WATER SANITATION FOR MEAT CHICKEN FARMS

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INTRODUCTION

The Australian Chicken Meat Federation Inc. is a signatory to the Emergency Animal Disease Response Agreement (EADRA) which is an agreement between government and industry to share the costs of emergency disease outbreaks. The agreement requires certain undertakings by the industry involved to be eligible for funding under the agreement. One such undertaking involves farmers undertaking adequate biosecurity to prevent the incursions of emergency animal diseases (EAD) such as Avian Influenza (AI).

Several poultry diseases including those covered by EADRA can gain entry to the poultry flock via water which has not been adequately sanitised. Contaminated water supplies have been implicated in the introduction and persistence of endemic pathogens such as *Escherichia coli* (*E. coli*), *Salmonella spp. Campylobacter spp.* and infectious bursal disease virus (IBDV) as well as EADs such as virulent Newcastle disease virus (vNDV) and AI. For breeder farms Egg Drop Syndrome (EDS) is also a serious problem which is spread via water.

It is thus critical to ensure that water sanitation for both drinking water and cooling water is adequate to ensure freedom from pathogens.

SOURCE OF WATER

The water source(s) and quality available to any particular farm determine the level of added input necessary to ensure adequate water sanitation to avoid exposure to water born diseases through that water.

Mains or town water

Mains water is generally treated and sanitised prior to distribution and is therefore the most biosecure. However on occasion high level of coliform contamination has been found in mains water and treatment has been necessary.

Bore water

Underground water is usually considered to have a very low risk of containing avian pathogens except for shallow bores or spring water which may be affected by surface run-off and can, particularly after heavy rains, contain levels of coliforms including *E. coli*. Bore water which has been stored in open tanks or dams can no longer be treated as a low risk water source and will need additional treatment.

Surface water

Water from dams, reservoirs, channels, rivers and streams provide the highest risk for potential contamination with avian pathogens, particularly those associated with aquatic water birds such as AI and EDS viruses and bacteria associated with water run-off, such as E. coli, Campylobacter spp and Salmonella spp. Effective sanitation of surface water is required to reduce the risk of an EAD in poultry. Surface water which provides a habitat for waterfowl, particularly ducks, geese, swans and for shore birds is at highest risk of contamination with AI virus.

Rainwater

Collected rainwater does carry some risk of contamination from vermin and wild birds including waterfowl.

With a knowledge of the source(s) of water and it's likelihood of contamination it is possible to make an informed decision regarding the typed of sanitation required on a particular farm.

TYPES OF WATER SANITISERS

The choice of sanitiser should primarily be based on efficacy, followed by other factors such as application method, cost and safety (for poultry, operators and equipment). The various sanitisers are discussed below and their properties summarised in table 1.

Halogens

Chlorine (hypochlorous acid/chlorite ion) is the most commonly recognised and used. The efficiency of chlorine disinfection decreases as water pH increases (optimum at around pH 6.7). Chlorine is available in liquid form as sodium hypochlorite (usually at concentrations of 10-12%) and in solid form as calcium hypochlorite. Chlorine has a broad spectrum of activity and is minimally affected by hard water and acts rapidly. It is corrosive. The efficacy of chlorine is affected by organic material and by turbidity, UV light and heat and by its limited residual activity. Chlorine has a very low cost and application systems involve only a small capital outlay.

Iodines or formulated variations such as iodophors are similar in effectiveness to chlorine and are slightly less affected by organic material.

Bromine is more stable than chlorine as it has a higher evaporation point. Bromine continues to be effective even after reacting with organic compounds. Hypobromous acid is the active form that inactivates the pathogens. After reacting the hypobromous acid is reduced back to bromide ions. The addition of an oxidizer will convert the bromide back to hypobromous acid – this occurs by the addition of fresh water.

Other oxidisers

Chlorine dioxide is broad spectrum, sporicidal and fast acting. It disinfects by oxidation but not by chlorination. It is significantly more resistant to organic quenching than chlorine and is less affected by pH. It can be effective at levels as low as 0.1ppm. Chlorine dioxide assists in reducing biofilm build-up in drinker systems and unlike halogens does not form complexes like chloramines which are potentially carcinogenic. The cost is much higher and there is also a requirement for the purchase of a chemical activator such as phosphoric acid. The application systems are also significantly more expensive than those required for chlorine. Operating costs can be reduced somewhat by the use of the cheaper precursor compound sodium chloride to generate chlorine dioxide using an electro-discharge plate that generates hydrogen ions. However the capital cost for the equipment is high.

Hydrogen peroxide has similar inactivation properties to chlorine dioxide. However it is corrosive, inactivated by heat and organic material, and needs to be used at high concentrations. It also has limited residual activity.

Peracetic acid is similar in activity to chlorine dioxide and is effective in the presence of organic matter. Compared with chlorine it is expensive and corrosive to soft metals, unstable at high ambient temperatures and is an irritant (particularly in its concentrated form).

Ozone is generated from electrical discharge units and bubbled into the water supply. The efficacy and activity of ozone are similar to chlorine dioxide. Set-up capital costs can be high, as are maintenance costs due to discharge tubes requiring replacement every few years.

Ultraviolet light

Is only useful in the sanitation of low volumes of clean water .It has not inactivated highly pathogenic AI virus after 45 minutes exposure. It has relatively low cost but cannot be used where there are high volumetric demands for water. It has no residual activity and is not affected by pH.

Organic and inorganic acids

Organic acids such as formic, citric, lactic, mallic, glutaric and propionic acids and inorganic acids such as nitric, hydrochloric, sulphuric, phosphoric, and sulphamic acids have high viricidal activity. They are generally slow acting. Organic acids vary in their ability to inactivate microbial contamination and their cost is high compared to chlorine High levels may decrease water intake and reduce performance due to an effect on taste. Acidifiers do not replace sanitisers but can be used to reduce pH where necessary to levels around 6-6.7 to improve the efficiency of sanitisers such as chlorine.

Table 1: Comparison of sanitisers for disinfection of water in poultry sheds.

Sanitiser	Efficacy	Effect of OM on efficacy	Effect of pH	Capital cost	Running cost	Residual activity	Corrosive	Other
Chlorine	Broad spectrum	High	Yes	Low	Low	Some	Yes	Formation of potential carcinogens
Iodines	Broad spectrum	Moderate	?Some	Moderate	Moderate	Some	No	
Bromine	Broad spectrum	Moderate	Some	Low	Low	Good	No	Useful for cooling pad recirculation tanks
Chlorine dioxide	Broad spectrum, rapid	Moderate	Less effect	High	High	Some	Minimal	Requires chemical activator Reduces biofilm
Hydrogen peroxide	Broad spectrum, rapid	High	Some	Low	Low	Low	Very (undiluted)	Unstable @ high temps
Peracetic acid	Broad spectrum, rapid	Low	No	Low	High	Some	Very (undiluted)	Unstable @ high temps, irritant
Ozone	Broad spectrum, rapid	Low	Minimal	High	High	Low	Some	
Ultraviolet light	Low vs HPAI, slow	High	Not affected	Moderate	Low	None	No	Not affected by heat
Acids	Viruses, slow	Some	Decrease pH	Low	High	Some	Not at normal use rates	May reduce production due to decreased water intake

EFFECTIVE WATER SANITATION

To achieve and sustain effective water sanitation, application equipment and its correct use are just as important as the type of sanitiser used. Effective water sanitation requires:

- effective pre-treatment of the water
- correct dosage of sanitiser
- adequate contact time
- reliable operation
- accurate monitoring in real time
- avoiding contamination post-sanitation
- adequate water storage and appropriate configuration of storage.

Pre-treatment of water

High organic load reduces the efficacy of water sanitation. In addition the presence of other chemicals such as mineral salts, nitrogenous compounds, iron and colloids will also interfere with the effectiveness of water sanitation. The pH of water and the level of oxygenation will influence the outcome. These factors will affect the need to pre-treat the water and will have some bearing on the type of sanitiser used.

In order to make rational decisions regarding pre-treatment of water it is essential to undertake a complete analysis of the surface water. This should include a complete chemical analysis (pH, total dissolved solids (TDS), chloride, nitrate, nitrite, sulphate, iron, copper, magnesium, zinc, sodium and calcium), turbidity, biochemical oxygen demand (BOD) and a microbiological examination (total coliforms, *E. coli* and faecal coliforms). Pre-treatment by desalination does not remove microbial pathogens so sanitation of the treated water is still required.

Biofilms are an impediment to effective sanitation and should be cleared from lines with flushing and the use of oxidizing sanitisers such as chlorine dioxide and peracetic acid. In some cases where the biofilms are long standing and associated with pipe corrosion it is necessary to replace the water lines.

Dosage of sanitiser

Correct dosage is critical. For liquid addition, dosage equipment must be able to deliver the correct amount of sanitiser to a measured quantity of water. This can be done either via mechanical flow detection pumps, electronic pulsating digital solenoid driven diaphragms, or peristaltic pumps. For the addition of chlorine dioxide, ozone and crystalline iodine systems, the technical aspects of application and dosage require the support of adequately qualified and trained distributors. The ongoing maintenance of dosage equipment is critical.

Adequate contact time

The duration of contact time is dependent on the contaminant, the quality of the water, the type of sanitiser used and the temperature of the water. Since all the details are not always known and the parameters vary it is necessary to be conservative about contact time At least two full hours contact time at the recommended sanitiser concentration is suggested as the minimum contact time. Adequate monitoring of microbiological outcomes will add confidence that the system and contact time is effective.

Reliable operation of equipment

Sanitation needs to be effective at all times given that chickens drink throughout the day. Even temporary failure of effective water sanitation increases the risk of incursion of a water-associated avian pathogen. Both operational aspects of equipment such as electronic mechanisms, seals and casings, and maintenance issues such as air locks, corrosion and filter blockage need to be routinely attended to.

Monitoring

It is essential that the effectiveness of equipment can be monitored. This can be done using inbuilt sensing equipment with remote readouts, or through manual measurements of flow rates and dosing volumes. Monitors can also be alarmed to warn the producer of a failure. Simple manual checks to ensure that the correct amount of sanitiser is being used can provide an effective cross check. Disciplined record keeping of sanitiser levels and other parameters including pH and oxidation and reduction potential (ORP) are critical in ensuring effective microbial inactivation potential in treated water. The use of chlorine test strips alone may not give a true indication of the disinfection potential of the chlorinated water. Technical assistance must be sought, particularly when dealing with halogens other than chlorine and with oxidising compounds such as chlorine dioxide.

Determination of ORP has become the procedure of choice for monitoring, and can be performed with incorporated systems or a hand-held apparatus.ORP is measured in millivolts (mV) and provides the operator with a rapid single-value assessment of the water sanitation outcome. The ideal ORP values lie between 650-700 mV. ORP is especially useful where water quality is poor and apparently acceptable levels of sanitiser may not be sufficient to overcome the problems associated with the poor water quality.

Avoidance of contamination post-sanitation

Effective water sanitation is of no use if recontamination is allowed after treatment. Treated water should be transferred in sealed systems and into sealed tanks. There should be no other source of water entering the treated water (eg untreated rain-water). If the system is closed then falling levels of sanitiser in the stored water are of no consequence as the avian pathogens will have already been inactivated.

Water storage

Where the sanitation of water is required, installation of a number of storage tanks of appropriate size is necessary. The procedure of injecting chlorine directly into the main water supply line to the shed does not allow adequate contact time. The use of only one water tank for sanitising and holding stored water is inadequate, particularly under periods of high water demand, as there will be a replenishment of raw water entering the system that will have inadequate contact time with the sanitising chemical. It is preferable, if not essential to have a two tank storage system that is solenoid controlled with high and low level ball valves. This allows for the delivery of sanitised water after a guaranteed minimum contact time. It should also be noted that avian pathogens can spread via cooling systems and therefore it is necessary to sanitise all water used in the poultry shed.

REFERENCES

Scott PC and Ahern T (2009) National Water Biosecurity Manual Poultry Production. 1st Edition, Department of Agriculture, Fisheries & Forestry, Commonwealth of Australia.