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Research Article

Effects of Hydrogen Peroxide and Silver Complex on the Potability of Drinking Water in Broiler Farms

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Abstract

Water is an essential component in poultry production. Drinking systems need regular cleaning, otherwise will become polluted and provide a source for uninhibited growth of bacteria. However, disinfectants happen to affect the effectivity and viability of supplements and antibiotics given through water. This survey on water potability in broiler farms of provinces in CALABARZON area gives an overview of water quality status of drinking water provided to flocks and with a study comparing the effectivity of commonly used disinfectant chlorine to hydrogen peroxide and silver complex. Water potability was assessed using total plate count, coliform count and confirmed test for presence of *E. coli*. Results revealed that there is a high incidence of non-potable water in CALABARZON area and hydrogen peroxide and silver complex is more effective disinfectant compared to chlorine as supported by water quality tests.

Keywords: Water potability; Broiler; Hydrogen peroxide; Silver complex

Introduction

The health of an animal is largely determined by water hygiene levels, a fact that is often overlooked. Drinking systems need regular cleaning, otherwise will become polluted and provide a source for uninhibited growth of bacteria. Contaminated water is often not visible to the eye, but animals become sick and performance levels drops. In order to eliminate the risk related to disease transfer, water intended for mass consumption is treated and disinfected before use. Monitoring of water sources involves the determination of important microbiological and physico-chemical parameters which indicate first of all potential organic pollution, particularly pollution originating from animal excrement, storage of waste, natural and artificial fertilisers, and others [1,2]. According to the [3] *Escherichia coli* are the only true indicator of faecal contamination; they are exclusively of intestinal origin and are found in faeces. Their presence indicates mostly fresh faecal contamination and thus points to serious shortcomings in protection of the specific water source, treatment of water and its hygienic safety. Improving access to safe drinking water can result in significant benefits to herd health. Regular assessments of water quality are necessary to ensure that microbial load and mineral content are within acceptable levels so that bird performance is not compromised.

Most of the nutritional supplements and antibiotics are given through water supply, which are many times better than via compound feed [4]. However, most commonly used water disinfectants happen to affect the effectivity and viability of these supplements and antibiotics [5]. With the increasing cost of antibiotics and concern for the development of resistance to antibiotics, other agents for water disinfection are being explored to maximize their use and effects.

Several disinfectants are being used in poultry farms and the most common would be chlorine. Chlorine is the cheapest water sanitizer available and it works well, although encouraging results have been obtained, there are noted drawbacks in its use. The major concern is about the inability to consistently remove bacteria, viruses and protozoa [6].

According to several studies, more than forty percent (40%) of privately owned individual drinking water supplies typically found on U.S. poultry farms are contaminated with coliform bacteria [5]. Medema et al., [5] also added that in some regions of the world, more than seventy percent (70%) of water supplies are contaminated with coliform bacteria. Due to the questionable integrity of water supply in poultry farms and effects of common water disinfectants on antimicrobial drugs and medications given through water, there is a need to study alternative water sanitizers. Although widely used chlorine has been shown to be effective to some extent in treating water, the use of hydrogen peroxide and silver complex is being explored. Hydrogen peroxide and silver have strong bactericidal properties and have been studied in different bacteria's [7-9].

While disinfection potency of several concentrations of hydrogen peroxide and silver has been investigated separately on different bacteria [10], just a few studies used a combination of these disinfectants [7,11]. This study will try to establish if broiler farms' water is safe and drinkable and to explore other options in water disinfection that can fit into the drawbacks of chlorine being commonly used disinfecting agent by commercial poultry raisers. Using hydrogen peroxide and silver complex (Aquaclean®) as an alternative disinfectant, this study will investigate its effectivity and its potential advantages and edge over use of chlorine.

Materials and Methods

Survey on potability of selected poultry farms

Forty commercial broiler farms in CALABARZON (Cavite, Laguna, Batangas, Rizal and Quezon Province) area have given their consent for water sample collection to be conducted in the farms and for this water samples to be subjected to water quality tests. 100 ml water samples were taken from the main tank and building faucet

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Table 1: Provinces, number of farms surveyed and percentage of farms with potable water supply.

Province	Number of farms surveyed	Percentage of farms with potable water supply
Cavite	3	0%
Laguna	12	33.34%
Batangas	4	0%
Rizal	18	16.67%
Quezon	3	0%

Table 2: Provinces, number of farms surveyed, number of potable water supply from main tank and faucet and number of farms which have main tank potability that differed from faucet potability.

Provinces	Number of farms surveyed	Number of potable main tank water sample	Number of potable faucet water sample	Number of farms which have main tank potability that differed from faucet potability
Cavite	3	0 (0%)	0 (0%)	0 (0%)
Laguna	12	5 (41.66%)	6 (50%)	3 (25%)
Batangas	4	1 (25%)	1 (25%)	1 (25%)
Rizal	18	5 (27.77%)	4 (22.22%)	3 (16.66%)
Quezon	3	0 (0%)	0 (0%)	0 (0%)

Table 3: Laboratory results of two broiler buildings prior to treatment with chlorine and Aquaclean® (Day 0).

Water quality tests	**Prior to treatment**			
	Farms to be treated with Chlorine and Aquaclean®			
	Farm 1		Farm 2	
	Main tank	Faucet	Main tank	Faucet
Total plate count	300	480	1250	1100
Coliform count/100 ml	4	4	2400	2400
Presence of *E. coli*	Negative	Negative	Positive	Positive
Potability	Non-potable	Non-potable	Non-potable	Non-potable

on selected broiler farms' buildings. Collection of water samples were done aseptically. Method of water sample collection for water quality tests was done as prescribed by Pitt R [12].

Comparison of bacterial count between chlorine and hydrogen peroxide and silver complex combination treated water.

Two broiler farms from a total of forty farms surveyed for water potability that have main tanks for each of their poultry houses were selected for chlorine and hydrogen peroxide and silver complex treatment. Main tanks of two buildings of each farms were treated, one with chlorine and the other one with hydrogen peroxide and silver complex. Examination of the water supply was conducted using the Most Probable Number (MPN) Total Plate Count (TPC) methods and confirmed test. On day 0, water was collected to serve as the baseline data. On the 4th and 8th day, water samples from both farms were collected again for bacteriological examination.

The mean total plate count/ml sample and coliforms/100ml sample were computed and the comparison between the presence of *E. coli* and classification of the water samples from the treatment groups of chlorine and Aquaclean® were determined.

Results

Results of water potability survey per province are presented in (Table 1). The bulk of the farms were in Rizal which comprised 18 (45%) farms and followed by Laguna with 12 (30%) farms. Batangas comprised 4 (10%) farms while Cavite and Quezon comprised 3 (7.5%) farms. Water samples from Batangas, Cavite, and Quezon all surveyed as 0% potable. Only provinces of Laguna and Rizal surveyed as 33.34% and 16.67% respectively have potable water supply indicative of poor water quality among provinces of CALABARZON area.

There are a number of farms which have main tank potability that differed from faucet potability. These are instances wherein either water from main tank is potable while water from its respective faucet is non-potable and *vice versa*. 25% of the farms surveyed in Batangas and Laguna have main tank potability that differed from its respective faucet. This is followed by Rizal which has 16.66% of the farms which have contrasting main tank and faucet results. However, Cavite and Quezon both have no discrepancy in terms of potability of water from main tank and faucets. Summary of the survey on potability of water samples collected from main tanks and faucets is shown in Table 2.

Water supplies of two farms selected out of forty farms surveyed were treated with chlorine and hydrogen peroxide with silver nitrate on days 0, 4 and 8. Results are shown in Tables 3 to 5. Prior to treatment, all water samples both from main tanks and respective faucets in farms 1 and 2 are classified as non-potable. In addition to this, farm 1 water supply was positive for *E. coli*. After 4 and 8 days, chlorine treated water samples were still non-potable and farm 1 which had positive results for *E. coli* prior to treatment was still positive even after chlorine treatment. However, Aquaclean® treated water samples have consistent potable water results. In all water samples, results of water from main tanks and its respective faucets have no discrepancy. Either both water samples from one farm have non-potable results or both have potable results.

Discussion

Survey on the potability of water supply of selected broiler farms in CALABARZON area.

From a total of forty farms surveyed, only 10 (25%) farms have excellent water quality and classified as potable. Water supply of farms in three out of 5 provinces (Batangas, Cavite and Quezon) all surveyed as 0% potable. While the remaining two provinces (Laguna

Table 4: Laboratory results of chlorine and Aquaclean® treated water from broiler farms collected at day 4.

Water quality tests	Chlorine treated				Aquaclean® treated			
	Main tank		Faucet		Main tank		Faucet	
	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
Total plate count	TNTC*	2	29	TNTC*	1	0	0	0
Coliform count/100 ml	240	4	4	4	0	0	0	0
Presence of *E. coli*	Positive	Negative	Positive	Negative	Negative	Negative	Negative	Negative
Potability	Non- potable	Non-potable	Non- potable	Non- potable	Potable	Potable	Potable	Potable

*Too numerous to count.

Table 5: Laboratory results of chlorine and Aquaclean® treated water from broiler farms collected at day 8.

Water quality tests	Chlorine treated				Aquaclean® treated			
	Main tank		Faucet		Main tank		Main tank	
	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
Total plate count	TNTC*	2	30	TNTC*	1	0	0	0
Coliform count	4	4	4	4	0	0	0	0
Presence of *E. coli*	Positive	Negative	Positive	Negative	Negative	Negative	Negative	Negative
Potability	Non-potable	Non-potable	Non-potable	Non-potable	Potable	Potable	Potable	Potable

*Too numerous to count.

and Rizal) were surveyed as 33.34% and 16.67% potable respectively. Out of 40 farms surveyed, 2 farms, one in Laguna and one in Rizal had cases of colibacillosis. Colibacillosis can be acquired and transmitted through contamination of feeds and water supply. Disease incidences can be related to the potability of water supplies in these farms. Upon survey, all provinces have more than 50% non-potable water supply. The result of the survey reflects evident bacterial contamination resulting to high incidence of non-potable water supply of broiler farms in the entire CALABARZON area.

It is very important to disinfect and sanitize the water that is being supplied to the entire farm to ensure excellent water quality and potability [13]. Comparing the potability of water samples from main tank and faucets of 40 farms surveyed, there are instances wherein water quality of main tanks differs from its respective faucets and vice versa. This have been reflected in 7 (17.5%) farms out of 40 farms surveyed. 25% of the farms surveyed in Batangas and Laguna have main tank potability that differed from its respective faucet while 16.66% of the farms in Rizal also have contrasting results. However, Cavite and Quezon both have no discrepancy in terms of potability of water from main tank and faucets. This results have also been evident by previous studies done by Watkins et al, [6] comparing the potability of water in main tank sources to the water when it reach the end line. Moreover it is not a guarantee that the water samples from the main tank will have the same quality upon reaching the end line. This may be attributed to the presence of biofilm inside the pipe linings. If biofilm is still present in the water pipe system, treatment and disinfection would be useless as the water quality will still be altered upon passage on contaminated water pipelines. This accounts for main tanks having potable water but upon reaching the faucet, becomes contaminated. Some farms treat water insufficiently, adding less amount of disinfectant resulting to incorrect water to disinfectant proportion. This accounts for the main tanks having contaminated water while water from the pipe lines has potable water. If proper maintenance of the water line does not occur, microbial contamination can build up resulting to formation of biofilm. This would affect water quality which leads to decline in bird performance, reduction in the effectiveness of medication and vaccination [4].

From the result of the survey, we can conclude that more than 50% of the farms in CALABARZON area have water supply which are not potable due to contamination with coliform and E. coli. This may be attributed to many factors. Efficiency of the disinfectants used and disinfection protocols should be assessed as well. Due to poor quality of water provided to the flock, water supply should undergo thorough treatment and disinfection. This is to prevent outbreak caused by water-borne pathogenic organisms.

Effects of hydrogen peroxide (Aquaclean®) treatment on the quality and potability of drinking water

Water samples collected at day 0 to serve as baseline data revealed that water supply is non-potable. Chlorine treated water samples were unsatisfactory and suspicious from day 4 and day 8 rendering the water supply as not potable. From this, it can be concluded that even though there is treatment of chlorine, it is not effective in thoroughly disinfecting the water supply. Aquaclean® treated samples were rendered as potable from days 4 and 8. Total plate count, coli form count and *E. coli* count are significantly higher in chlorine treated water samples prior and after treatment as compared with Aquaclean® treated samples ($p<0.05$).

Chlorine is one of the most commonly used disinfectants for water disinfection. Chlorine kills pathogens such as bacteria and viruses by breaking the chemical bonds in their molecules. Underchloric acid can penetrate slime layers, cell walls and protective layers of microorganisms and effectively kills pathogens as a result. The microorganisms will either die or suffer from reproductive failure [14].

Chlorine can be easily applied, measured and controlled. It is fairly persistent and relatively cheap but chlorination as commonly practiced in wastewater treatment is insufficient to inactivate all of the enteric (intestinal) viruses which may be present in water [15].

When dosing chlorine, one has to take into account that chlorine reacts with compounds in the water. The dose has to be high enough for a significant amount of chlorine to remain in the water for disinfection [16-18]. Although proven to be an effective disinfectant, continual usage of chlorine over time leads to decline in its effectivity. Unsatisfactory and suspicious classification of water samples even after treatment can be accounted to this. Chlorine will only eliminate bacteria in the drinking water but will not remove the pollution.

Aquaclean® treated water samples on the other hand were all excellent in water quality and classified as potable. It is known that hydrogen peroxide, a natural disinfectant, which breaks down to environmentally acceptable products, is used by the biological cells of the immune system to kill antigens. The use of silver salts enhances the biocidal activity of hydrogen peroxide [19]. Hydrogen peroxide with silver complex formulation is safe to use and demonstrates biofilm treatment capability [19].

Mechanism of action of hydrogen peroxide is by the reduction of molecular oxygen passing through the superoxide anion intermediate. While the primary hydrogen peroxide targets are the lipids, proteins and nucleic acids of microorganisms, it is suggested that silver mainly acts on sulfhydryl protein groups [19]. It is estimated in Watkins et al. [6] previous studies that the hydrogen peroxide with silver complex is 50% more efficient as compared to other commercially available water disinfectants. Apart from a possible chemical answer, an additional advantage of the use of hydrogen peroxide is that its degradation leads to the formation of gaseous molecular oxygen. This formation results in small amounts of turbulence at the vicinity of the biofilm which causes the biofilm to fragment. Comparing chlorine and hydrogen peroxide with silver complex, results showed that coliforms and bacterial contamination are more likely to occur and reoccur in water samples treated with chlorine disinfectant as opposed to hydrogen peroxide with silver complex. This may be attributed to the difference in their mechanism of actions and disinfecting capability against biofilm.

Conclusion

It can be concluded from the findings of this study that majority of broiler farms in the provinces of CALABARZON have non-potable water supply which are being used as flocks' drinking water and other farm operations. Providing non-potable drinking water to broiler chickens might increase chances of pathogen and disease transmission and may further result to decrease in flocks' performance. Within a number of farms, there are instances wherein main tank potability differs from potability upon reaching respective end lines. Biofilm formation within pipelines and insufficient dosing of disinfectant may be accounted for this. Comparing the commonly used chlorine disinfectant to hydrogen peroxide and silver complex, showed that coliforms and bacterial contamination are more likely to occur and reoccur in water samples treated with chlorine disinfectants as opposed to hydrogen peroxide with silver complex. This may be attributed to the difference in their mechanism of actions and disinfecting capability against biofilm.

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