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Effect of Disinfectant Added Drinking Water on the Growth Performance of Different Hen Strains

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AK designed and planned the experiments. MO and NA collected and analysed the results and prepared the manuscript.

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ABSTRACT

The effect of disinfectant (2% Halamid, N-Chloro-Paratoluenesulphonamide trihydrate) addition into drinking water on the growth performance of three different chicken strains, Plymouth Rock, Australorp and Village (local mix-breed village chickens) was evaluated in the present study. Supplementation of disinfectant clearly improved the microbiological quality of chicken drinking water, by reducing the total bacteria, coliform and *E.coli* counts. On the other hand, disinfectant addition decreased feed and water intake of all chicken strains. Furthermore, the results revealed that feed and water intake was strain dependent. Lower feed conversion ratio was observed for chickens provided with disinfectant supplemented drinking water. When considering the live weight gain (LWG) monitored through the 10-week trial, it was found out that the live weight gain of the Australorp and Village strains were negatively affected by disinfectant addition, while the live weight gain of the Plymouth strain was not affected by addition of disinfectant. In the present study, it was shown that addition of disinfectant clearly improved the microbiological quality of drinking water, while the response of different chicken strains to disinfectant addition may vary.

INTRODUCTION

Water is accepted as the primary source of life as well as the vector of many diseases on human and animal life. However, hazardous wastes, municipal wastes, agricultural practices, accidental spills and leaks, industrialization and growing population are seen as the main reason of water pollution (Vodela *et al*., 1997). Hence, the drinking water resources of earth decrease, while the waterborne diseases increase day by day. Most of these diseases are microbial diseases. This situation not only affects human health but also affects livestock industry. One of the most common livestock industry branches is the poultry industry. Due to water-borne diseases, the meat and egg yields of poultry are declining and even deaths occur. Hence, poultry industry is suffering from economical losses due to waterborne diseases, such as chronic respiratory disease, colibacillosis, avian cholera, etc. (Carter and Sneed, 1996; Vodela *et al*., 1997; Amaral, 2004; Jafari *et al*., 2006; Umar *et al*., 2016).

The poultry body is composed of 55-77% water depending on their sex, age and strain. Water is used for adjustment of body heat, digestion of feed and removal of waste. Also, high quality drinking water is constantly needed for optimal growth, production and effective utilization of feed. Additionally, there is a linear relationship between drinking water quality and feed and water intake of poultry (Lott *et al*., 2003; Jafari *et al*., 2006; Fairchild and Ritz, 2009; Eleroğlu *et al*., 2013). Drinking water is also used as a carrier when vaccine, medicines and other additives are given to poultry. According to literature data, poultry eggs contain an average of 65% water. On the other hand, poultry meat and egg quality is directly influenced by the drinking water quality (Eleroğlu and Sarıca, 2004; Jafari *et al*., 2006). Because of this, various additives were added into drinking water for improving growth performance and efficiency of poultry. In literature, addition of carbonate (Bottje and Harrison, 1985), sodium bicarbonate (Yasoob and Tauqir, 2017), glucose (Zhou *et al*., 1998), calcium lactate (Damron and Flunker, 1995), sodium hypochlorite (Damron and Flunker, 1993) and acetyl salicylic acid (Hassan *et al*., 2003), saline (Balnave,

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1993), were reported.

In order to improve the microbiological quality of drinking water, disinfectant addition is becoming a common application in animal husbandry. Maharjan *et al*. (2016) stressed on the importance of water sanitation in broiler house water supplies. Toit and Casey (2010) reported that bromine and iodine supplemented drinking water affected the production parameters of broilers. Halamid (Chloramine-T) is a disinfectant approved by Food and Drug Administration (FDA) for use in aquaculture. Besides, Halamid is evaluated as a sanitizing agent in veterinary facilities, since it is effective on gram-negative bacteria (Trushenski and Bowker, 2014). Based on this data, in the present study, Halamid was used as a disinfectant in the drinking water of poultry strains. Thus, the main aim of the present study was to investigate the effects of Halamid added drinking water on the growth performance of three different chicken strains: Plymouth Rock, Australorp and Village.

Table I.- The composition of the standard diets supplied to chickens.

Ingredients (%)
Crude protein, 17; Crude cellulose, 4.50; Crude oil, 5.10; Crude ash, 14; Lysine, 0.78; Methionine, 0.35.
Vitamins (kg)
Vitamin A, 12500 IU; Vitamin D_3, 2500IU; Vitamin E, 40 mg
Elements (kg)
Ca, 4.20; P, 0.45; Na, 0.16; I, 0.6; Co, 0.1; Cu, 5; Mn, 100; Zn, 60; Se, 0.3

MATERIALS AND METHODS

Materials

Sixteen, seven days old Plymouth Rock, Australorp and Village chickens were purchased from local supplier in the province of Çanakkale-Bayramiç (Turkey). The all strain samples were divided into two groups (subgroups) of same number of population for each strain. In this way, present study was designed replicated twice and all analyses within each replicate samples were accomplished in duplicate. All chickens were fed standard diets in each cage (Table I). One of the cages was given drinking city network water, while the other was given drinking water containing 2% disinfectant (Halamid: Chloramine-T) solution. Halamid is a commercial biodegradable disinfectant purchased from Axcentive SARL (Chemin de Champouse, France). Halamid is a white crystalline powder with weak chlorine odour and excellent storage stability. Halamid is currently approved by FDA for use in (i) control of mortality in all freshwater-reared salmonids due to bacterial gill disease, (ii) control of mortality in walleye due to external columnaris disease and (iii) control of mortality in all freshwater-reared warm water finfish due to external columnaris disease (Trushenski and Bowker, 2014). Standard chicken feed was purchased from local market in Çanakkale-Bayramiç province of Turkey. All chemicals were purchased from Sigma-Aldrich and Merck.

Water analysis

The drinking water samples of the chickens were collected once a week from each water tank. The pH, temperature, electrical conductivity (EC) and dissolved oxygen (DO) measurements were done immediately. pH and temperature values of the water samples were measured by using pH meter (Sartorius PP-50, Gottingen, Germany), while electrical conductivity (EC) and dissolved oxygen (DO) values were determined by using Hanna HI98311 EC meter (Hanna Instrument Inc., USA) and Hanna HI9146 DO meter (Hanna Instrument Inc., USA), respectively.

For the microbiological examination of the samples, water sampling first from the source and then from the bowls in the chicken cages was accomplished and total bacteria, total coliforms, and *Escherichia coli* determination was done according to Standard Methods for the Examination of Water and Wastewater (9222) (Rice *et al*., 2012).

Growth performance parameters

The growth performance of the chicken was monitored for 10 weeks. Feed and water intake per cage were calculated weekly for the trial period. Live weight gains were recorded each week. The weekly live weight gains and feed intake values were used to calculate feed conversion ratio.

Statistical analysis

The results were represented as mean values with standard deviations. The data were analysed by ANOVA and the multiple comparisons of the means accomplished by Tukey's test. Statistical analysis was performed with Minitab v.17.1.0.

RESULTS AND DISCUSSION

Water quality

Water is the one of the most important nutrient in poultry farming. Water intake of poultry is depending on sex, age, species, stress and environmental conditions. On the other hand, the amount of water intake is correlated with water quality. Generally, water quality is determined and controlled via criteria such as, pH, electrical conductivity, dissolved oxygen, temperatures, microbiological loadings and mineral composition. In Table II, the characteristics

Table II.- Quality parameters of the drinking water.

Features	Samples	1	2	3	4	5	6	7	8	9	10
pH	NW	6.97± 0.02h*	7.09± 0.03f	7.02± 0.02g	6.97± 0.02h	6.97± 0.02h	7.09± 0.03f	6.97± 0.02h	7.31± 0.01d	7.41± 0.01b	7.55± 0.01a
	HAW	7.22± 0.01e	7.32± 0.02d	7.13± 0.04f	7.22± 0.01e	7.22± 0.01e	7.32± 0.02d	7.22± 0.01e	6.99± 0.01gh	7.36± 0.01c	7.30± 0.01d
EC (µs/cm)	NW	307.5± 3.54kl	308± 2.82kl	304± 1.42l	312± 2.82jk	342± 2.82h	312± 2.82jk	313± 1.41jk	317± 1.41ıj	320.5± 0.7ı	311± 1.42jk
	HAW	1564.5± 6.36e	1562.5± 3.53e	1496.5± 2.12f	1426.5± 2.12g	1637± 2.82d	1721.5± 2.12b	1722.5± 0.7b	1731± 1.41a	1704.5± 6.36c	1721± 1.41b
DO (mg/l)	NW	5.76± 0.01a	4.61± 0.01ef	4.92± 0.03c	4.73± 0.04d	4.41± 0.01g	3.73± 0.03h	3.71± 0.01h	3.23± 0.04jk	3.21± 0.01jk	3.38± 0.01ı
	HAW	5.47± 0.02b	4.61± 0.01ef	4.52± 0.03f	4.51± 0.01fg	4.66± 0.01de	3.14± 0.19k	3.26± 0.01j	2.72± 0.02l	3.22± 0.03jk	2.77± 0.01l
Temperature (°C)	NW	23.05± 0.07g	22.60± 0.14h	21.25± 0.07ı	23.05± 0.07g	24.15± 0.21f	27.15± 0.21b	27.15± 0.21b	25.25± 0.07d	28.55± 0.07a	26.45± 0.01c
	HAW	24.05± 0.49f	22.75± 0.07gh	20.85± 0.07ı	24.05± 0.49f	24.65± 0.21e	27.30± 0.01b	27.30± 0.01b	25.30± 0.01d	28.65± 0.07a	26.40± 0.01c

EC, electrical conductivity; DO, dissolved oxygen; NW, network water; HAW, Halamid added water. *Different letters in the same column show differences between samples in each features and different letters in the lines show differences among the weeks ($p \leq 0.05$).

of the network (NW) and Halamid added water (HAW) supplied to chicken are given. According to Table II, the pH values of the NW and HAW samples ranged between 6.97-7.55 and 6.99-7.36, respectively, during the trial period of ten weeks. Additionally, in terms of the pH values, there were significant differences during the trial period and between the water samples. However, both of the water samples were found to be near the neutral pH value. In literature, many works reported that drinking water with neutral or basic pH values were healthier for livestock (Bagley *et al*., 1997). Electrical conductivity (EC) value refers to total dissolved ions in water. There were statistically significant differences between NW and HAW samples and the electrical conductivity values of HAW sample were fairly higher than that of NW sample. These results may be explained with the fact that the HAW samples contained 2% disinfectant. In literature, it was reported that EC values less than 1670 µ/cm waters have a relatively low level of salinity and should present no serious burden to any livestock or poultry. Additionally, EC values ranged between 1670 and 5000 µ/cm waters were indicated that should be satisfactory for all classes of livestock and poultry (Bagley *et al*., 1997). In terms of EC values, the NW sample was found to be not within the aforementioned limits, while the HAW samples were within these limits. The other quality parameter of drinking water was dissolved oxygen (DO) value. This parameter was found to depend on temperature and salt concentration in water and it was indicated to influence the chemical and biochemical reactions in water. Moreover, the DO values of water should be at least 4 mg/L. In Table II, the DO values of the NW and HAW samples were in the ranges of 3.38-5.76 and 2.72-5.47, respectively. These results revealed that the DO values decreased with increasing storage time of waters. Hence, among the 6-10 weeks drinking water supplied to the chicken were not suitable. Water temperature affects not only the pH, EC and DO values of any water sample, but it is also effective on water intake of chicken. Hence, it was important to monitor this parameter throughout the trial. The temperature values of the water samples varied between 20 and 30°C, with respect the climatic conditions. In Figure 1, the effectiveness of the disinfectant added water sample on microorganisms was presented. The addition of disinfectant is not only effective on network drinking water, but it is also effective on the water in bowl against *E. coli,* coliform and bacteria. Figure 1 clearly indicated that NW drinking water sample was higher in *E. coli*, coliform and total bacteria counts than the HAW drinking water sample in chicken bowls. *Escherichia coli* is located in the intestine systems of animals; thus *E. coli* is an indicator of faecal contamination. In poultry farming, *E. coli* was associated with some infections such as intestinal, respiratory, urinary or invasive infections. In literature, the limits for total bacteria and coliform bacteria were reported to be up to 100 and 50 CFU/ml, respectively (Fairchild and Ritz, 2009). The findings of the NW, HAW and HAW-bowl samples were close to the literature limits. Amaral (2004) reported that the most important poultry diseases potentially transmitted by drinking water were chronic respiratory disease, colibacillosis (*Escherichia coli*), avian cholera (*Pasteurella multocida*) and fowl typhoid (*Salmonella gallinarum*). In the present study, for all chicken strains no diseases were observed. Hence, the findings of present study demonstrated that addition of disinfectant into drinking water is effective in eliminating the above mentioned disease risk factors.

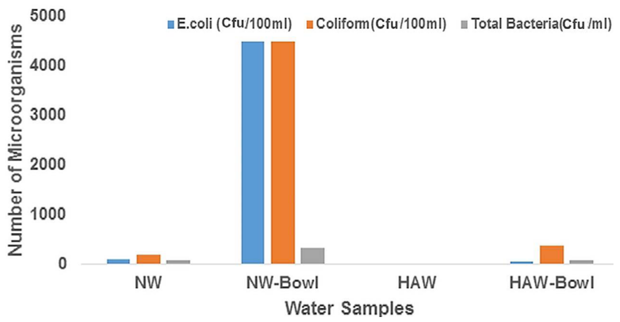

Fig. 1. Microbiological quality of drinking water (NW, Network water; HAW, Halamid added water).

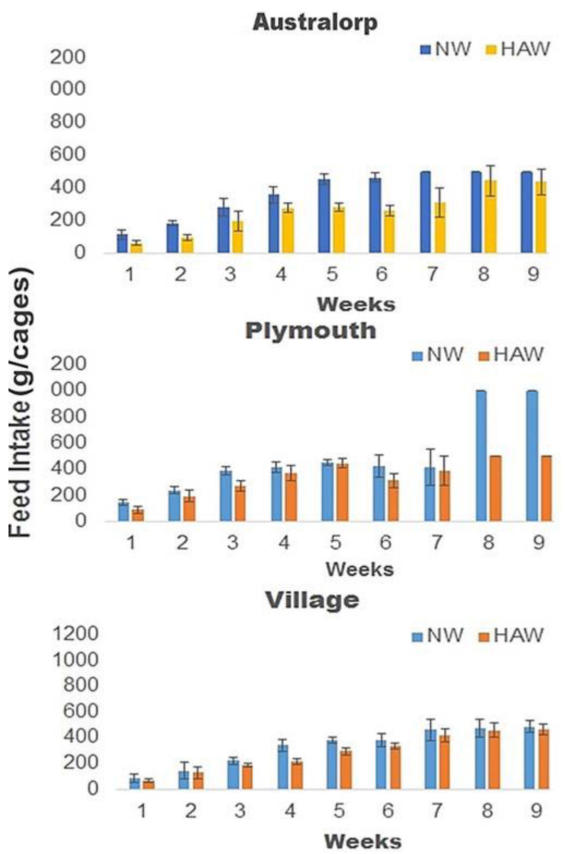

Fig. 2. Feed intake of the chicken strains (NW, Network water; HAW, Halamid added water).

Growth performance parameters

For determination of the chicken growth performance, feed intake (FI), water intake (WI), feed conversion ratio (FCR), live weight and death rate were monitored during the ten-week trial. The feed intake and water intake values of the chickens are given in Figures 2 and 3, respectively. According to Figure 2, the feed intake values of the NW samples supplied chickens were fairly higher than that of the HAW sample supplied chickens for all chicken strains. These results indicated that addition of disinfectant into drinking water decreased the feed intake values. Damron and Flunker (1995) reported that waterborne calcium supplementation reduced feed and water consumption of hens.

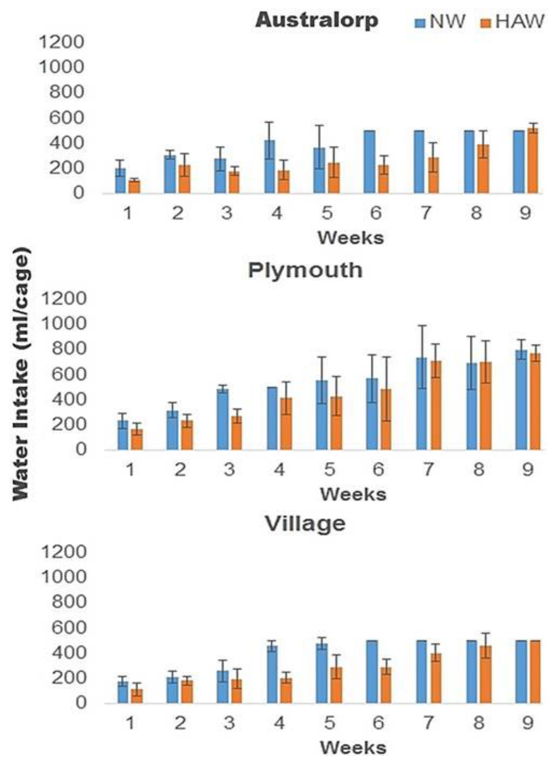

Fig. 3. Water intake of the chicken strains (NW, Network water; HAW, Halamid added water).

Furthermore, the Plymouth strain compared with the Australorp and Village strains consumed more feed both for NW and HAW groups. The other monitored parameter of growth performance was the water intake. The water intake values of the NW groups were higher than the HAW chicken group, especially during the first 5 weeks of growing for all chicken strains. Also, the Plymouth strain had higher water intake values than the other chicken strains and these results were correlated with feed intake values. These results clearly demonstrated that the feed and water intake was strain dependent. Damron and Flunker (1993) reported that sodium chloride (NaCl) supplementation into drinking water has an adverse effect level at 40 ppm NaCl, while 100 ppm NaCl supplementation reduced water intake of hens. According to Blanave (1993), there are strain differences in the response of hens to saline drinking water, and within a strain there is also considerable variation. Strain differences appear to exist, and even within a strain there is considerable variation in the responses of individual hens to saline drinking water. The feed conversion ratio (FCR) values of the chickens are shown in Figure 4. The FCR values of all chickens increased during the first 5 weeks of growing, while the FCR values decreased during the last five weeks. Generally, chickens supplied with NW drinking water exhibited higher FCR values than chickens provided with HAW drinking water.

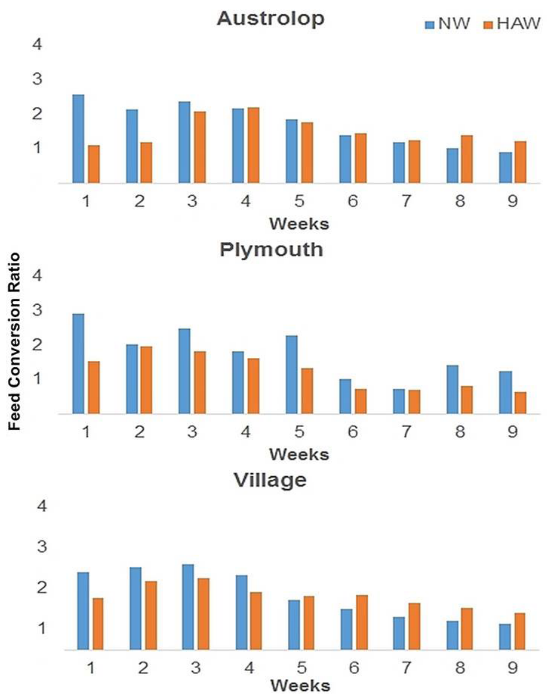

Fig. 4. Feed conversion ratio of the chicken strains (NW, Network water; HAW, Halamid added water).

Moreover, the Plymouth strain had higher FCR values than the Australorp strain, while the Australorp strain had higher FCR values than the Village strain. Similar result was observed for the FI and WI values of the chickens. All of these results clearly demonstrated that FI, WI and FCR values were not only affected by disinfectant addition, but were also affected by chicken strains. Another important parameter for poultry growth is the live weight gain (LWG) and the LWG values of the chickens are shown in Figure 5. The live weight gain (LWG) values of the NW group Plymouth strain varied from 51 to 797 g, while this value for the HAW group Plymouth strain ranged from 58 to 779 g during the 10 weeks growing period. The LWG values of the NW and HAW group Australorp strain ranged between 45-561g and 56-358 g, respectively. Moreover, the LWG values of the NW and HAW group Village strain varied in the range of 45-755 g and 63-512 g, respectively. These findings revealed that the LWG of the Australorp and Village strains were fairly affected by disinfectant addition into drinking water, while the Plymouth strain was not affected. Damron and Flunker (1993) reported that the body weight gain of the hens was reduced by supplementation of drinking water with 300 ppm sodium chloride. While considering previous studies and our present study, it can be stated that the response of different chicken strains to various chemical supplements into drinking water may vary.

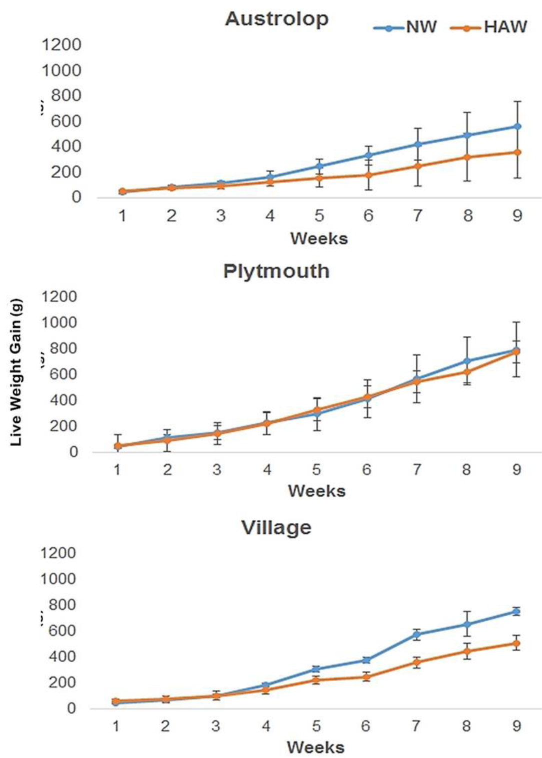

Fig. 5. Live weight gains of the chicken strains (NW, Network water; HAW, Halamid added water).

CONCLUSION

Supplementation of disinfectant clearly improved the microbiological quality of chicken drinking water, by reducing the number of total bacteria, coliform and *E. coli*. On the other hand, disinfectant addition led to a decrease in feed and water intake of all chicken strains. Furthermore, it was found out that feed and water intake of different chicken strains varied. Lower feed conversion ratio was observed for chickens provided with disinfectant supplemented drinking water. Addition of disinfectant improved the microbiological quality of drinking water, while the response of the three different chicken strains, Plymouth Rock, Australorp and Village, to disinfectant addition was significantly different.

Statement of conflict of interest

The authors declare that there is no conflict of interests.

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