



PARTNERS **IN**
PROGRESS

Water hygiene in poultry farms

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What we will talk about

- Some facts about water in general
- Waterborne diseases & symptoms related to water quality
- Standard water quality for poultry
- Water sampling
- Water treatment methods
- Take home messages

Some general facts about water which are good to know

Water..

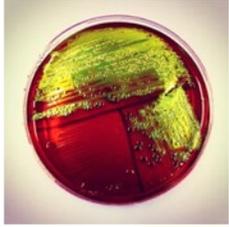
- is the main solvent involved in metabolic processes
- represents 50-70% of the adult live weight
- systems are the perfect host for many type of bacteria, viruses, and fungi
- The poultry house environment especially in the brooding period is considered a good environment for many pathogens to grow.

Water hygiene is important for animal health

- Water hygiene is an essential part of biosecurity and ABF and ABR programs
- Understanding the basics of water quality and water hygiene is crucial for poultry farm workers
- Color, taste, and odor are the main indications for the quality of water

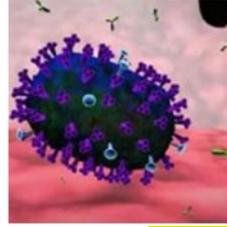


Diseases can be transmitted via water



Bacterial

- CRD
- Colibacillosis
- Avian Cholera
- Fowl Typhoid



Viral

- NCD
- IB
- Marek's Disease
- Avian Encephalomyelitis
- Gumboro



Protozoal

- Histomoniasis
- Coccidiosis

Water quality issues can cause symptoms

- **Potassium** > 300mg/l ⇒ Diarrhea
- **Nitrite** >1mg/l ⇒ Lower oxygen intake, reduced fertility, blueish comb, lobes, and head.
- **Nitrate** >200mg/l ⇒ Respiratory problem
- **Sodium** >200 mg/l ⇒ Cerebral symptoms, wryneck, and lameness
- **Sulfide** >250 ml/l under the influence of bacteria ⇒ Smell of rotten eggs



Chemical and biological characteristics



Water must meet certain chemical requirements

	Level considered Average (ppm)	Maximum Values (ppm)	Remarks
pH	6-7.8	8	pH below 3.8 could decrease water intake > 8 unsatisfactory for poultry
Calcium	60	600	above 110 mg/l may require water softener, polyphosphates or acidifier to prevent scale build up
Chloride	50	150	When combined with high Sodium creates salty water. Which act as a laxative and causing feed passage
Iron	0.2	0.3	<ul style="list-style-type: none"> ➤ Cause leaking drinkers ➤ Promote growth of E.coli and Pseudomonas and has been linked to botulism
Zinc		1.5	Higher level are toxic
Nitrite		4	
Nitrate	1-5 mg/l	25	<ul style="list-style-type: none"> • Level of 3 to 20 ppm may affect performance • Can be indication for fecal contamination
Sodium		50	>50 may affect performance
Manganese	.01 mg/l	.05 mg/l	Can result in black grainy residue on filters and in drinkers
Lead	0 mg/1	.014 mg/l	Long term exposure can cause weak bones and fertility problems in breeders and turkeys.

Water must meet certain biological requirements

Parameters	Recommendation		
Total Germs			
TBC CFU/ml	<1000		
at 22°C at 37°C	<100 (in 1 ml) <10 (in 1 ml)	Yeast	<1000 CFU/ml
Total Coliforms	0 (in 100ml)	Mold	<100 CFU/ml
Fecal E. Col	0 (in 100ml)		
Intestinal enterococci	0 (in 100ml)		
Sulphatic-reducing bacteria	0 (in 20 ml)		

Chemical treatment and water filtration can eliminate bacterial growth

What happens if the pH is not adequate?

pH > 8

- Decreased solubility of some antibiotics
- Inhibition of vaccines
- Increased proliferation of gram-negative bacteria
- Lower effectiveness of chlorination

pH < 5

- Urinary or digestive disorders
- Weakening of the skeleton
- Decreased solubility of some acidic antibiotics
- Corrosion



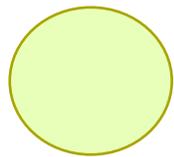
Total dissolved solids (TDS)

- a measure of anything dissolved in water that is not an H₂O molecule
- Calcium, Chloride, Magnesium, Potassium, Zinc, Aluminum, Copper, Lead, Arsenic, Iron, Chlorine, Sodium, Fluoride, Bicarbonates, Sulfates, Pesticides, and Herbicides.

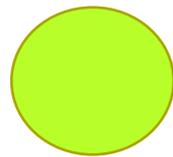
<1000	Acceptable
1000-2999	May cause drop in weight gain and death in broiler in upper limit
3000-4999	Poor water, often causes watery droppings, increased mortality and decreased growth
5000-7000	Unacceptable for poultry

Hardness stands for the mineral content of water

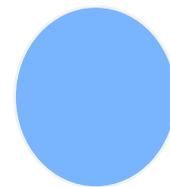
- The amount of calcium and magnesium salts in water, generally in the form of bicarbonates, chlorides, and sulphates
- Hardness causes scale which can reduce pipe volume and cause drinkers to be hard to trigger or leak



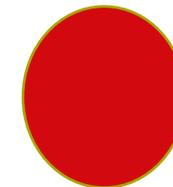
Soft
<60 ppm



Moderately hard
60-120 ppm



Hard
120-180 ppm



Very Hard
>180 ppm

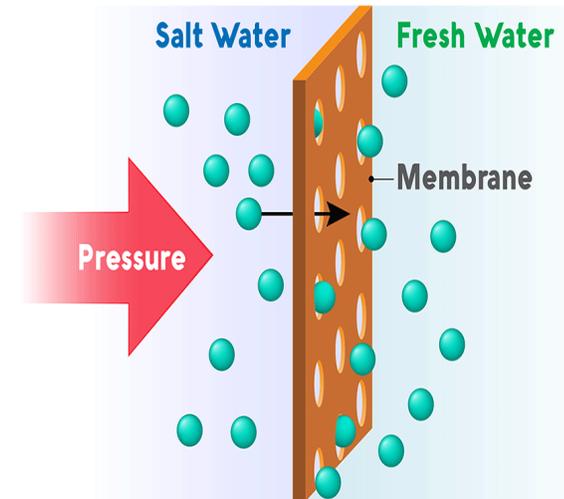
Reverse osmosis Unit

- Most effective water filtration method
- Fluoride? **Yes.**
- Salt? **Yes.**
- Sediment? **Yes.**
- Chlorine? **Yes.**
- Arsenic? **Yes.**
- Volatile organic compounds? **Yes.**
- Herbicides and pesticides? **Yes.**
- Many other contaminants? **Yes.**
- Virus and Bacteria: **No**



pH, Hardness , TDS, & Pathogenic bacteria

Reverse Osmosis



Water Sampling techniques

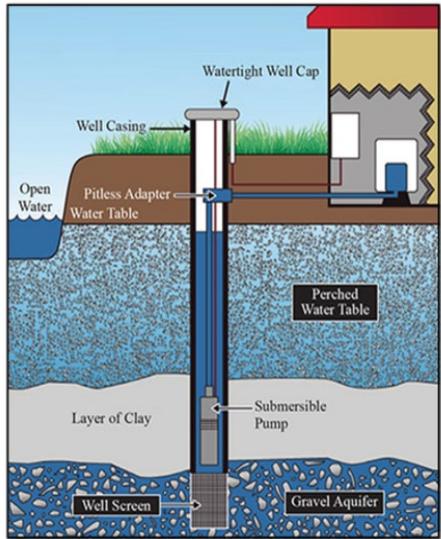


When to do a test ?

- Installation of new resources, such as drilling a new well for groundwater
- Noticeable changes in odor, color, or taste of water
- Noticeably decreased water consumption by flock
- Following maintenance of water supply system
- Animals become sick with waterborne disease.
- Poorly performing flocks, poor water quality might be to blame
- **Follow your lab instruction and procedure(amount, site of samples, etc.)**

Correct sample procedure is crucial to achieve a correct results

Identify the source of contamination



1. Water well



2. Water Pool



3. Water tank



4. Nipple line

Check water quality – taking samples from the drinking nipple



Cleaning the tweezers.



Check water quality - take bacterial swabs from the water pipes



Butterfield's Phosphate Diluent (BPD)



Cleaning the tweezers



Removing the sponge



Inserting the sponge



Swabbing water lines can be done for any type of line, but just make sure to remove any parts that will prevent you from getting the sponge into the true waterline



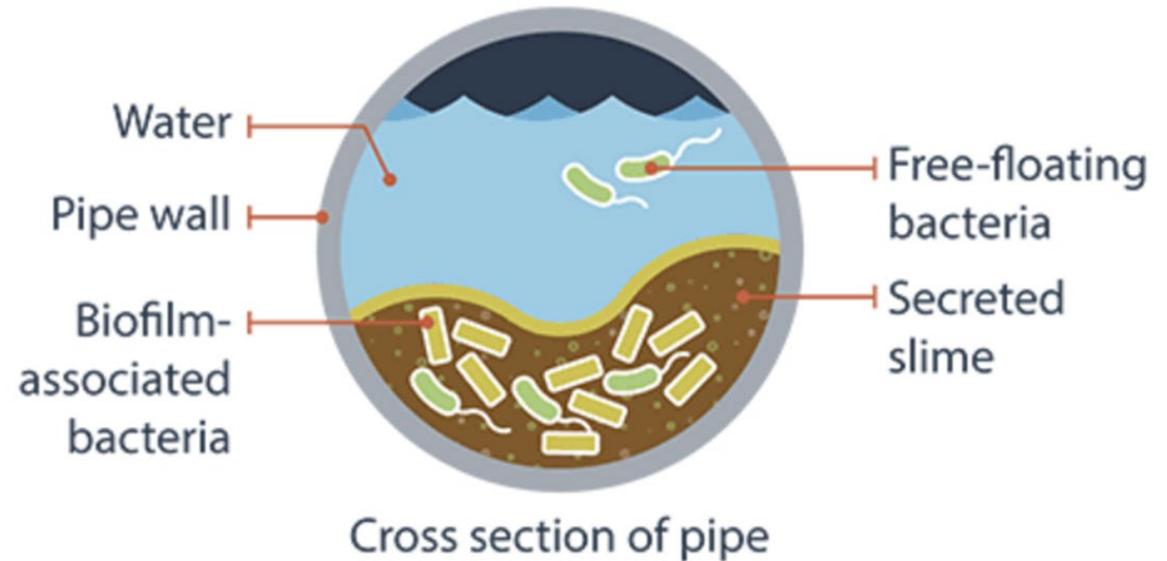
Taking the sample

Water treatment



Organic acids reduce the formation of biofilm

- Some bacteria excrete a slimy substance
 - ⇒ to adhere to the surface
 - ⇒ to be protected against chemicals
- Over time, other bacteria and organic and inorganic materials can become trapped in the slime, creating the biofilm.
- Biofilms will continue to shed bacteria, including pathogens, into the water
 - ⇒ contaminated water
 - ⇒ poor flock to flock performance



Acidification of drinking water reduces bacterial proliferation and limescale build-up in the drinker lines, and, therefore, biofilm formation.

Products to improve water quality

Agent	Recommended concentration	Advantages	Disadvantage
Chlorine	0.5-3.0 ppm, depending on the pH of the water	Easy handling, effective disinfectant, low cost	Inactivated by organic material; unstable if stored incorrectly
Hydrogen peroxide	30-50 ppm	Broad spectrum, not sensitive to different pH, very good action against biofilm	High cost, corrodes metal parts, is inactivated by organic matter
Organic acids	Titration to reach the target level of pH	<ul style="list-style-type: none">• Reducing pH▪ Inhibiting the growth of bacteria, yeasts, and molds▪ Act in the upper GIT	<3.5 could be corrosive to the water equipment and might decreased water consumption

Water chlorination acts against microorganisms

- **Strong oxidative agent**

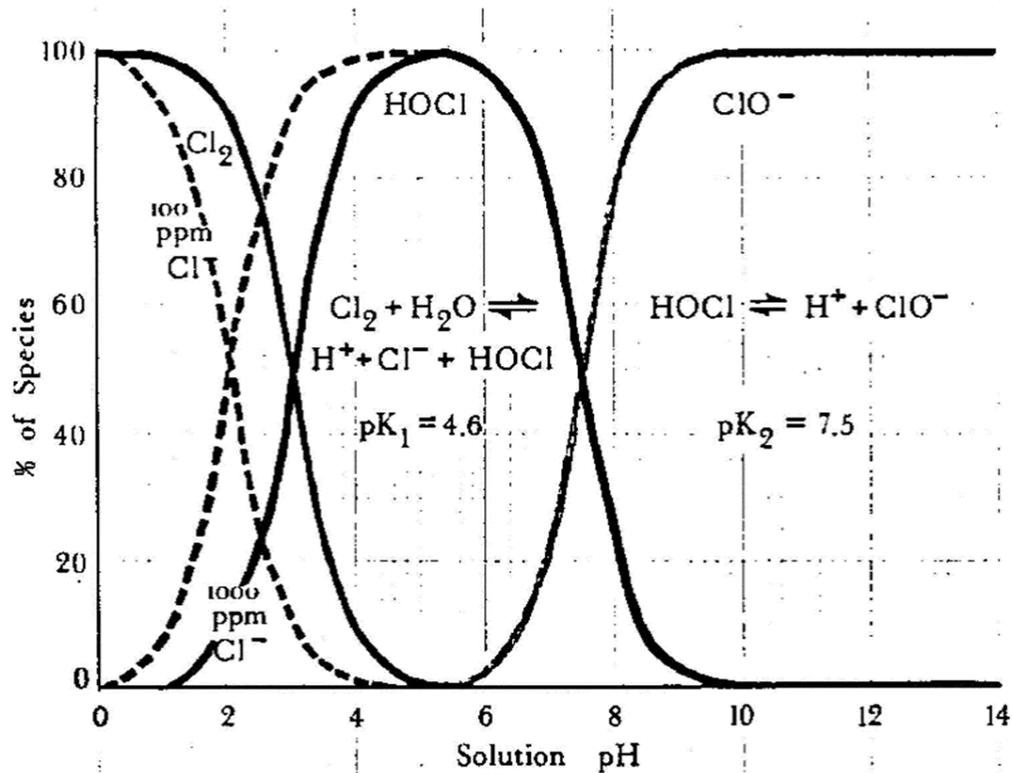
Altering the chemical structure and disrupting the integrity and normal function of the cell

- Most common form is sodium hypochlorite (NaOCl)
- Prevents or minimizes the formation of biofilm
- Reduces the spread of infection agents through the contaminated water in the drinkers
- Very effective against gram+ and gram- bacteria, enveloped and non-enveloped viruses, mycoplasmas and protozoa

pH is important in water chlorination

- pH plays important rule in the effectiveness of water chlorination
- Hypochlorous acid production is directly affected by pH
- $\text{Cl}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}^+ + \text{Cl}^- + \text{HOCl}$
- Chlorine free concentration: 0.1-0.5 ppm
- Almost 100% of chlorine was converted to HOCL at pH 5

pH influences the dissociation of hypochlorous acid



Percent Fraction of Chlorine, Hypochlorous Acid, and Hypochlorite vs. Solution pH

Percentage of hypochlorous acid(HOCL) and hypochlorite ion(OCL) at certain pH values		
PH	% as HOCL	% as OCL
8.5	10	90
8	21	79
7.5	48	52
7	72	28
6.5	90	10
6	96	4
5	100	0

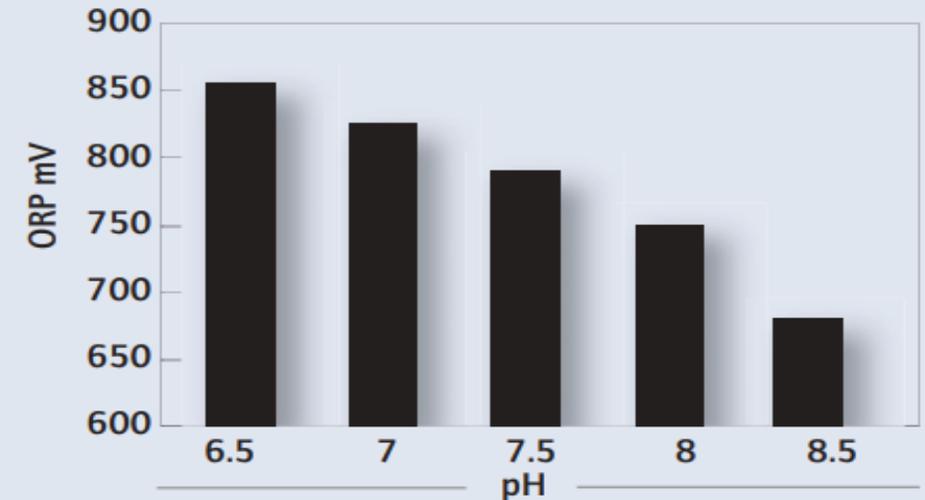
World Poultry, Vol. 21 No 5, 2005

ORP value (Reduction oxidation potential)

- Activity of chlorine is measured by the Oxygen Reduction Potential (ORP, oxidation level in water, millivolts - mV)
- ROP Value at 650 mV can kill most of bacteria and virus in seconds.
- 700-750 mV is recommended for poultry water.
- Above this value, less chlorine is needed, below this value more chlorine is needed.
- Using Acidifiers to decrease the pH of water for optimum ROP value.



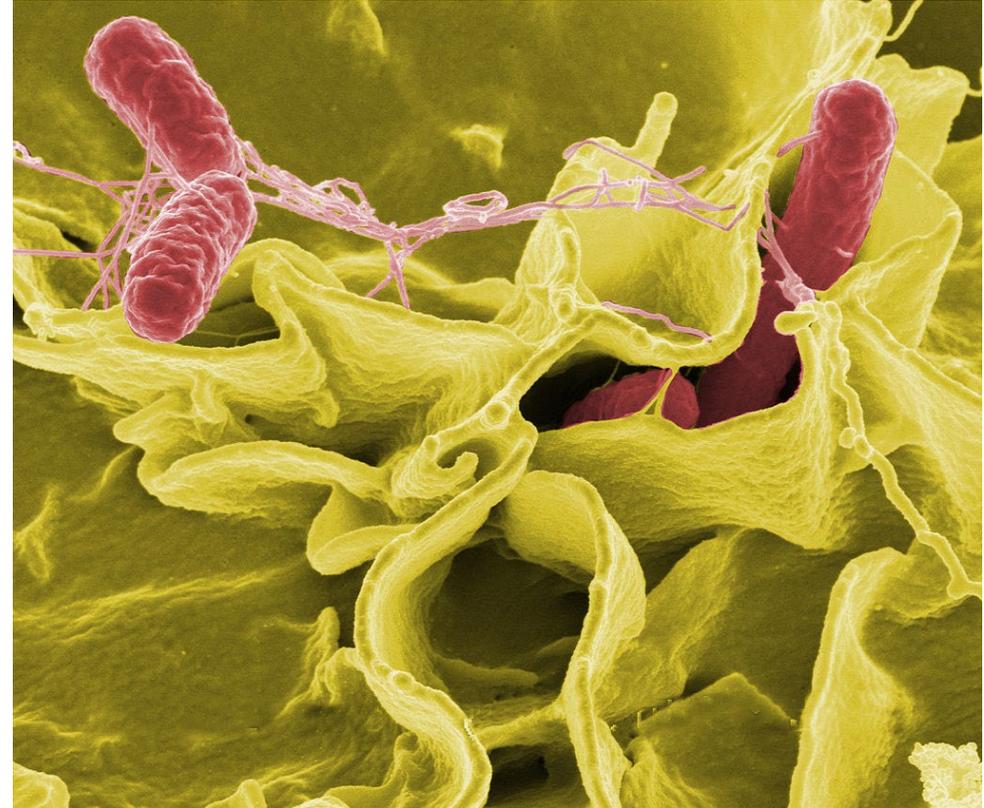
Figure 2 - The ORP values in water with 2 ppm free chlorine at a pH range of 6.5 to 8.5



Note that as the pH decreases, the ORP value increases

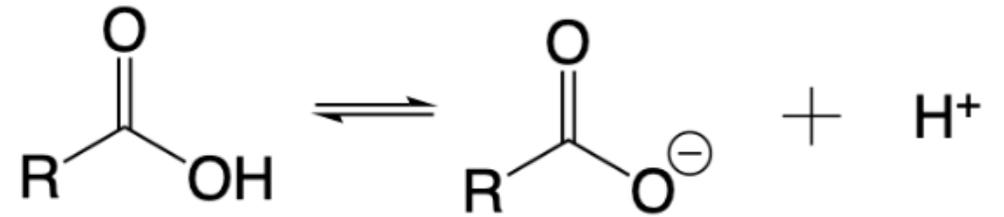
Organic acids - how does water acidification help?

1. Acidification reduces bacterial proliferation
⇒ **antimicrobial effect**
1. Prevents formation of limescale and biofilm in water lines
2. Promote nutrient digestion



pH determines the efficacy of organic acids

- Organic acids only have an antibacterial effect if they are undissociated and unloaded
- pH < 4.5: more undissociated acids (equilibrium goes to the left)
- pH > 4.5: more dissociated acids (equilibrium goes to the right)
- Most acids have no antibacterial effect at pH >5.0



Organic acids act against bacteria due to pH decrease

pH	E.Coli	Salmonella	Clostridium
6.4	++++	++++	++++
6.0	+++	+++	++++
5.8	++	++	++++
5.4	+	+	+++
5.0	-	+	++
4.5	-	-	+
4	-	-	-

The more "+" the better bacteria grows

Campylobacter and enterobacteria react on pH

Campylobacter and enterobacteriaceae numbers in and pH of drinking water provided to chickens

Groups ¹	pH	Day 13		pH	Day 15		pH	Day 19	
		Average numbers (log cfu/mL) ± SD			Average numbers (log cfu/mL) ± SD			Average numbers (log cfu/mL) ± SD	
		<i>Campylobacter</i>	<i>Enterobacteriaceae</i>		<i>Campylobacter</i>	<i>Enterobacteriaceae</i>		<i>Campylobacter</i>	<i>Enterobacteriaceae</i>
1	6.68 ± 0.20	NF ³	6.12 ± 0.86**	6.66 ± 0.20	0.58 ± 0.80	8.38 ± 0.75**	4.78 ± 0.90	1.22 ± 1.74	7.37 ± 0.58**
2	6.71 ± 0.11	2.16 ± 2.06*	7.67 ± 1.01	6.68 ± 0.09	2.24 ± 0.72**	5.63 ± 3.16	5.32 ± 0.80	2.64 ± 2.15*	8.45 ± 1.02
3	3.86 ± 0.06	NF	0.48 ± 1.06**	3.87 ± 0.15	NF	2.01 ± 2.79**	3.84 ± 0.06	NF	1.76 ± 1.77**
4	3.89 ± 0.08	NF*	1.85 ± 1.95	3.83 ± 0.03	NF**	4.16 ± 0.65	3.94 ± 0.33	NF*	1.95 ± 1.46

¹Group 1 = ordinary drinking water and chickens inoculated with 10³ cfu/mL of *Campylobacter*; group 2 = ordinary drinking water and chickens inoculated with 10⁵ cfu/mL of *Campylobacter*; group 3 = acidified drinking water and chickens inoculated with 10³ cfu/mL of *Campylobacter*; group 4 = acidified drinking water and chickens inoculated with 10⁵ cfu/mL of *Campylobacter*.

²Mean of pH measurement of individual drinking water ± SD.

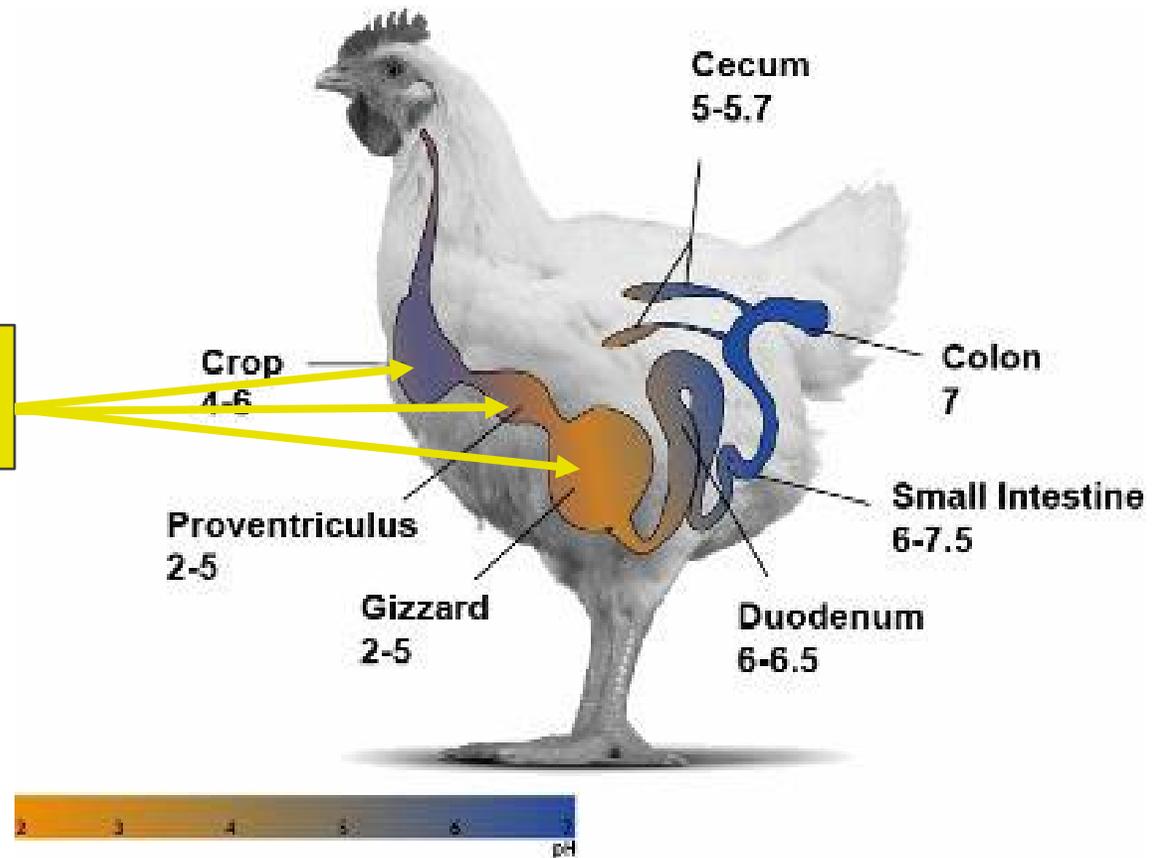
³NF = not found (0 was representative for statistical comparison).

*Significant difference at $P < 0.05$.

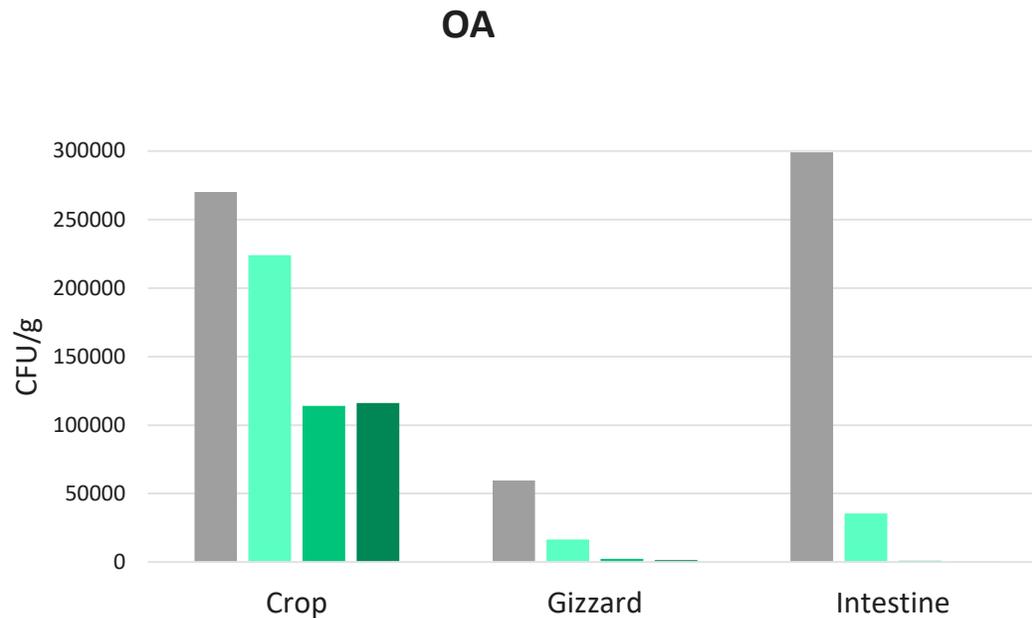
**Significant difference at $P < 0.01$.

OA action in upper gut

Sites OA Blend action to control harmful pathogens and establish preferred gut microbial colonization



Effective pathogen control in the upper gut works to establish an improved microbial environment in the lower gut resulting in improved flock performance

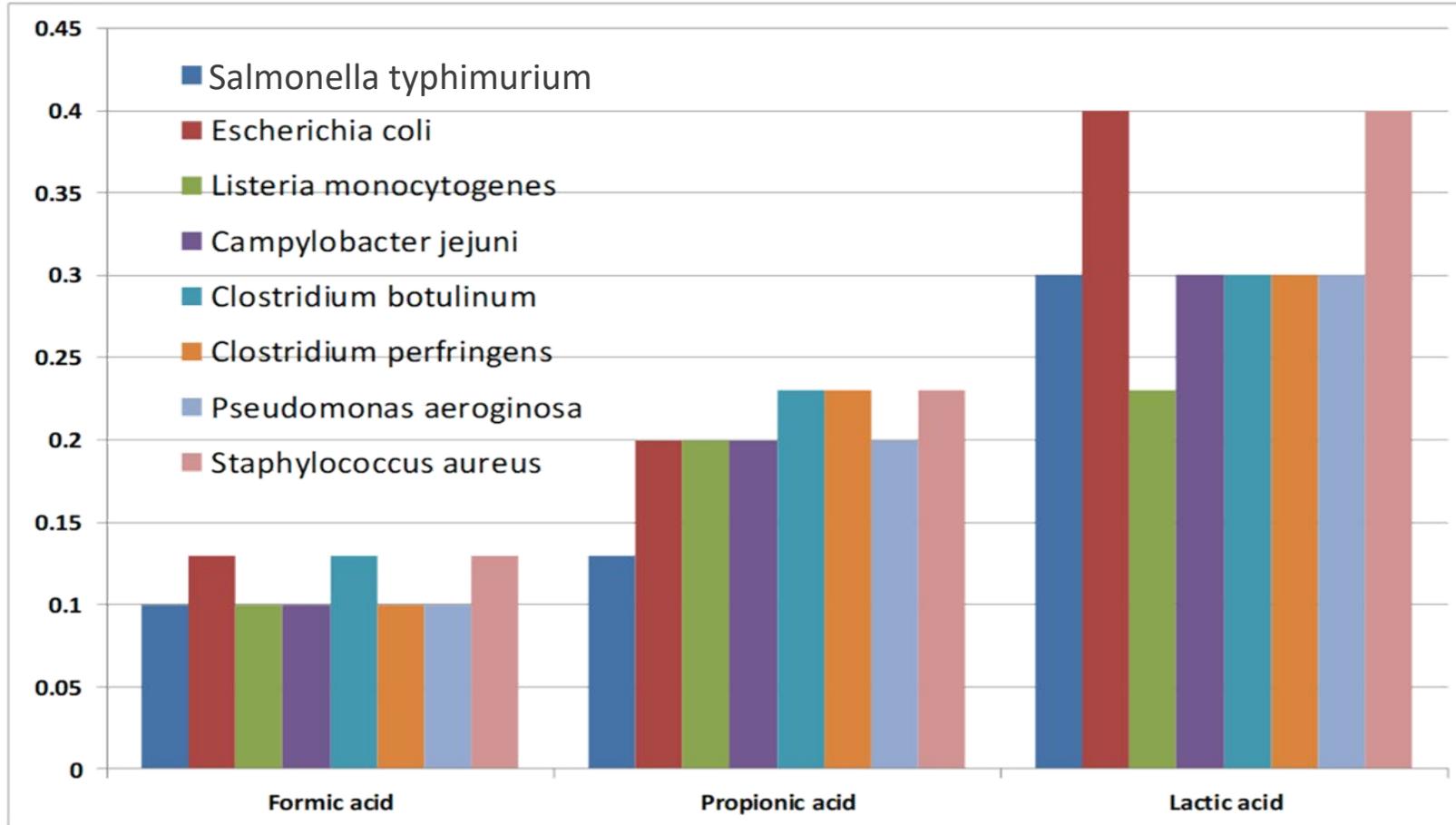


■ Acidomix AFL Control (0 ppm) ■ Acidomix AFL 1000 ppm ■ Acidomix AFL 2000 ppm ■ Acidomix AFL 3000 ppm

Limiting the bacterial population will improve:

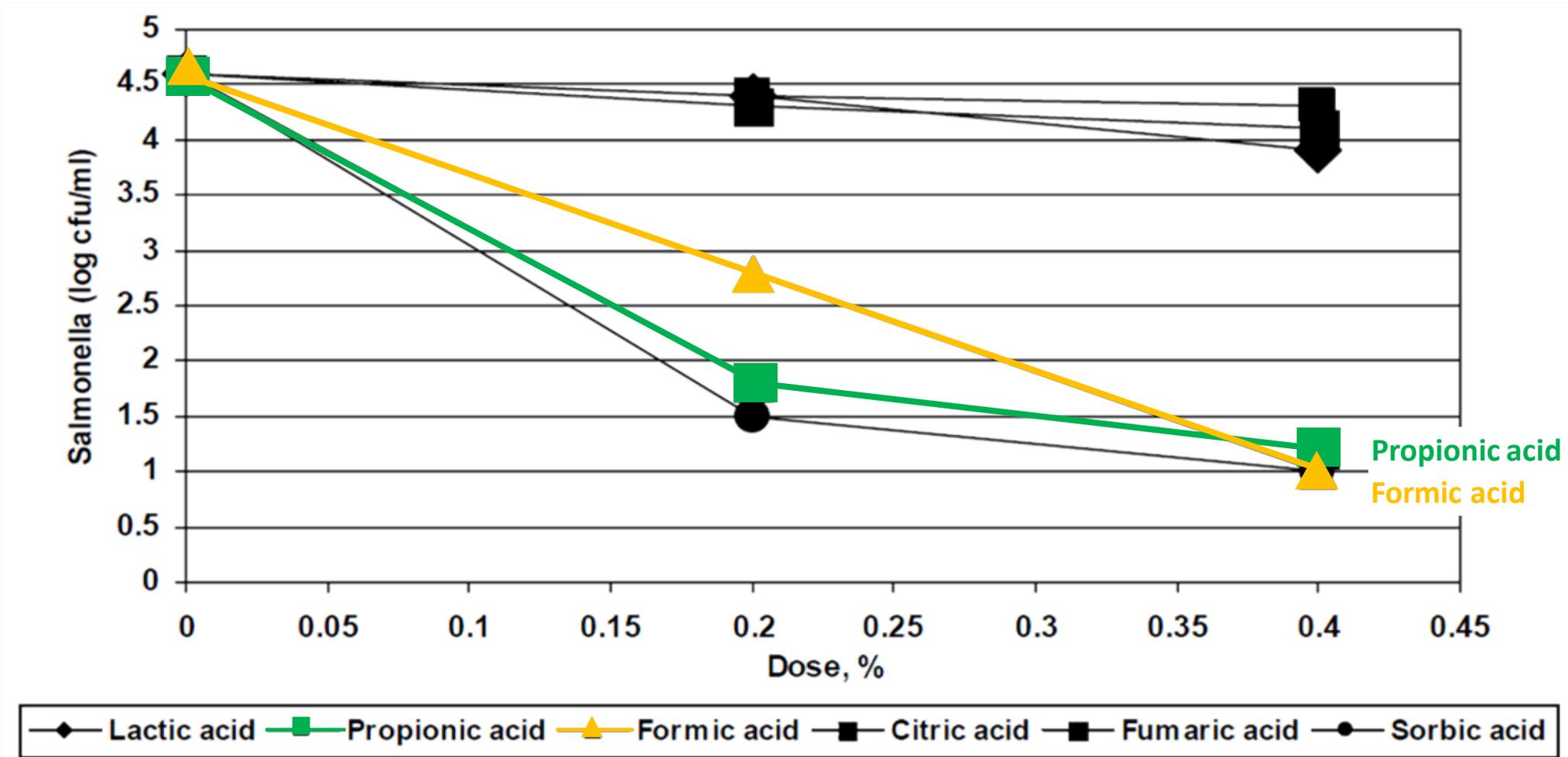
- The growth of Lactobacillus (competitive exclusion)
- Villi Height and crypt depth
- No harm effect on the digestive tract

MIC Value Organic Acids



Antimicrobial effect of formic, propionic and lactic acid against different bacteria (Strauss and Hayler, 2001)

Effective organic acids against Salmonella at pH 3.5



General rules in water Hygiene

Designing a water quality program

- Understanding the challenges of every farm
- Sample collection
- Monitoring of the bacterial, yeast, and molds load
- Monitoring the water pH
- Cleaning and disinfection of the water lines regularly
- Evaluate your program and strategy based on the outcome

THANK YOU!