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Effect of Different Water Quality with and Without Vitamin C on Some Physiological Parameters of Broiler Chickens

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Abstract. The current study was designed to investigate the effect of different water quality with and without vitamin C on some blood parameters and the relative weight of the heart, liver, gizzard, spleen and bursa gland of broiler chickens. A total of 252 one day old, unsexed chicks of broiler chicken (ROSS 308), average body weight 42 g were used in this study. The birds were randomly distributed into seven treatment groups (each group 36 birds), with three replicates per each (12 birds per replicate) based on completely randomized design for 35 days. The first group drank reverse osmosis (R.O) without any addition containing 28.16 total dissolved solids mg.l-1 (TDS), whereas the second, third and fourth groups drank water containing 1849.6, 1452.8 and 1356.8 TDS mg.l-l respectively. The fifth, sixth and seventh group drank water containing 1849.6, 1452.8 and 1356.8 TDS mg.l-1 with 100 mg.l-1 vitamin C respectively. The birds fed *ad libitum* a starter diet for 21 days and thereafter, on a grower diet. Increasing water TDS resulted in a significant increase in AST and ALT enzymes. On the other hand, increasing water TDS causing a decrease in the total protein and globulin. Addition vitamin C to different water quality causing a significant decrease in AST and ALT enzymes and increase in the total protein and globulin. Different water quality with or without vitamin C had no effect on albumin in serum and relative weight of heart, liver, gizzard and spleen. Increasing water TDS resulted in a significant increase in the relative weight of bursa gland. On the other hand, addition vitamin C to different water quality causing a significant decrease in the relative weight of bursa gland. It can be concluded that an increasing the level total dissolved solids (TDS) in broiler chickens drinking water caused stress for birds. The addition of vitamin C by 100 mg per liter led to a reduction in the stress of birds.

Keywords. TDS, Water quality, Broiler, Blood parameters.

1. Introduction

Water is essential in the poultry industry. It is a necessary ingredient for several elements of fowl metabolism, such as digestion, feed absorption, and reproduction. The provision of high-quality water is required to achieve high poultry and plant production [1,2] .Chickens can go for much longer periods of time without food than they can without water [3]. The bird consumes 1.5 to 2 times the amount of food it consumes in terms of water [4]. As a result, changes in water content are expected to have a greater impact on broiler performance than changes in feed content. Water pollution, according to Crompton [5], is an undesired alteration in the physical and chemical qualities of water that causes health problems for humans, animals, and plants. Due to high temperatures and increased evaporation, the biggest concern currently facing water purity is high salinity in it, particularly in marshes, depressions, and rivers. According to the World Health Organization (WHO), pollutants that impair

the quality of water acceptable for human, animal, and plant consumption include different salts, which can be harmful at high concentrations. Minerals and salts at high concentrations in animal drinking water produce physiological abnormalities in the animal, resulting in loss of the animal's health and immune status [6]. TDS (total dissolved solids) is a major indicator of water quality that determines whether or not water is safe to drink for animals [7,8]. Electrical conductivity (EC) is a water salinity index that is widely used to quantify TDS [9]. TDS estimation is a great way to assess water quality and availability [3]. Because it is well known that high total dissolved solids cause stress in birds, herbs or their extracts, as well as ascorbic acid, could be given to them in their drinking water to improve performance [10,11]. Ascorbic acid, also known as vitamin C, helps animals cope with stress by producing anti-stress hormones. Vitamin C is a water-soluble antioxidant produced in sufficient amounts by the metabolism of birds when they are not stressed [12,13]. Vitamin C is an excellent natural antioxidant. Vitamin C supplementation decreases oxidative stress in animals grown in a diversity of stressful conditions, according to several animal studies [14,15]. Vitamin C supplements, whether taken orally or in drinking water, have been demonstrated to have beneficial benefits in several studies. Supplements increased the physiological status of broiler chicks and improved growth performance [16,17]. The goal of this study is to investigate the effect of different water quality with and without vitamin C affects some blood parameters as well as the relative weight of the heart, liver, gizzard, spleen, and bursa gland in broiler chickens.

2. Materials and Methods

2.1. Period and Study Area

During the months of November and December 2021, this study was conducted at a poultry farm in the College of Agriculture, University of Basrah, Basrah city, Iraq.

2.2. Study Treatments and Animals

The current study included seven treatment groups. A total of 252 one-day-old, unsexed broiler chicks (ROSS 308) weighing 42 g were used. The birds were divided into seven treatment groups (each with 36 birds), with three replicates in each group (12 birds per replicate). The first group drank reverse osmosis (R.O) water with no additives (28.16 TDS mg.l-1), while the second, third and fourth groups drank water with 1849.6, 1452.8, and 1356.8 TDS mg.l-1. The fifth, sixth and seventh groups drank water with TDS levels of 1849.6, 1452.8, and 1356.8 mg.l-1, respectively, and vitamin C levels of 100 $mg.l^{-1}$.

2.3. Animal Management

According to the Ross 308 broiler management manual, the chicks were reared for five weeks (35 days) under similar conditions. In a closed broiler house, the chicks were housed and raised. The chicks were raised in a littered sawdust-covered floor. There were twenty-one replicates, each with twelve chicks (length: 200 cm; width: 80 cm; height: 54 cm). For the first week, the temperature was set at 33°C, then steadily reduced by 3°C each week until the end of the fifth week. The lighting plan was 23 hours of light and 1 hour of darkness from the first to the 35th day. Two different basal diets were fed to the chicks, the first diet containing 23.68 % crude protein and 2876.5 kcal\kg metabolizable energy. The second diets, were included 20.05 % crude protein and 3148.5 kcal\kg metabolizable energy. Pellet diets and ad libitum water were supplied to the chicks.

2.4. Data Collection

Blood samples were obtained at the end of the study after the broiler chicks had fasted for 3 hours. 2-3 ml of blood was taken from a shank vein and centrifuged at 3000 RPM for 10 minutes to extract serum. Total protein, albumin, globulin, AST and ALT enzymes concentrations in serum were measured using commercial kits.

2.5. Organs Relative Weight

Five birds of similar body weight from each group were utilized to evaluate heart, liver, gizzard, spleen and bursa gland relative weight at the end of the 35-day. The birds were chosen, weighed individually, then slaughtered. Organs were removed, weighed, and expressed as a percentage of live body weight.

2.6. Statistical Analysis

A completely randomized design (One –way ANOVA) was applied to analyze experimental data using the program SPSS [18]. Duncan's multiple range tests [19] were also used to assess significant differences between means at a 0.05 percent level of significance.

3. Results and Discussions

3.1. Blood Parameters

The results of Table 1 indicate a significant increase ($p \leq 0.05$) in AST and ALT enzymes in the blood of birds of the second, third and fourth treatments compared to the different study treatments. The reason for this increase may be attributed to an increase in the level of corticosterone hormone in the blood serum as a result of the exposure of these birds to stress, as this hormone affects many liver enzymes, including AST and ALT, leading to an increase in their activity in the blood [20]. The results indicated that there was a significant decrease ($p \leq 0.05$) in total protein and globulin in the serum of birds of the second and third treatments compared to the other treatments. This decrease may be attributed to the birds'exposure to stress, as the birds' exposure to stress causes an increase in the level of corticosterone hormone in the blood [21], which works to destroy part of the protein for the purpose of creating sugar from protein sources [22]. The results of the current study are in agreement with what was confirmed by Morsy et al. [23] who showed a significant decrease in the concentration of total protein and globulin in the serum of laying hens that were given saline water containing 4000 and 6000 ppm TDS compared to the birds that were given tap water. Morsy [24] confirmed when studying the effect of wells water with a saline level (3398) ppm of TDS on roosters (Montazah), a significant increase in liver enzymes ALT and AST and a significant decrease in the concentration of total protein and globulin. Emam et al, [25] indicated that broilers consumed salty drinking water at a level of 3398 parts per million of TDS led to a significant increase in the activity of ALT and AST enzymes and a decrease in the level of albumin. The results indicate a significant decrease ($p \leq 0.05$) in AST and ALT enzymes in the blood of birds of the fifth, sixth and seventh treatments compared to the different study treatments. The reason for this decrease can be attributed to the role of vitamin C in reducing the secretion of corticosterone from the adrenal gland [26]. Desoky and Kamel [27] confirmed that adding vitamin C to the diet of broilers exposed to heat stress at a rate of 250 mg/kg feed led to significant differences between treatments, as there was a decrease in the activity of liver enzymes AST and ALT in the blood serum at the age of 21, 35 and 42 days. The results indicated that there was a significant increase ($p \leq 0.05$) in total protein and globulin in the serum of birds of the seventh treatment compared to the other treatments. The reason for the increase in total protein concentration may be attributed to the role of vitamin C in resisting stress by controlling the secretion of the corticosterone hormone secreted by the adrenal cortex, as vitamin C has an important role in the synthesis of corticosterone, as this hormone works to increase the utilization of glucose by breaking down protein to produce energy [13]. Desoky and Kamal [27] confirmed that adding vitamin C to broiler diet at a rate of 250 mg/kg feed led to a significant increase in the levels of total protein, albumin and globulin in plasma. The results indicated that there were no significant differences ($p > 0.05$) among the different treatments in the concentration of albumin.

Table 1. Some blood parameters of broiler chickens supplemented different water quality with and without vitamin C (Mean± SE).

Treatments / Parameters	T1	T2	T3	T4	T5	T6	T7
AST (IU/L)	118.33^{b} ± 22.42	294.66^{a} ± 22.69	271.33^{a} ± 7.21	267.66^{a} ± 8.17	183.33^{b} ± 36.24	166.33^{b}± 20.43	129.33^{b} ± 4.33
ALT (IU/L)	112.33^{c} ± 7.21	167.33^{a} ± 4.33	162.33^{a} ± 7.21	164^{a}± 5.85	132.33^{b} ± 4.33	139^{b}± 7.37	136.33^{b} ± 7.31
Total protein(g/ml)	5.67^{ab}± 0.16	4.24^{b} ± 0.11	4.40^{b} ± 0.34	5.20^{ab} ± 0.74	5.27^{ab} ± 0.81	5.95^{ab} ± 0.60	6.63^{a} ± 0.23
Albumin (g/ml)	2.28± 0.31	2.58 ± 0.62	2.74 ± 0.58	2.76 ± 0.71	3.09 ± 0.75	3.51 ± 0.38	2.43 ± 0.44
Globulin (g/ml)	3.39^{ab} ± 0.21	1.66^{c} ± 0.53	1.66^{c} ± 0.24	2.44^{bc} ± 0.57	2.18^{bc} ± 0.10	2.44^{bc} ± 0.95	4.20^{a}± 0.20

Different letters in the same row mean there are significant different at $p \leq 0.05$. T1: drank reverse osmosis (R.O) containing 28.16 TDS $mg.l^{-1}$, T2,T3,T4: drank water containing 1849.6, 1452.8 and 1356.8 TDS $mg.l^{-1}$ respectively. T5,T6,T7: drank water containing 1849.6, 1452.8 and 1356.8 TDS $mg.l^{-1}$ with 100 $mg.l^{-1}$ vitamin C respectively.

3.2. Organs Relative Weight

The results of relative weight of some organs are shown in Table 2. Different levels of water quality with and without vitamin C had no significant effect ($p > 0.05$) on relative weight of heart, liver, gizzard and spleen. The results indicated a significant increase ($p \leq 0.05$) in the relative weight of the bursa gland in the second, third and fourth treatments, while a significant decrease ($p \leq 0.05$) in the relative weight of the gland occurred in the fifth, sixth and seventh treatments. Perhaps the reason for the high relative weights of the bursa gland in the birds of second, third and fourth treatments is due to its exposure to stress. On the other hand, the reason for their low relative weights in vitamin C treatments is the role of vitamin C in reducing the stress that birds are exposed to due to the increased salinity of drinking water. Our findings are in agreement with Emam et al, [25] who indicated that broilers' consumption of salty drinking water at a level of 3398 parts per million of TDS did not lead to significant differences in the relative weights of heart, gizzard, liver and spleen. Mbajiorgu [28] indicated that adding vitamin C to drinking water had no effect on the relative weights of the liver, heart and gizzard of broiler carcasses that were given different levels of vitamin C, which are 100, 200, 300 and 1000 mg/liter of water. Abioja et al. [29] reported that adding vitamin C at a rate of 500 mg/liter of drinking water to broilers did not have a significant effect on the relative weights of the liver, spleen and heart.

Table 2. Effect of different levels of water quality with and without vitamin C on some relative weight of organs (Mean±SE).

Treatments / Parameters	T1	T2	T3	T4	T5	T6	T7
Relative weight of liver	2.30 ± 0.25	2.55 ± 0.28	2.20 ± 0.29	2.67 ± 0.08	2.24 ± 0.13	2.50 ± 0.15	2.79 ± 0.29
Relative weight of heart	0.42 ± 0.02	0.47 ± 0.03	0.47 ± 0.01	0.47 ± 0.02	0.43 ± 0.02	0.48 ± 0.01	0.48 ± 0.04
Relative weight of gizzard	1.46 ± 0.25	1.47 ± 0.04	1.42 ± 0.16	1.24 ± 0.16	1.72 ± 0.06	1.36 ± 0.10	1.52 ± 0.11
Relative weight of spleen	0.15 ± 0.01	0.12 ± 0.01	0.15 ± 0.01	0.15 ± 0.01	0.10 ± 0.01	0.14± 0.01	0.16 ± 0.02
Relative weight of bursa	0.13^{b} ± 0.01	0.20^{a} ± 0.01	0.18^{a} ± 0.02	0.18^{a} ± 0.01	0.13^{b} ± 0.01	0.14^{b} ± 0.02	0.13^{b} ± 0.02

Different letters in the same row mean there are significant different at $p \leq 0.05$. T1: drank reverse osmosis (R.O) containing 28.16 TDS $mg.l^{-1}$, T2,T3,T4: drank water containing 1849.6, 1452.8 and 1356.8 TDS $mg.l^{-1}$ respectively. T5,T6,T7: drank water containing 1849.6, 1452.8 and 1356.8 TDS $mg.l^{-1}$ with 100 $mg.l^{-1}$ vitamin C respectively.

Conclusions

In conclusions, increasing the level total dissolved solids (TDS) in broiler chickens drinking water caused stress for birds. The addition of vitamin C by 100 mg per liter led to a reduction in the stress of birds.

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