms means the presence of other bacteria & viruses can be more
- Bacteriological test should be done at least twice a year

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Water sample collection procedure for bacteriology

- Use sterilized bottles, gloves & flame to disinfect the tap
- Open the tap & let water to run for 20 sec. & then collect the water sample
- Do not touch the mouth of the bottle & inside of the lid
- Collect water samples from
  - Bore water/ fresh water without any sanitizer
  - Tank water
  - Beginning of water line
  - Middle of water line
  - End of water line

Water sample collection procedure for bacteriology

- Store at 0-4^{o}C
- Transport to the laboratory within 12 hours

Contaminant or characteristic	Level considered average	Maximum acceptable level	Remarks
Bacteria			
Total bacteria	0/ml	100/ml	0/ml is desirable
Coliform bacteria	0/ml	50/ml	0/ml is desirable

Source: Adapted from T.A. Carter and R.E. Sneed, *Drinking water guidelines for poultry*. Poultry Science and Technology Guide No. 42, North Carolina State University

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Water sample collection procedure for bacteriology

Effect of Drinker Types on Water Bacteria Contamination (Micro-Organisms/ mL of Sample)

Micro-Organisms	Nipple		Bell Drinker	
	Entrance+	End++	Entrance	End
Total Coliforms	640	3,300	1,600	1,700,000,000
Faecal Coliforms	130	230	1,000	80,000,000
Escherichia Coli	110	900	900	66,000,000
Faecal Streptococcus	55	1,200	2,000	36,000,000
Mesofiles Micro-Organisms+++	24,000	700,000,000	86,000	1,400,000,000

Reference: Macari and Amaral, 1997.

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2. Chemical Quality

- pH
- Hardness
- TDS
- Dissolved Minerals

- If new water well/bore is dug check the chemical composition of water immediately before placing the chicks.
- It is suggested to check chemical composition of water at least once every year

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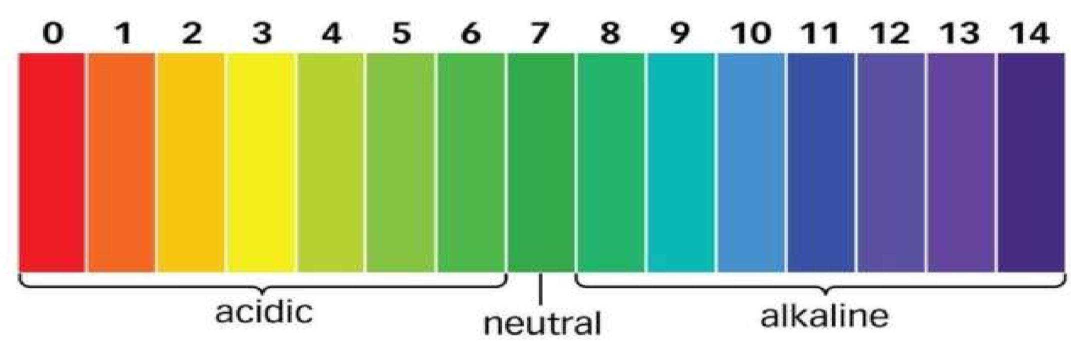
pH



- Poultry birds accept water on slightly acidic side better than the water on alkaline side
- Too low pH water will decrease palatability & is corrosive to metal equipment
- High pH water is also not acceptable as it contains high levels of calcium & magnesium & affects production
- Poultry prefer water with a pH of 6.0 to 6.8*

- Reference: Dr. Jacquie Jacob, University of Kentucky, Water Requirements of Poultry (http://articles.extension.org/pages/68305/water-requirements-of-poultry)

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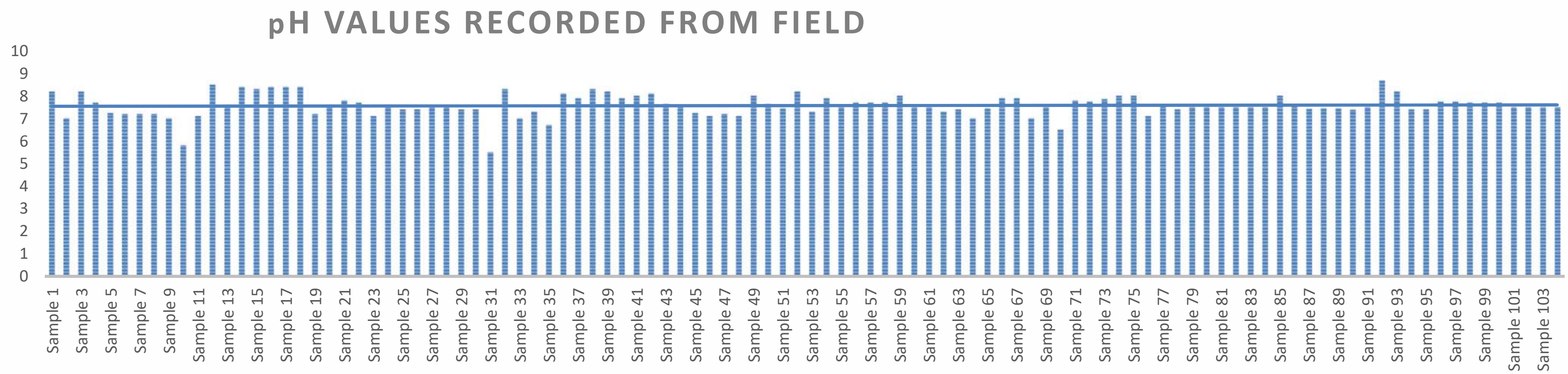
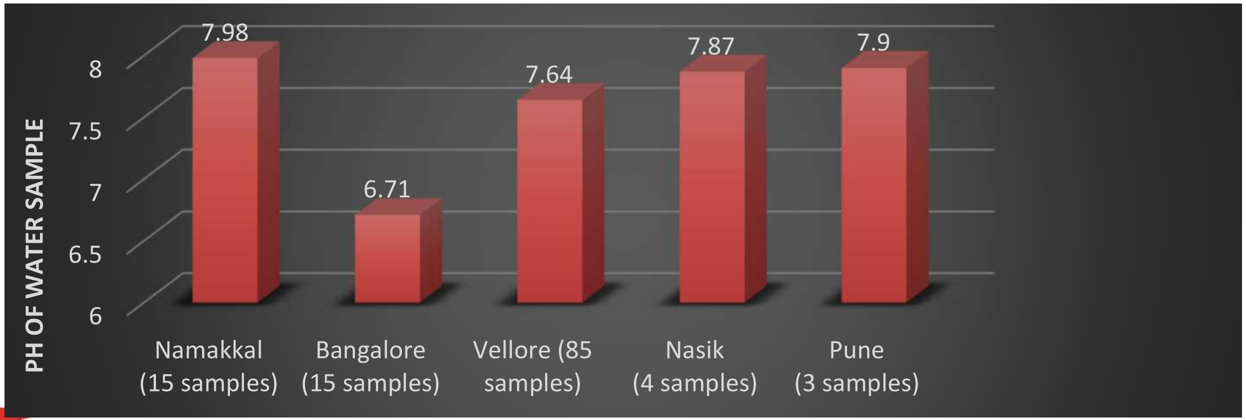
Water quality - pH

- pH of drinking water for poultry is more important
- A low pH prevails in the upper GI tract. This acidic pH helps in the maintenance of acidophilic bacteria, which are benevolent for the performance of the birds
- These bacteria exclude the pathogens
- On the other hand, a slightly high pH is present in the lower intestine, which makes it suitable for the growth of pathogens in this area
- Alkaline pH, leads to wet litter problems

Water pH: Field Observations (2022)



Average Water pH (Across India) : 7.6



pH of water in different regions of India

(Source: Kemin Internal)

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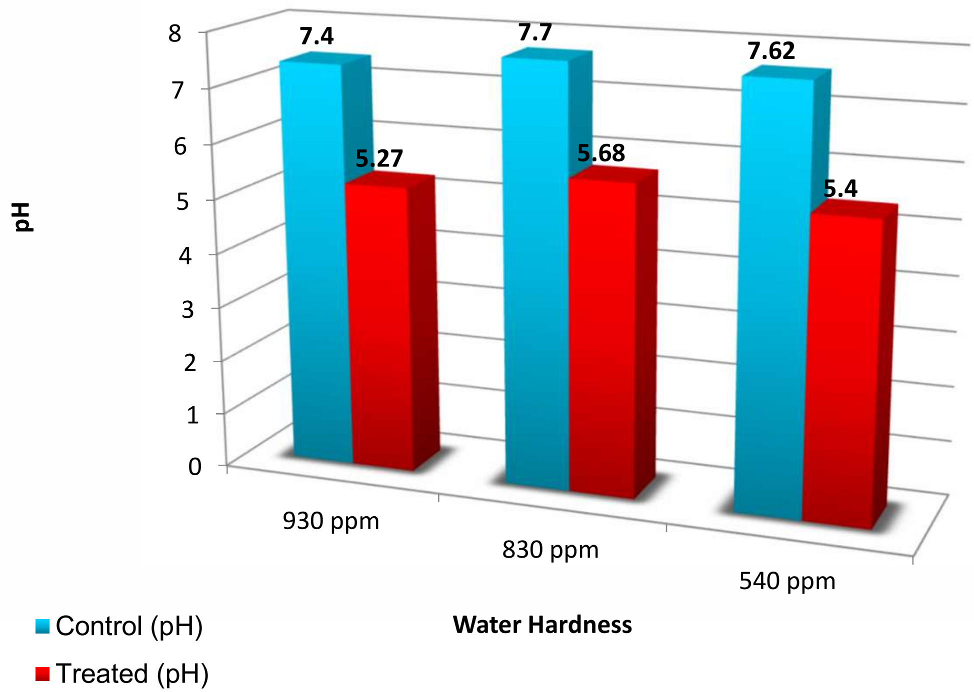
Effect on pH of water at different levels of hardness



Technical Litterature : “An effective antimicrobial agent and acidifer for poultry farm water”

Hardness

- Hardness refers to the presence of dissolved minerals such as calcium and magnesium in either bicarbonate or sulfate form
- Hard water commonly causes deposits and scale in the watering system.
- Birds can tolerate high level of hardness, unless certain ions are present in toxic amounts.
- High levels of magnesium sulfate may cause an increase in water consumption, wet droppings, and a drop in production.
- Hard water decreases the efficacy of disinfectants, cleaning agent & water administered medications

Hardness range (mg/l)	Description
0-60	Soft
61-120	Moderately hard
121-180	Hard
>180	Very hard

Ref: PennState Extension

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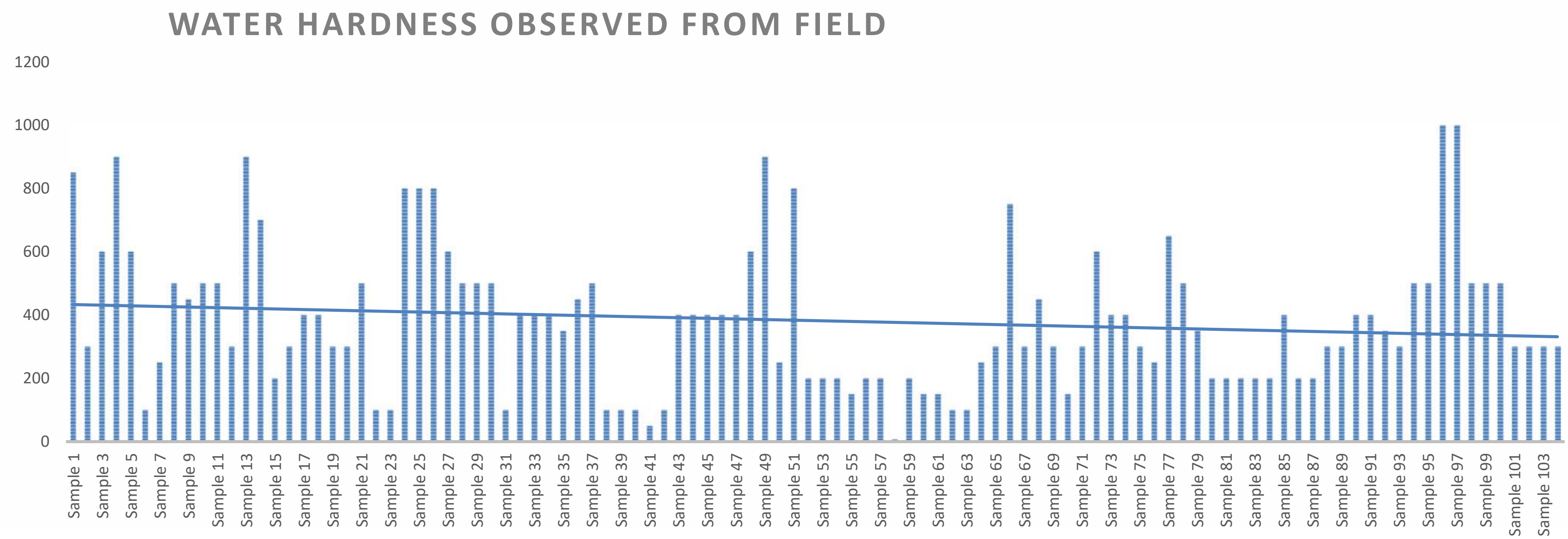
Water Hardness: Field Observations (2022)



Average Water Hardness: 383 ppm

(Source: Kemin Internal)

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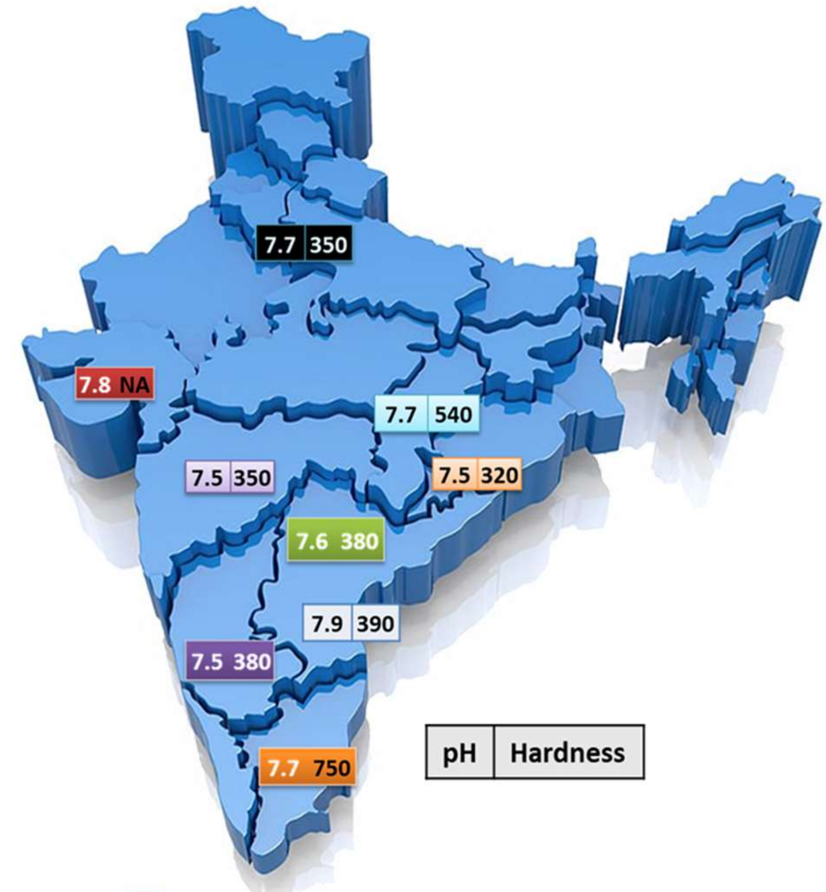
pH and Hardness of poultry drinking water in different regions of India



	Min pH	Max pH	Avg pH	% sample>7.0 pH	Avg Hardness (PPM)
Andra Pradesh	6.9	8.4	7.9	92	390
Telangana	6.7	8.9	7.6	92	380
Chhattisgarh	7	8.2	7.7	100	540
Gujarat	7.2	8.2	7.8	100	0
Karnataka	7	7.9	7.5	100	380
Maharashtra	6.7	8.5	7.5	86	350
Odisha/WB	6.7	8.5	7.5	77	320
Tamil Nadu	7.3	8.9	7.7	100	750
Punjab/Haryana	6.9	8.7	7.7	92	350

(Source: Kemin Internal)

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Total dissolved solids (TDS)

- It is a measure of total inorganic ions/salts dissolved in water (especially calcium, magnesium & sodium)
- High level of TDS had detrimental effect on bid's health

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 to 2,999	These waters should be satisfactory for all classes of poultry. They may cause watery droppings (especially at higher levels) but should not affect health or performance.
3,000 to 4,999	These are poor waters for poultry, often causing watery droppings, increased mortality, and decreased growth.
5,000 to 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 to 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. National Academy of Sciences, Washington, DC

Mineral Contaminants

- Wide variety of minerals are present in water
- At low levels they are not harmful to the birds. But when present in high amount, will affect the performance
- Normally, water is checked for following minerals

S. No.	Minerals
1	Calcium
2	Magnesium
3	Sodium
4	Lead
5	Iron
6	Chloride
7	Sulfate
8	Zinc

Mineral Contaminants

Magnesium:

- Higher level cause laxative effect
- Maximum acceptable limit: 125mg/Lit
- If sulfate level is high, then even 50mg/Lit will affect performance

Nitrates & Nitrites:

- Presence of nitrates indicates decomposition of organic matter
- Nitrates are converted into nitrites in intestine by bacteria
- Nitrites bind with hemoglobin & reduce the oxygen carrying capacity of blood
- Maximum acceptable limit: Nitrates: 25mg/Lit
Nitrites: 4mg/Lit

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Mineral Contaminants

Chloride:

- Maximum acceptable limit: 250mg/Lit
- Levels as low as 14 mg/Lit can affect production if sodium levels are more than 50mg/Lit

Zinc:

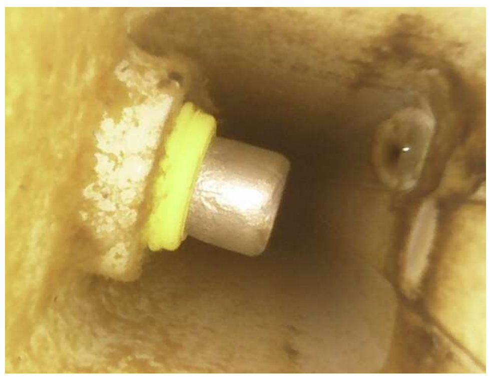
- Higher levels are toxic
- Maximum acceptable limit: 1.5mg/Lit

Iron:

- Common water quality problem in India
- Higher level produces bad odor & taste
- High concentration of iron favors bacterial growth
- Maximum acceptable limit: 0.3mg/Lit

How Does our water generally look like?

Microbial Load & Hardness



Biofilms in Drinking system

Higher pH

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IMPACT

- Digestibility Disturbances (Nutrient Absorption)
- Decreased Water Consumption
- Disrupt Mineral (Ca) Metabolism
- Failure of sanitization efficiency
- Immunosuppression
- Increased microbial load
- Biofilm formation

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Methods of Water Sanitization/ treatments

- Quaternary ammonium compounds
- Ultraviolet Rays
- Iodophors
- Ozonation
- Peracetic acid cleaners
- Hydrogen peroxide
- Chlorination/ Bromination (Usage of Halogen compounds)
- Organic acids

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Target water quality

Microbiological:

- Total Heterotrophic plate count: < 100 cfu/ml
- Total Coliform count: 0 cfu/ml
- Salmonella spp: negative

Physical quality:

- pH: 5 – 6.8
- Hardness: less than 180 ppm
- Iron< 0.3 ppm
- Temperature: 18°C -21°C (not less than 15°C and not higher than 30°C)

Water sanitation:

- Free chlorine: 2-5 ppm
- ORP: 650-750 mVolts

Quaternary Ammonium Compound (QAT)

Benefits

- Non-toxic
- Non-corrosive
- Relatively stable in the presence of organic matter
- Broad spectrum- effective in most bacteria, viruses & fungi including yeasts and molds
- Have residual antimicrobial activity

Disadvantages

- low hard-water tolerance

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Ultraviolet (UV) light

Benefits

- Effective against most bacteria & viruses
- Does not increase water TDS

Disadvantages

- Effectiveness reduces by turbidity
- Does not provide residual effect
- Less effect against certain viruses

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Iodophors

Benefits

- Broad spectrum of antimicrobial action
- Less irritating to the skin/mucus membrane as compared to chlorine
- Less corrosive than chlorine
- In the presence of organic matter sanitizing activity is better than chlorine

Disadvantages

- Adversely affected by water hardness
- Form foam

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Ozonation

Benefits

- Very effective bactericide, virucide and chemical oxidant
- React with iron and manganese making both more easily removable by filtration
- Not affected by pH

Disadvantages

- Point of contact sanitizer
- Dissipate rapidly providing no sanitizing residual activity in the water system.

Peracetic acid

Benefits

- Very powerful oxidizer (second to ozone)
- Removes biofilm at higher dosage
- Very Effective on viruses, bacteria, and fungi
- Does not increase water TDS

Disadvantages

- Corrosive to some metals (galvanized steel, brass, copper & steel)
- Strong pungent smell
- Safe handling must be followed

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Hydrogen Peroxide

Benefits

- Broad spectrum- effective in most bacteria, viruses & fungi
- Acts by oxidation
- Deals with biofilms

Disadvantages

- Corrosive
- Not stable in treated water
- Does not provide any lasting residual activity
- Deteriorates upon long standing
- Needs to add silver nitrate for stabilizing

Chlorination

Commonly used products are

- Bleaching powder/Chlorine dioxide gas
- Chlorine tablets (Sodium Dichloroisocyanurate or NaDCC)

Calcium Hypochlorite (Bleaching powder)

Benefits

- Acts by oxidizing
- Broad spectrum- effective in most bacteria, viruses & fungi
- Cheap
- Readily available

Disadvantages

- Corrosive
- Unstable & dissipates rapidly
- Toxic chlorine gas forms if pH drops below 4
- Irritant to mucus membrane
- Efficacy reduces in presence of organic matter

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Sodium Dichloroisocyanurate or NaDCC

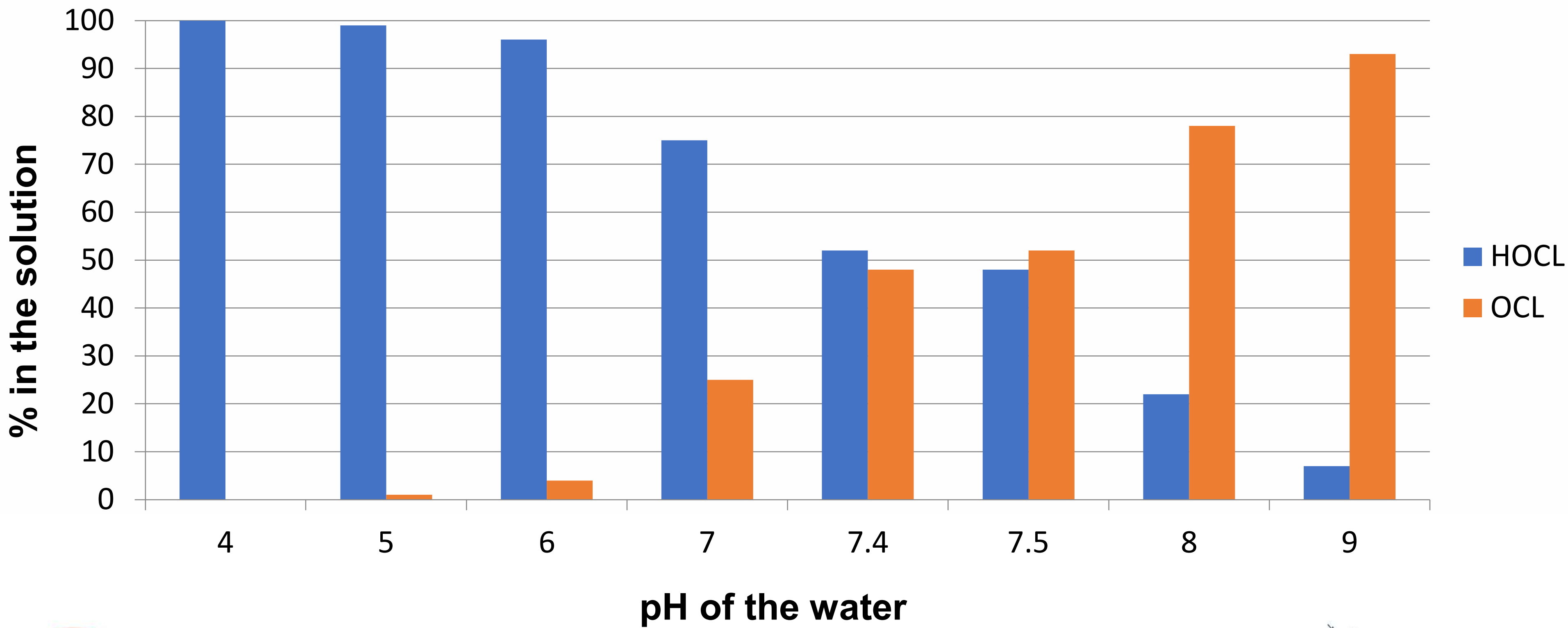
- Most commonly used water sanitizer used in poultry due to its cost effectiveness, easy in handling & application

- NaDCC Contains 64.5 % available chlorine

- Free chlorine is not effective unless it is 80-85% hypochlorous acid.

Amount of Hypochlorous acid (HOCl)& OCL in water depends on pH

Effect of pH on HOCl:OCl ratio



Ref: Effective Chlorination: Info Sheet. Hybrid- A Hendrix Genetics Company

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- The effectiveness of free chlorine is dependent of water pH
- The HOCL:OCL ratio determined by water pH
- Chlorine test detects both as free chlorine
- The general recommended level of free chlorine is 2 to 3 ppm in the end drinker

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Disinfection with MIXED chemicals

NaDCC & BCDMH (Bromochlorodimethylhydantoin)

Benefits

- Both effective individual
- Bromine enhances biocidal effect of NaDCC (essp. coliforms)
- Almost same effect along water lines
- Active in the presence of ammonia

Disadvantages

- No effect on water pH
- No effect on scale formation

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Why Organic Acids in Water

- Water is an essential nutrient, and birds consume more water than feed
- Open drinking-water systems are easily infected with bacteria by feed or manure. Water as a carrier for medicines, vaccines, or vitamin, residues are ideal growth medium for all kinds of micro-organisms
- Bacteria such as *E. coli*, and Salmonella may contaminate water from wells, header tanks, drinkers, and wild birds
- Fungi and algae may proliferate in the water system

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Importance of Acidification

- Reduces microbial load in drinking water
- Improves performance
- Improves feed Conversion ratio
- Improves weight gain
- Decreases mortality

Acidic Water	Alkaline Water
Naturally occurring acidic water is generally soft	Naturally occurring alkaline water has more hardness
Contains few amount of Calcium & Magnesium salts	contain large amounts of dissolved minerals
Development of germs is slow in water lines	They favor the development of bacteria in water lines

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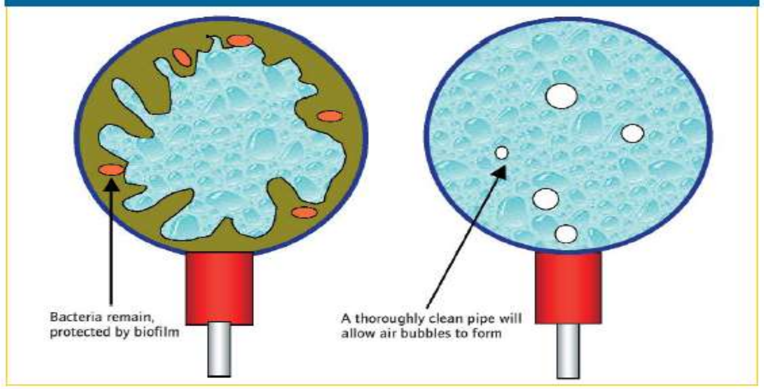
Biofilms

- Biofilms are composed of many types of bacteria and organisms that live together in a sticky film inside pipes, regulators and even nipple drinkers.
- Biofilm, shields itself by secreting a thick polysaccharide that is not easily penetrated by most sanitizers (like chlorine) or acidifiers.
- Mineral deposits like calcium build up and provides shelter for microbes
- This polysaccharide can even neutralize the sanitizers before it has a chance to kill harmful organisms.

Figure 1. Bacteria trapped in a biofilm will not be easily flushed out only using chlorine



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Purification & Sanitization

Iron Removal/reduce hardness if required	Reverse osmosis/water softner, Alum, chlorination
Reduce pH	Potent water acidifier
Proper sanitation	Potent water sanitizer or combination
Biofilm,bacteria, scales	Acidifiers/H 2O2

- Use good organic acid along with a good water sanitizer in drinking water regularly
- Flush the water lines at least once a week with pressure water
- It will help in keeping check on growth of germs
- It will reduce the chances of biofilm and hard water scale formation

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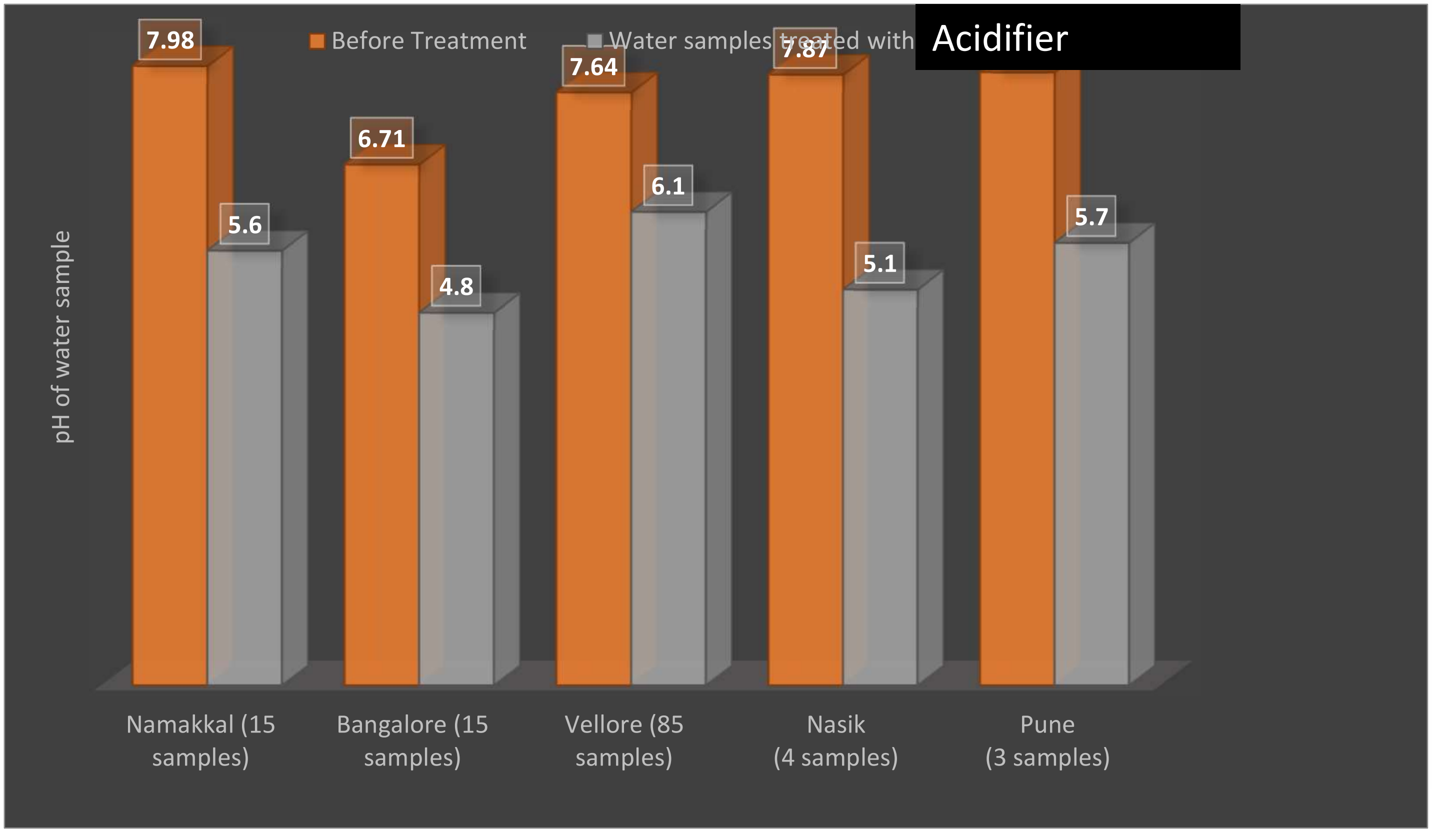
Effect on pH of water in different regions of India



Average initial pH : 7.62
Average final pH: 5.46
Average decrease: 2.16

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Endoscopic Camera Video Recording

Regular Flushing with H2O2

Before Usage of potent acidifier

After Usage of potent acidifier

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Proof of Performance

Potent acidifier has proven record in reducing the biofilm formation in prescribed dosage on daily basis.

Result:

- Better FCR
- Pathogenic bacterial count 3-4 log unit reduction
- Dirty eggs (0.5% onwards Reduction)

Potent acidifier has significantly reduced the mineral deposition at adverse conditions.

Result:

- Better eggshell quality
- Visible decrease in eggshell breakage
- Gradual increase Production %

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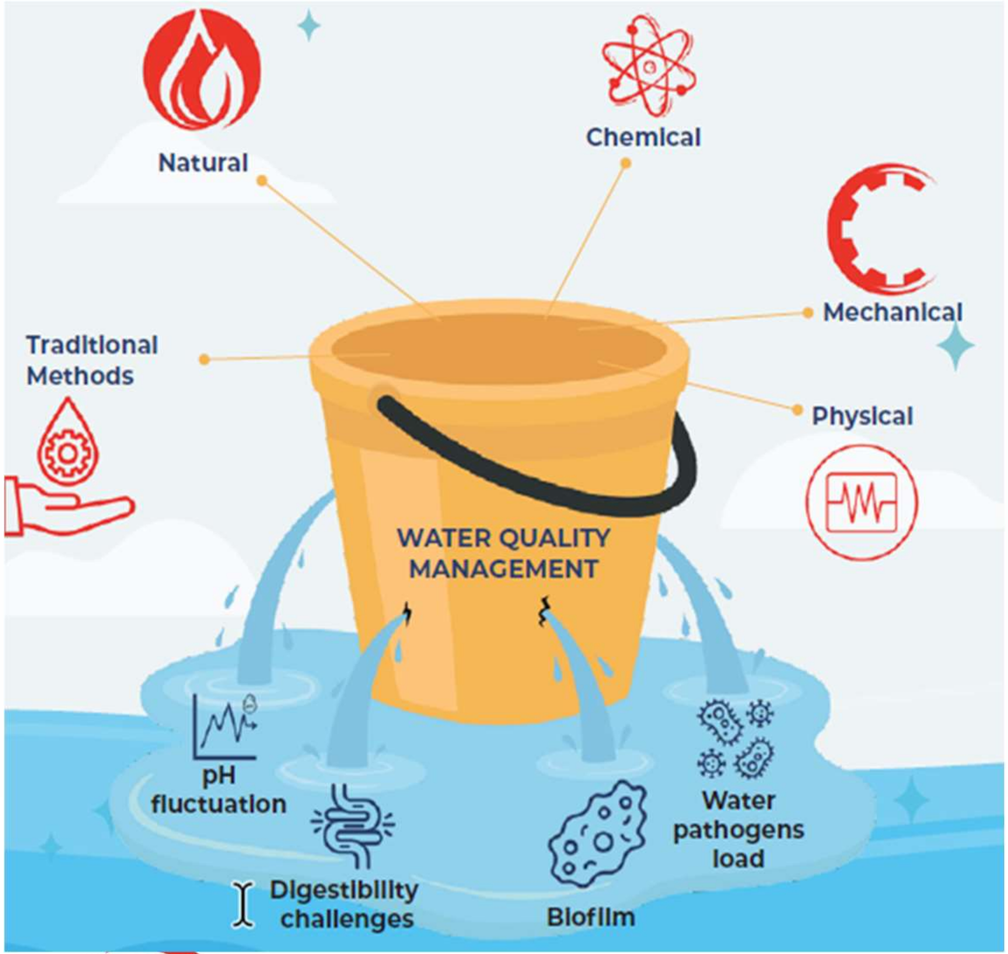
Leaky bucket of current Water Quality Management



Demands a solution to ensure

1.Consistent pH maintenance

2. Enhance digestibility – Better litter condition

3.Reduce microbial load

4.Addresses biofilm challenges

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Do’s and Don’ts of Water Management

DO’S	DON’TS
Clean the drinker twice a day	Do not store water more than one day in shed water tank
Maintain water tank under shade	Do not administer water in bent pipelines
Store water sanitizers in cool and dark places	Do not keep water sanitizers on the top of the tank
Daily check out for water sanitizers available in store (Quantity and quality)	Do not use multi source water to the birds

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Water Management In poultry

Always ensure min. 80% of water in the tank.

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Water Management In poultry

Flush the water line 2 to 3 times in summer.

Cover the exposed pipe lines with gunny cloth

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Water Hygiene

To provide cool water, clean the drinker frequently.

- Adjust the height of drinkers at a convenient level for birds
- Maintain water level up to brim, to make wattle & comb wet – reduces body temp.

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The goal of every poultry farmers should be to provide the birds with best water supply possible

- Is daily cleaning of poultry drinking water systems done properly?
- Is our daily water sanitation program sufficient?
- Reasons for water contamination?
- Why biofilm form easily?
- Often, we use vitamins and other water additives in water lines that helps a biofilm to become established in the pipes within as little as two to three days.

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Good water management program ensures

SUPPORTS

Optimum and sustained pH Maintenance

Restricts biofilm formation

Reduces proliferation of microbes like *E.coli*, *Salmonella Spp.*

Reduces microbial load in Gut

Enhance water sanitization efficiency

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Summary

- Water is the most essential nutrient birds receive, yet the quality of bird drinking water is often overlooked
- Providing flocks with a clean water will make a difference in performance
- Bacteriology (MPN) gives idea about level of bacterial contamination
- In case of any flock health issues, check the bacterial load in water
- Select the right sanitizer & cleaning procedure for efficient cleaning of water lines & water sanitization

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THANK YOU

KEMIN
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