WATER QUALITY FOR BREEDERS AND BROILERS

Water is an integral part of many biological processes. Its quality is very important 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 larger than the consumption of feed. In addition to being the main component of the body, it is the main solvent involved in 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

Controlling good water quality starts with knowing its chemical and biological characteristics at the source, positioning the source in relation to other installations, and controlling the supply of water from a public network.

There are two types of potability criteria: physicochemical criteria and bacteriological criteria. Table 1 shows the main water quality indicators to be analysed and their limits for the classification of potability.

In the event of nonconformities between the recommended values and the actual values of the water quality indicators, it is important to identify the cause of the differences observed. These can have consequences for many factors including the material (corrosion, fouling), the effectiveness of the products prescribed for animals (inactivation) or on the performance of animals (chemical or bacteriological pollution).

Table 1 - Criteria for water potability before admission into the farm

Criteria for potability				
Physico-chemical		**Bacteriological**		
Indicator	**Values**		**Parameters**	**Recommendations**
pH	5.5-6.5	Total Flora	Total Germs	
Hardness	100 to 150 ppm $CaCO_3$		at 22°C	<100 (in 1 ml)
Iron	<0.2 mg/l		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 O2/l			

To avoid any nonconformity, controls must take place over a defined periodicity (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. This will, among other effects, optimise the action of water treatments such disinfectants used afterwards.

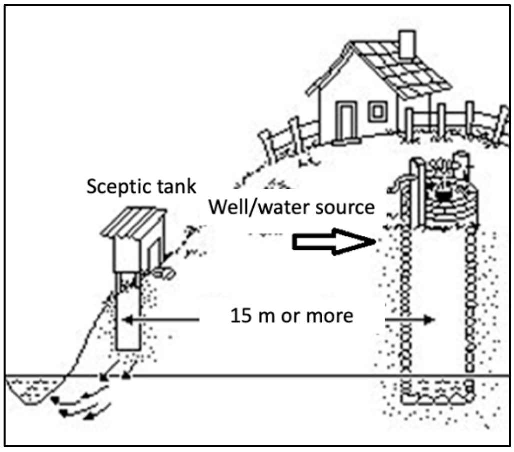

Fig. 1 – Example of a good position of a well in relation to a septic tank

The French research institute ITAVI has listed the possible consequences should water components not meet the water quality standards (Table 2).

Table 2 – 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 solubilisation
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 microorganisms 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
Promote biofilm development
Toxic at low concentrations
Ammonium: < 0.5 mg/l
Higher levels
Often associated with high organic matter content
Promote biofilm development
Decreased effectiveness of chlorination
Organic matter: < 2 mg O2/l
Higher levels (MO > 5 mg O2/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;
- Avoid contact of other animals with water.

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

Fig.2 – Not correct

Fig.3 – 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 very important.

Flushing water circuits and drinker lines is also important, 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 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 in order 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 to remove organic deposits, then rinsed with clear water under pressure (1-2 bar), if possible, in order to considerably remove the biofilm.

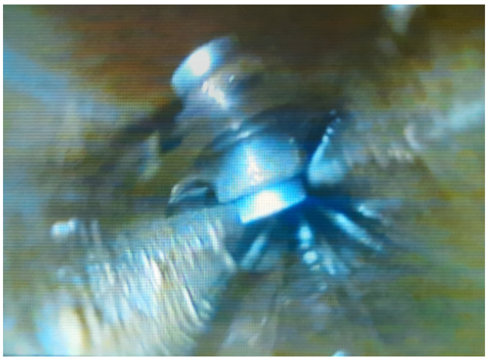

Fig.4 – Dirty pipe

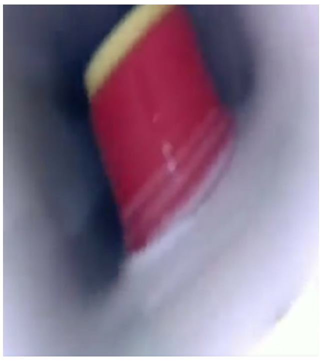

Fig.5 – Clean pipe

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 the previous conditions 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 » water will be rinsed shortly before the animals arrive. The quality of cleaning can be checked by the use of an endoscope.

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

Fig. 6 – Bell drinkers

Fig. 7 – Cup drinkers

Fig. 8 – 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 eliminate any potential source 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: e.g. online electrolysis, anolyte, peroxymonosulfates, etc.

The interaction of disinfectants with water according to its chemical and microbiological characteristics can be observed in Table 3.

Table 3 - Interaction of water chemistry with certain disinfectants and their effect on certain bacteria, parasites

		Target	Chlorine	DCCNa	Chlorine dioxide	Peroxide
Influence of chemistry: + Low influence +++ High influence	pH	< 6.5	+++	++	+/-	0
	Hardness	100 to 150 ppm $CaCO_3$	+	+	+/-	0
	Mn	<0.05 ppm	++	++	0	0
	Fe	<0.2 ppm				
	Br	<0.01 ppm*				
	Nitrates	<50 ppm				
	Organic material	<2mg O_2/l	+++	++	+/-	+++
Disinfection efficacy: + Low efficacy +++ High efficacy	Mesophilic Flora 22°C	<100CFU/ml	+++	+++	+++	+++
	Mesophilic Flora 37°C	<10 CFU/100ml	+++	+++	+++	+++
	Total coliforms 37°C	0	+++	+++	+++	+++
	E. coli	0	+++	+++	+++	+++
	Enterococci	0	+++	+++	+++	+++
	Clostridium	0	++	++	+++	+++
	Parasites	0	+	+	++	+++
	Biofilm	N/A	+	+	+++	+++

**human standard*

In addition to the interactions between water chemistry and the disinfectant, there are other factors to consider when choosing.

Price and ease of handling are often the first two factors that can influence or be decisive when deciding.

The advantages and disadvantages of each disinfectant are listed in the Table 4 below.

Table 4 - Advantages and disadvantages of various disinfectants

Product	Recommended concentration	Advantages	Disadvantages
Chlorine	0.5-3 ppm depending on the pH of the water	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	0.5-1 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. Therefore, the rest of the article focuses on chlorine, considering that it remains the disinfectant of choice for most farmers and technicians.

✓ 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: $Cl_2 + H_2O \rightleftharpoons HOCl + HCl$. The latter is in equilibrium in water with hypochlorite, which essentially depends on the pH of the water: $HClO \rightleftharpoons H^+ + ClO^-$. 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.

Check the amount of chlorine. The residual chlorine dose should be around 0.5 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 chlorine disinfection capacity can also be checked by measuring the Redox Potential. Values higher than 650 mV indicate good efficacy of the chlorine in the water.

In addition to chemical analyses to check chlorine levels, periodic bacteriological analysis is 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.

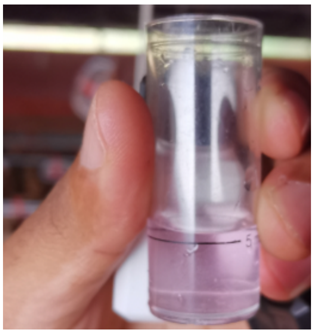

Fig. 9 – 0.5 ppm of chlorine at the end of the system

Fig. 10 – 2 ppm of chlorine at the end of the system

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 technical 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 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.

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