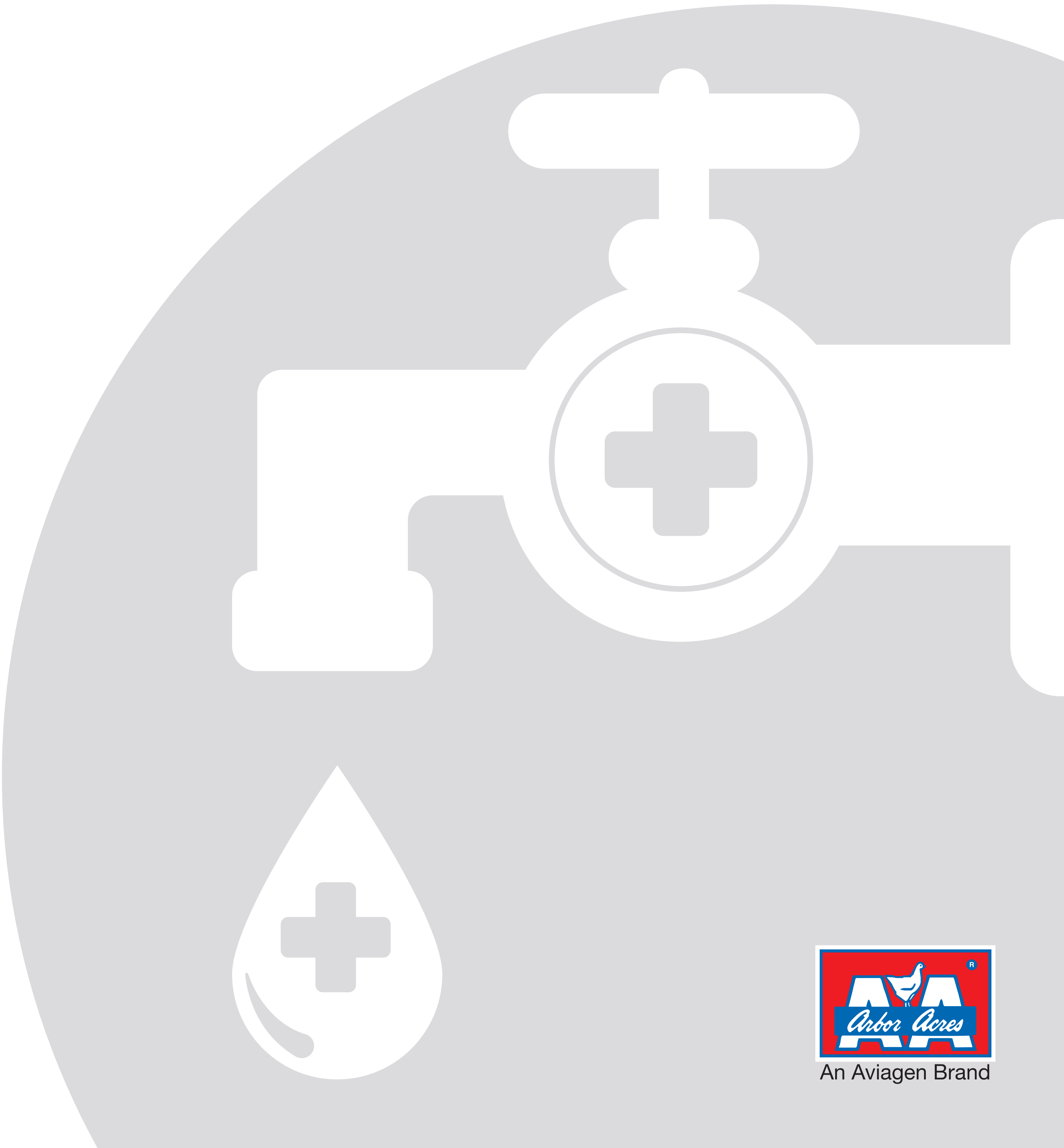
Best Practice
on the Farm

Alternative Water Disinfection Methods during Production



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Introduction

Sanitizers can protect water supplies from being vectors for disease challenges like cholera, E. coli, staphylococcus, and Salmonella. While chlorine is widely used because it is effective, easy to monitor, inexpensive, easy to use and widely available, it is not always the best choice due to various factors such as water pH, organic matter present, water storage time, or local legislation. Knowing and understanding the available alternatives for disinfecting drinking water supplies can prepare poultry managers to make sound decisions on what tools best fit their operations.

Best Practice for using Alternative Water Disinfection Methods during Production

1 **Use sanitizing products to treat the water while birds are in production.** There are options to successfully treat drinking water; the key is to find what works best for the flock, complements the water quality and is compliant with legislation.

2 **A good water sanitation program:**

- Uses products that are easily accessible and economical.
- Allows for easy testing and monitoring.
- Offers several options for application.
- Promotes good flock health.

3 **While chlorination is a common method used for water sanitation in many countries, local legislation may prevent its use in others.** Options such as chlorine dioxide, hydrogen peroxide, peracetic acid, ultraviolet (UV) light, and ozone are effective if chlorination is not allowed.

Alternative Water Disinfection Methods

1

Chlorine dioxide (ClO_2)

Chlorine dioxide is a strong oxidizer that is effective against a wide range of bacteria, viruses and protozoal pathogens. Chlorine dioxide has two advantages over chlorine, including better efficacy at a higher pH (8 vs 6) and not creating taste and odor issues when organic matter is present in the water supply.

- Unlike chlorine, chlorine dioxide does not take part in addition or substitution reactions that result in chlorine atoms being added to organic material.
- Heat, exposure to UV light or sunlight, as well as water temperature or low pH can reduce its efficacy, taking approximately twice as much chlorine dioxide as chlorine for the same oxidation benefit.
- The most common system available for poultry production is an acid-chlorite generator that can give a maximum 80% efficiency yield of chlorine dioxide.
  - This system can have a slow reaction time, as well as a lower pH that may affect the reaction efficiency.
  - If the pH is <3 in the reaction chamber, there will be an excess of chlorate ions formed which are not beneficial for disinfection.
  - The formation of chlorine dioxide is best managed in a sealed container.
  - A pre-generated solution of up to 1% chlorine dioxide can be safely stored and used as a disinfectant as long as it is protected from sunlight.
- Typical disinfectant dosages of chlorine dioxide in drinking water range from 0.8 to 2.0 mg/l or ppm with the desired measurable residual in the 0.07 to 1.4 ppm range at the end of the drinking line. Higher levels are discouraged due to the increased risk of the byproducts chlorite and chlorate.

1

An in-line chamber provides improved reaction time for chlorine dioxide.

2

Hydrogen peroxide (H_2O_2)
Hydrogen peroxide is a strong oxidizer that is readily soluble in water and breaks down into water and oxygen, leaving no harmful byproducts. While not as effective as chlorine in oxidizing iron and manganese, it is often used for oxidizing sulfides and sulfites prior to filtration.

- The effectiveness of hydrogen peroxide depends on several factors, such as pH, catalyzers, temperature, peroxide concentration and reaction time.
- Target residual levels for drinking water are 25-75 ppm, but levels as high as 100 ppm have been reported with no negative effects on birds.
- Stabilized hydrogen peroxide products can provide active residual in water longer than chlorine or chlorine dioxide (days vs hours), and may be used during slow or low water flow periods such as brooding to maintain a sanitizing residual in the water.
- Advanced Oxidation Processes (AOP) involves combining hydrogen peroxide with ozone or UV lights to create an even more powerful sanitizer. However, optimizing effectiveness of AOP is similar to UV in that water flow must be appropriately matched to the system capacity.
- Hydrogen peroxide degrades when exposed to sunlight and should not be exposed.

2

A commonly used dosing pump can be used for the application of hydrogen peroxide.

3 **Peracetic acid ($CH_3H_4O_3$)**
Peracetic acid or peroxyacetic acid is a combination of hydrogen peroxide and acetic acid. It is a stronger oxidizer than chlorine or chlorine dioxide. It is effective against a wide range of bacteria, viruses and spore forms or organisms and is less affected by the presence of organic matter.

- Colorless, it has a strong, pungent odor and is typically available in concentrations of 5-15% with a pH ~ 2.8.
- It easily dissolves in water and breaks down into non-toxic products.
- It is more effective at a pH of 7 vs 8 and water temperature of 35°C vs 15°C (95°F vs 59°F).
- Peracetic acid can be monitored by hydrogen peroxide residual (25-50 ppm target) or by PAA residual (8-10 ppm target).

4 **Ultraviolet light (UV)**
Ultraviolet light inactivates microorganisms with light energy in the form of electromagnetic waves. Wavelengths between the 245 to 285 nm range provide an optimal germicidal effect. Since it is a physical process, it introduces no chemicals into the water.

- UV lamps range from:
  - Low-pressure lamps that emit in the 253 nm wavelength.
  - Median-pressure lamps that emit wavelengths from 180-1370 nm.
  - High intensity wavelength lamps that pulse.
- A power supply is required to operate the UV lamp.

4

UV lights can be used to disinfect water. Due to a lack in residual effect, UV treatment is often paired with other water disinfection methods.

4
- Effective dose is correlated to exposure time and light intensity, with optimal effectiveness best achieved by maintaining a consistent water flow through the reactor, and generating turbulence in the water to create uniform exposure.
- While effective against bacteria and viruses, UV does not work well against large protozoa like Giardia.
- Efficacy is not affected by water temperature, pH alkalinity or total carbon.
- As UV lamps age, their output will diminish. Tubes will need to be replaced on an annual basis.
- UV waves must be absorbed by the cell for inactivation to occur, and effectiveness is significantly limited by:
  - Suspended solids or turbidity that block the waves from reaching the organisms.
  - Minerals like iron, hydrogen sulfide or organic matter.
  - Scale build-up or chemical films on the UV lamp surface.
- Since UV provides no residual disinfectant it is often combined with a chemical sanitizer to provide residual in the drinking water. Ozone or hydrogen peroxide enhance the effectiveness of UV.

5
Ozone (O_3)
Ozone a colorless gas, is a strong oxidizer that reacts rapidly to inactivate microorganisms and oxidize iron, manganese, sulfides and nitrites. While it is more reactive than chlorine, it's half-life of 10-30 minutes, or less, when the pH is >8, means it must be generated on-site.

- Ozone decomposes spontaneously into oxygen (O2) and OH- and creates no harmful disinfectant byproducts.
- It is effective in controlling taste and odor issues associated with surface water supplies with a high organic load, such as algae.
- Because ozone does not maintain a disinfecting residual in the water, it is highly recommended that water be filtered post-treatment, to remove nutrients released into the water and a secondary disinfectant added.
- Ozone systems require electricity. To generate ozone, air is pumped across two separated electrodes that have a voltage applied. When ambient air is used instead of a purified oxygen source, the process generates 1-3.5% ozone by weight. This is adequate to dissolve enough ozone for an effective concentration–contact time. It is critical that the air stream is filtered to remove contaminants and is dehumidified to prevent damage to the reactor.

Notes:

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