WATER QUALITY FOR BREEDERS AND BROILERS

Water is an integral part of many biological processes. Its quality is critical as it represents between 50-70% of the live weight of an adult bird and its consumption may typically be 2 to 2.5 times higher than the consumption of feed. In addition to being the main component of the body, it is a solvent that is fundamental to many metabolic processes.
Even if it is regarded as an inorganic medium, water can be the source of transmission of microbes (viruses, bacteria), fungi, parasites and pollutants (heavy metals, pesticides, etc.).

FROM THE SOURCE TO THE ENTRANCE OF THE BUILDING

Before applying any water treatment, good water quality starts with knowing its chemical and biological characteristics. Choosing a water source needs planning, and considering the potential contaminants: slope, type of soil, depth, presence of septic tanks, etc. It is also important to have control measures for the supply of water from a public network.

There are two types of potability criteria: physicochemical and bacteriological. The table below shows the main water quality indicators to be analysed and their limits for the classification of potability.

CRITERIA FOR POTABILITY BEFORE ADMISSION INTO THE FARM				
PHYSICOCHEMICAL		BACTERIOLOGICAL		
INDICATOR	VALUES		PARAMETERS	RECOMMENDATIONS
pH	5.5-6.5	Total Flora	Total Germs at 22°C	< 100 (in 1 ml)
Hardness	100 to 150 ppm $CaCO_3$			
Iron	< 0.2 mg/l		Total Germs at 37°C	< 10 (in 1 ml)
Manganese	< 0.05 mg/l	Indicator Flora (faecal germs)	Total Coliforms	0 (in 100 ml)
Nitrates	< 50 mg/l		Faecal E. Coli	0 (in 100 ml)
Nitrites	< 0.1 mg/l		Intestinal enterococci	0 (in 100 ml)
Ammonium	< 0.5 mg/l		Sulphite-reducing bacteria	0 (in 20 ml)
Organic material	< 2 mg O_2/l			

Variation between recommended and actual values need to be addressed as these can have consequences on:

- corrosion and fouling of the materials used;
- the effectiveness of the products prescribed for animals (inactivation);
- the performance of animals (chemical or bacteriological pollution).

To avoid any variation, control to monitor water quality must take place over a defined period according to local regulations and corrective actions must be implemented as soon as an anomaly is detected.

The first corrective step is to implement simple filtration to remove any organic matter. The second step will consist of the installation of systems for removal of iron and manganese, water softening systems, activated carbon or water acidification. (see an example of a water treatment system on the right). This will, among other effects, optimise the action of water treatments such disinfectants used afterwards.


Example of a water treatment system

The French research institute ITAVI has listed the possible consequences should water components not meet the water quality standards. The table is adapted from “Eau de boisson en élevage avicole, un levier majeur de réussite”.

UNDESIRED EFFECTS IN CASE COMPONENTS DO NOT MEET WATER QUALITY STANDARDS *The acceptable concentrations for each component are shown at the top of each section and consequences are shown below.*
pH: 5.5 < pH < 6.5
Higher values (> 8)
Decreased solubility of some antibiotics, inhibition of vaccines
Increased proliferation of gram-negative bacteria
Lowering the effectiveness of chlorination
Lower values (< 5)
Urinary or digestive disorders, weakening of the skeleton
Decreased solubility of some acidic antibiotics
Corrosion
Hardness: 100 to 150 ppm $CaCO_3$
Higher degrees (> 200)
Lower absorption of trace elements
Decreased solubility of some antibiotics and vitamins
Creation of insoluble complexes between calcium, magnesium ions and active antibiotic molecules
Scaling of the equipment (lime deposit)
Detergent precipitation
Lower degrees (< 60)
Deficiencies in trace elements. Influence on the quality of the eggshell
Decreased solubility of sulphonamides
Corrosion
Heavy metal solubility
Iron: < 0.2 mg/l and Manganese: < 0.05 mg/l
Higher levels (Fe > 1 mg/l and/or Mn > 0.15 mg/l)
Degradation of the appearance (colouring) and taste (inappetence) of water
Decreased effectiveness of chlorination
Development of micro-organisms on internal deposits in the water pipes
Risk of clogging in the water pipes
Nitrates: < 50 mg/l
Higher levels
Indicators of water resource contamination
Digestive disorders possible at very high concentration
Decreased efficiency of vaccines
Nitrites: < 0.1 mg/l
Higher levels
Often associated with high organic matter content
Promotion of biofilm development
Toxic at low concentrations
Ammonium: < 0.5 mg/l
Higher levels
Often associated with high organic matter content
Promotion of biofilm development
Decreased effectiveness of chlorination
Organic matter: < 2 mg O_2/l
Higher levels (MO > 5 mg O_2/l)
Investigate the origin of the contamination (surface water infiltration at the source, or biofilm development)

STORAGE OF WATER INSIDE THE BUILDING

Upon arrival at the farm, the containers used for storage of water must be suitable to preserve water quality.

To do this, it is important to observe a few basic rules:

- The tank must be tightly closed in order to avoid the entry of organic matter and protected from the sun to avoid heating of the water.
- Avoid stagnation of water in the tank.
- The tank(s) must be emptied, cleaned and sanitised during the empty period. Ideally, a disinfectant able to achieve this during the presence of animals is preferred (subject to local regulations).
- Avoid contact of other animals with water.

Once the storage is properly managed then any necessary treatments can be applied to the water.

Not correct

Correct

DISTRIBUTION NETWORK, EQUIPMENT AND MAINTENANCE

The cleanliness of the water supply circuit from the central tank on a farm to the water tanks in each building or to the drinkers is a key factor.

Flushing water circuits and drinker lines does help, especially after placement of chicks when the water flow is low and the ambient temperature of the building may be higher than during the production period. It is advisable to flush the water circuits at least once a day during the starter period, then at least once or twice a week to reduce the biofilm development.

Disinfection and maintenance of distribution circuits must be carried out during clean out periods. Beforehand, a cleaning protocol must be accurately followed to ensure a later proper disinfection of the water circuits without degrading the equipment. Thus, the circuit must initially be cleaned with a strong base product (high pH) to remove organic deposits, then rinsed with clear water under pressure (1-2 bar), if possible, to considerably remove the biofilm.

Dirty pipe

Clean pipe

Then, a strong acid or citric acid should be used to remove the mineral deposits often seen in case of hard water. A final rinse under pressure (1-2 bar) is necessary. Peroxides can also be used as an alternative to the base/acid protocol. In addition, mechanical cleaning systems by alternating air/water injection help the stripping of the pipes by a water hammer effect. Finally, the circuit – ideally dried beforehand for better results – may be disinfected with chlorine or another approved disinfectant, the pipes remaining in "disinfectant" should be rinsed shortly before the birds arrive. The quality of cleaning can be checked using an endoscope (see photos above).

Several models of drinkers are used in poultry houses. Bell drinkers, cups or nipple drinkers are the three types of drinkers commonly used and are very effective if they are properly maintained.


Bell drinkers


Cup drinkers


Nipple drinkers

Bell drinkers and cups allow water to accumulate. Therefore, regular cleaning of bell drinkers and cups is essential to avoid stagnation of water contaminated with organic matter and thus to reduce the risk of microbial growth. For bell drinkers it is important to also regularly check and clean the filter in each drinker.

DRINKING WATER DISINFECTION

Different products are available on the market for the treatment and disinfection of drinking water for poultry. The most common are based on hypochlorous acid, chlorine dioxide and hydrogen peroxide. Other, less widespread, methods are also used and can bring very good results. For example, online electrolysis, anolyte, peroxymonosulphates, etc.

<table>
<tr><th colspan="7">INTERACTION OF DISINFECTANTS WITH WATER
ACCORDING TO ITS CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS</th></tr>
<tr><th colspan="2"></th><th>Target</th><th>Chlorine</th><th>DCCNa*</th><th>Chlorine dioxide</th><th>Peroxide</th></tr>
<tr><td rowspan="7">Influence of chemistry:

+ Low influence

+++ High influence</td><td>pH</td><td>< 6.5</td><td>+++</td><td>++</td><td>+/-</td><td>0</td></tr>
<tr><td>Hardness</td><td>100 to 150 ppm $CaCO_3$</td><td>+</td><td>+</td><td>+/-</td><td>0</td></tr>
<tr><td>Mn</td><td>< 0.05 ppm</td><td rowspan="4">++</td><td rowspan="4">++</td><td rowspan="4">0</td><td rowspan="4">0</td></tr>
<tr><td>Fe</td><td>< 0.2 ppm</td></tr>
<tr><td>Br</td><td>< 0.01 ppm**</td></tr>
<tr><td>Nitrates</td><td>< 50 ppm</td></tr>
<tr><td>Organic material</td><td>< 2mg O_2/l</td><td>+++</td><td>++</td><td>+/-</td><td>+++</td></tr>
<tr><td rowspan="8">Disinfection efficacy:

+ Low efficacy

+++ High efficacy</td><td>Mesophilic Flora 22°C</td><td>< 100CFU/ml</td><td>+++</td><td>+++</td><td>+++</td><td>+++</td></tr>
<tr><td>Mesophilic Flora 37°C</td><td>< 10 CFU/100ml</td><td>+++</td><td>+++</td><td>+++</td><td>+++</td></tr>
<tr><td>Total coliforms 37°C</td><td>0</td><td>+++</td><td>+++</td><td>+++</td><td>+++</td></tr>
<tr><td>E. coli</td><td>0</td><td>+++</td><td>+++</td><td>+++</td><td>+++</td></tr>
<tr><td>Enterococci</td><td>0</td><td>+++</td><td>+++</td><td>+++</td><td>+++</td></tr>
<tr><td>Clostridium</td><td>0</td><td>++</td><td>++</td><td>+++</td><td>+++</td></tr>
<tr><td>Parasites</td><td>0</td><td>+</td><td>+</td><td>++</td><td>+++</td></tr>
<tr><td>Biofilm</td><td>N/A</td><td>+</td><td>+</td><td>+++</td><td>+++</td></tr>
</table>

** Sodium dichloroisocyanurate*
***Water quality standards for humans*

In addition to the interactions between water chemistry and the disinfectant, there are other factors to consider when making a choice for the best disinfection strategy. Price and ease of handling are often the first two factors that can influence the decision.

ADVANTAGES AND DISADVANTAGES OF EACH DISINFECTANT			
PRODUCT	RECOMMENDED CONCENTRATION	ADVANTAGES	DISADVANTAGES
Chlorine	Target: 1 ppm at the end of the pipe (Acceptable range = 0.5-3 ppm)	⇨ Easy handling ⇨ Good disinfectant quality ⇨ Low cost	⇨ Inactivated by organic matter ⇨ Unstable if stored incorrectly
Hydrogen Peroxide	30-50 ppm	⇨ Broad spectrum ⇨ Not sensitive to different pH ⇨ Very good action on biofilm	⇨ High cost ⇨ Corrosion of metal parts ⇨ Inactivated by organic matter
Chlorine Dioxide	Target 0.5 ppm at the end of the pipe (Acceptable range = 0.2-1 ppm)	⇨ Significant persistence ⇨ Does not react with ammonia ⇨ Destroys the biofilm and prevent its formation	⇨ High cost ⇨ Problems of interaction with certain antibiotics ⇨ Need specific equipment ⇨ Handling of dangerous products (strong acids/dichlor)

CHLORINE

Despite a growing supply of alternative water disinfectants, hypochlorite in many cases is the least expensive and is still the most widely used.

➨ CHEMICAL FORMS OF CHLORINE

Under normal conditions of temperature and pressure chlorine is in the form of the molecule of chlorine (Cl_2), a yellow-green gas 2.5 times denser than air. It can also be in liquid form (sodium hypochlorite) and solid form (calcium hypochlorite). Sodium hypochlorite is the easiest to use and the least expensive.

When dissolved in water it mainly forms hypochlorous acid: $Cl_2 + H_2O \leftrightarrows HOCl + HCl$. The latter is in equilibrium in water with hypochlorite, which essentially depends on the pH of the water: $HOCl \leftrightarrows H^+ + ClO^-$. As the disinfecting power of hypochlorous acid is 100 times greater than that of hypochlorite, controlling the pH is essential to ensure effective chlorine disinfection. In fact, the natural balance is as follows:

- ⇨ pH ≤ 5: no dissociation of HOCl;
- ⇨ neutral pH: HOCl dissociates and in pH > 7.5, 50% of the HOCl is converted into hypochlorite (ClO^-);
- ⇨ very basic pH (10): 100% of the chlorine is converted into the hypochlorite ion.

The goal is to ensure that hypochlorous acid (HOCl) does not dissociate and can act as a disinfectant in drinking water.

➨ MANAGING DISINFECTION WITH CHLORINE

Acid water is a necessary condition for effective disinfection with chlorine. The use of (organic or mineral) acids lowers the pH of basic water. Note that hard waters generally have a strong buffering capacity which implies the use of higher doses of acids to lower the pH. To ensure the optimal pH, it is necessary to measure it regularly.


1 ppm of chlorine at the end of the system

Check the amount of chlorine. The residual chlorine dose should be around 1 ppm at the end of the water line. This value shows that despite the activity of the product in the water line, it remains in the water. The presence of the disinfectant in an active dose at the end of the water line confirms its activity.

If the chlorine level at the end of the line is low, there are four main possibilities:

- ➭ The dose at the beginning of the water line is low;
- ➭ The biofilm present in the water system has consumed the chlorine;
- ➭ The chemistry is incompatible (high Fe and Mg, presence of organic matter);
- ➭ The chlorine has evaporated and the product is no longer effective;
- ➭ The water is too hot.


Redox and pH meter

The chlorine disinfection capacity can also be checked by measuring the Oxidation Reduction Potential (ORP) or Redox potential. Values higher than 600 mV indicate good efficacy of the chlorine in the water. Consider values higher than 450 mV with chlorine dioxide and 300 mV with peracetic acid or peroxide. For peroxide it is advisable to use test strips which will give a proper evaluation of actual levels as Redox is not the most adapted method.

In addition to chemical analyses to check chlorine levels, periodic bacteriological analyses are also essential. These will be able to assess the efficacy of the product on certain microbes and will allow the treatment programme to be adjusted if unacceptable concentrations of pathogens are present in the sample.

Water treatment is not an option, it is mandatory to ensure good quality drinking water for our animals, laying down a good foundation for their health, well-being and performance.

SUMMARY:

1. The evaluation of the water quality starts before it gets into the water system at the farm.
2. Simple filtration of water is a method of limiting the presence of physical agents in the water.
3. A pH lower than 6.5 is critical for good disinfection when using chlorine.
4. Checking chlorine and pH levels is necessary to guarantee an optimal disinfection process.
5. Water treatment management must be considered when applying vaccinations and treatments to the birds. The advice of vaccine or medicinal products manufacturers should be followed.

AMERICAS
HUBBARD LLC
1070 MAIN STREET
PIKEVILLE, TN 37367 – U.S.A.
TEL. +1 (423) 447 6224
contact.americas@hubbardbreedersusa.com

EUROPE, MIDDLE EAST, AFRICA
HUBBARD S.A.S.
MAUGUÉRAND
22800 LE FOEIL – FRANCE
TEL. +33 2 96 79 63 70
contact.emea@hubbardbreeders.com

ASIA
HUBBARD S.A.S.
MAUGUÉRAND
22800 LE FOEIL – FRANCE
TEL. +33 2 96 79 63 70
contact.asia@hubbardbreeders.com

V-2024-01