EFFECTS OF OXYGENATED AND MAGNETIC WATER ON GROWTH PERFORMANCE, ANTIOXIDANT ENZYMES ACTIVITY AND INTESTINAL MICROBIAL LOAD OF BROILER CHICKS

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SUMMARY

The present study was conducted to evaluate the effects of using oxygenated and magnetized water on the productive performance, immunity, and antioxidant status of broiler chicks. A total of 240 seven-day-old broiler (Arbor Acres) chicks were weighed and randomly allocated into four treatment groups with three replicates of 20 birds each. The treatment groups were arranged as follows: (T1) control group, (T2) received freshly oxygenated water containing up to 28 mg oxygen/L H_2O, (T3) received magnetic water and (T4) received both oxygenated and magnetic water. Results showed that chicks in groups T3 and T4 were significantly increased in body weight and feed intake ($P<0.05$). Also, the values of total antioxidant capacity (TAC), glutathione (GSH), sodium dismutase (SODs), and catalase (CAT) showed a significant increase ($P\leq0.05$) in the antioxidant enzymes of treated groups (T3, T4, and T2) compared with the control group (T1). The analysis of variance showed that antibody titer response was significantly ($P\leq0.05$) increased in T3 that received magnetic water compared with other groups. Further, T2 and T4 had lower total colony and total coliform counts compared to other groups ($P\leq0.05$). In conclusion**,** the use of oxygenated and magnetic water enhanced growth performance and immunity and reduced total colony and coliform counts of broiler chicks.

Keywords: *(oxygenated and magnetic water, Arbor Acres broiler chicks, antioxidant enzymes, microbial count).*

INTRODUCTION

Water molecules are tiny and V-shaped with the molecular formula H_2O. The water molecule has a central single oxygen atom covalently bonded to two hydrogen atoms. Pure water is a tasteless, odorless, colorless, clear liquid. It shimmers slightly blue in thick layers (Kalinichev and Churakov, 1999).

About 60 to 85% of the weight of birds is made up of water as all tissues and cells contain it (Degen *et al.*, 1991). Water plays a fundamental part in a variety of metabolic processes, including the control of body temperature, digestion, movement and absorption of nutrients. Also, it is important for the breakdown of proteins, fats, and carbohydrates, the maintenance of sight and hearing, respiration, and perspiration (Karabayir, 2001). Any agents that can affect water quality may have a direct impact on feed intake and bird production. Drinking water quality is determined by its chemical, physical, and microbiological features (Kazi *et al.*, 2009). Along with pH and temperature, dissolved oxygen concentration is a crucial component of these quality standards. Several methods are currently utilized to increase the quality of water, one of them involves the use of an exogenous supply of oxygen to obtain oxygenated water and the other is magnetic forces to magnetize the water (Dinçer *et al.*, 2007; El Sabry *et al.*, 2018).

Since the early 1990s, several producers, primarily in Europe and the US, have created drinking water with elevated dissolved oxygen contents, ranging from 30 to 120 mg/L H_2O. Fresh fountain water has 10 -12 mg/L of dissolved oxygen, while regular drinking water has 5-7 mg oxygen /L H_2O. The company that makes the product claims that drinking oxygenated water increases the amount of oxygen available, and the overall metabolism and health, as well as resistance to pollutants and drugs (Gruber *et al*., 2005). Shin

et al. (2016) found that oxygen-enriched water enhanced feed conversion and increased body weight in broiler chickens. Also, Jung *et al*. (2012) suggested that oxygenated drinking water enhanced immunity in broiler chicks and improved resistance to *S. Gallinarum* in broiler chickens that were experimentally infected.

Many researchers examined the detrimental changes in the natural water following sterilization and named this water (dead water). Magnetic water transforms water from dead to live (Al-Nuemi *et al.,* 2015). Magnetic water means passing water through a magnetic device, or by placing a magnet in water so the characteristic of water turns very fertile and active causing several indirect or direct changes in the physical, chemical, and electromagnetic properties of water such as boiling point, viscosity, surface tension, electrical conductivity, pH, and molecular energy, high oxygen content and speeding up the dissolving of salts and amino acids in water (Hafizi *et al.,* 2014; Wang *et al.,* 2018; El Sabry *et al.,* 2021) and increased water flexibility and penetration (Daviss, 2004).

As mentioned above, water is very important in poultry production. So, the present work was conducted to study the effect of using oxygenated and magnetized water and their mixture on productive and physiological performance, immunity, microbial counts, and antioxidant status of broiler chicks.

MATERIALS AND METHODS

The site and aim of study:

This study was carried out at a commercial broiler farm equipped with a battery system in the Al-Behira governorate during the summer season (October to November 2021). The main objective of this study was to examine the beneficial effects of oxygenated and magnetic water on the productive and physiological performance, immunity, some microbial counts, and antioxidant status of broiler chicks (Arbor Acres) during the fattening period (extended from 7 to 42 days of age).

Broiler chick's husbandry:

Before the start of the experiment, all pens that will be used in this study were cleaned and disinfected. On the other hand, the cages were equipped with Nipple drinking systems. The battery cage dimensions were 60 H x 100 L x 150Wcm^2. The chicks were housed in a power ventilated poultry house. The farm was lighted by using artificial light throughout the experimental period. From one to seven Days of age chicks provided 23 hours light and 1 hour dark after seven days chicks provided of darkness 6 hours until the end of experimental period according to Arbor Acres broiler management guide.

A total number of 240 broiler chicks, seven-day-old (Arbor Acres) with an average weight of 42 g were purchased from a local commercial hatchery (Al-Watania Poultry Company).

Preparation of oxygenated and magnetic water:

Oxygenated water:

Oxygenated water was obtained by spraying water through fine sprinklers in a medium saturated with oxygen inside a closed cylinder under a pressure of 3 to 4 bar. Oxygen partial pressure in the water was measured using a model ADWA AD630 apparatus (ADWA Instruments, Szeged, Hungary) or by the chemical method according to Benson and Krause (1984). Freshly oxygenated water contained up to 28 mg oxygen/L H_2O, which was 4.5 times more than that of non-oxygenated fresh tap water (6 mg/L H_2O).

Magnetic water:

The magnetized water was obtained by a magnetizer device from Delta Water Company (14500 Gauss; Alexandria, Egypt) (Web site: http://www.deltawater.net/).

Experimental design:

At the beginning of the experiment, all chicks were individually weighed to the nearest gram to avoid any significant differences among the experimental groups. Then the chicks were allocated completely randomized into 4 treatment groups with 3 replicates of 20 chicks each. Chicks in group T1 (control group) received plain water without any treatment. Chicks in group T2 received oxygenated water contained up to 28 mg oxygen/L H_2O. Chicks in group T3 received magnetic water, while the chicks in group T4 were received both of oxygenated and magnetic water as drinking water throughout the duration of the experiment. The basal diet was formulated to meet all nutrient recommendations published in the Arbor Acres rearing guideline (Aviagen, 2019). A three-phase feeding program was used, with a starter diet until

10 days of age, a grower diet until 27 days of age and the grower finisher diet until the end of the experiment. All diets were formulated and pelleted in Al-Rahma feed Factory. The composition of the basal diets is shown in Table (1). During all experimental periods water and feed were provided to chicks *ad libitum*. All groups were vaccinated with subcutaneous injections with inactivated H9+ND at the chick placement. Also, all groups were vaccinated with attenuated IB variant 2 and H120 at 7 d, IBD at 14 d and LaSota at 20 d of age via eye drop.

Table (1): The ingredients and calculated compositions of experimental diets.

Ingredients	**Starter (1-10)**	**Grower (11-26)**	**Finisher (27-42)**
Ground yellow Corn (8.5%)	53.283	58.3	61.07
Soybean meal (46% CP)	33.7	30	26.6
Full-Fat Soybean	7.5	7.4	7.1
DL-Methionine (100%)	0.419	0.365	0.345
L-Lysine (100%)	0.226	0.169	0.165
Threonine	012	0.083	0.068
Valine	0.047	0.01	0.007
Isoleucine	0.01	0	0
L Arginine	0.036	0	0
monocalcium phosphate (CaH4P2O8)	0.57	0.375	0.26
Calcium carbonate (Caco3)	1.33	1.2	1.12
Sodium chloride (NaCl)	2.8	0.28	0.28
Sodium bicarbonate	0.2	0.2	0.2
Vegetable oil*[*]	2	1.35	2.5
Premix*	0.2	0.2	0.2
Choline chloride (60%)	0.064	0.058	0.07
phytase enzyme	0.015	0.015	0.015
Total (Kg)	100	100	100
Calculated diet compositions:			
Crude protein (%).	23.02	21.55	20.09
Metabolizable energy (Kcal /Kg).	3000.6	3100.6	3200.8
L-Lysine (%).	1.44	1.29	1.19
DL-Methionine (%).	0.74	0.67	0.63
L-threonine%	0.97	0.88	0.81
Methionine + Cystine (%).	1.08	0.99	0.94
L Arginine	1.52	1.37	1.26
Valine	1.1	1.0	0.93
Isoleucine	0.97	0.89	0.82
Tryptophan	0.274	0.25	0.23
Calcium (%).	0.964	0.87	0.81
Available phosphorus (%).	0.483	0.437	0.40
Sodium	0.186	0.185	0.18
Chlorine	0.216	0.216	0.21
Potassium	0.898	0.835	0.77
Linolenic acid	1.26	1.369	1.42
Choline	0.17	0.159	0.15

**The premix (Vit. & Min) was added at a rate of 3 kg per ton of diet and supplied the following (as mg or I.U. per kg of diet): Vit. A 12000 I.U., Vit. D3 2000 I.U., Vit. E 40 mg, Vit. K3 4 mg, Vit. B1 3 mg, Vit. B2 6 mg, Vit. B6 4 mg, Vit. B12 0.03 mg, Niacin 30 mg, Biotin 0.08 mg, Pantothenic acid 12 mg, Folic acid 1.5 mg, Choline chloride 700 mg, Mn 80 mg, Cu 10 mg, Se 0.2 mg, I 40 mg, Fe 40 mg, Zn 70 mg and Co 0.25mg.*

***Vegetable oil[*]: soybean oil and sunflower oil*

-This diet is formulated according to the Arbor Acres rearing guideline ***(Aviagen, 2019).***

Data collection:

Growth performance:

Live body weight (LBW), body weight gain (BWG), and feed intake (FI) were recorded for whole period of the experiment. However, feed conversion ratio (FCR) was calculated in terms of total FI (g) per BWG (g).

Blood samples collection:

Blood samples were withdrawn from one bird from each replicate at 7 weeks of age from the jugular vein. The blood samples were collected into dry clean centrifuge tubes without anticoagulants. Serum was collected by centrifugation for 15 minutes at 3000 rpm and stored at –20 ^{o}C until use for analyses.

Immune response:

In order to measure the antibody titer response against Newcastle disease virus (ND) micro technique of haemagglutination inhibition test was done according to Takatasy (1955).

Antioxidant enzymes activity:

The biochemical analysis of serum was carried out for quantitative determination of blood parameters by spectrophotometer, serum total antioxidant capacity (TAC), glutathione peroxidase (GSH), sodium dismutase (SOD) and catalase (CTA) activities were measured by using bio-diagnostic commercial kits according to method described by Koracevic *et al.* (2001), Beutler *et al.* (1963), Nishikimi *et al. (*1972) and Aebi, (1984).

Free T3 and T4 Hormones:

Thyroid hormones (total and free T_3 and T_4) were done according to Pharaoh *et al.* (1973). Determinations were done by using commercial kits produced by Diamond Laboratory, Inc.

Bacterial count:

Determination of the total bacterial count and total coliform count, the intestinal contents were collected from 15 birds (3 birds per treatment) using sampling technique methods described by Quinn *et al.* (1994). Microbial counts were expressed as colony forming units (CFU) per gram of sample. The different isolated bacterial colonies were further identified according to Holt *et al*. (1994).

Statistical analysis:

Data analysis was performed by using the General Linear Models (GLM) procedure of the SPSS software program package (SPSS, 2011). Differences were considered statistically significant at ($P \leq 0.05$). The original data for the microbial colony forming unit were transformed to $\log_{10}$ CFU g-1 of intestinal content for statistical analysis. All obtained data were analyzed by using the following Model: $Xijk = M + \alpha i + eijk$, where M = general mean, αi = effect of oxygenated or magnetic water, and eijk=standard error for observations.

RESULTS AND DISCUSSIONS

Productive performance:

The effects of oxygenated and magnetic water on the productive performance during the whole experimental period are given in Table (2). Results showed that body weight (BW) and body weight gain (BWG) were significantly ($P \leq 0.05$) increased due to oxygenated and magnetic drinking water. The present study indicated that T4 (received a mix of oxygenated and magnetic water) and T3 (magnetic water) recorded the highest ($P \leq 0.05$) values for both BW and BWG compared with oxygenated water or control groups.

In the current study, it was observed that feed intake (FI) was significantly ($P \leq 0.05$) increased especially in groups that received a combination of oxygenated and magnetic water (T4) and the treated group that drank magnetic water (T3). While T3 group registered the best FCR compared with the other groups as shown in Table (2).

The obtained results mentioned above indicated that the change that occurred in the properties of water as a result of exposure to a magnetic field could be related to the improvement in the growth rate as recorded in our study.

Table (2): Effect of oxygenated and magnetic water on Productive performance of Arbor Acres chicks (Means ± SE).

Parameters	T1	T2	T3	T4	Sig.
Body weight (g) at 7 days	200.10±0.31	200.30±0.33	200.20±0.16	200.20±0.14	NS.
Body weight (g) at 42 days	3126.70±72.40^{ab}	2980.00±37.0^{b}	3246.00±27.70^{a}	3239.70±44.70^{a}	*
Body weight gain (g) (7-42 days)	2926.60±72.50^{ab}	2779.80±37.18 ^{b}	3046.50±27.7^{a}	3039.50±44.60^{a}	*
Feed intake (g) from 7- 42 days	4445.70±39.80^{b}	4497.70±46.60 ^{b}	4560.30 ±11.8^{ab}	4649.00±31.00^{a}	*
FCR (g feed/g gain) 7 - 42 days	1.52±0.03^{b}	1.62±0.01^{a}	1.49±0.01^{b}	1.53±0.02^{ab}	*

$^{a, b, c.....}$ *means within a row that do not share common superscript differ significantly (P≤0.05)*

*T1- Control group, chicks received plain water without any treatment. T2- chicks received oxygenated water. T3- chicks received magnetic water. T4- chicks received oxygenated and magnetic water. FCR= feed conversion ratio. * Refer to significance level.*

These results are consistent with Al-Hassani and Amin (2012) which reported that BW significantly increased in broilers that consumed magnetized water. The reasons for such improvements in performance are most likely associated with the reduction of *E. Coli* load in the gut (Lee *et al.,* 2004), which is related to the microbial metabolites that affect the nutritional status as well as health. Also, (Olteanu *et al.*, 2012) reported that water quality significantly improves with magnetic water and this improvement is reflected in the broiler production parameters. Furthermore, the broilers treated with magnetic water improved their growth rate and their growing period was shortened and had lower mortality rate (Ali *et al.,* 2014). Day-old broiler chicks that received magnetic water for 5 weeks showed a significant rise in body weight compared to the non-treated control group (Mustafa, 2007). In addition, magnetized water significantly enhanced body weight, weight gain, and feed efficiency during 1-35 days of age (Al-Fadul, 2006). El-Hanoun *et al.* (2017) showed that broiler geese receiving magnetized tap water had a better body weight and feed conversion ratio than the group that received well water. Broiler chicks were given magnetized water showed improvement in final body weight, daily weight increase, feed conversion ratio, protein efficiency ratio, and production index (Ahmed *et al.,* 2018). Likewise, these results may be due to the reduction of biofilm formation inside the pipeline as the formation of biofilm by pathogens increases the danger of health problems for the chicks (Gholizadeh *et al.,* 2008). Also, when water is magnetized, cations and anions are rearranged in the medium in a way that produces numerous beneficial changes in water quality such as increasing the oxygen content, accelerating the solubility of minerals facilitating the movement of water and nutrients throughout the body's compartments, and promoting the growth of cells. As a result, the permeability of the cell wall will be improved and the surface tension will be decrease (Nakagawa *et al.,*1999; Olteanu *et al.,* 2012; Hafizi *et al.,* 2014). Furthermore, magnetic water treatment could improve the health of animals by decreasing lime deposition and the microbial load in water pipes (Sargolzehi *et al.,* 2009). As the results mentioned above, the using of magnetized water can improve the quality of drinking water, and this could positively enhance the bird's health and productive performance.

The magnetic field makes a change in water properties, so the characteristic of water turns very fertile and active causing a high oxygen content and speeding up the dissolving of salts and amino acids in water (El Sabry *et al.,* 2021) and increasing flexibility and penetration of water (Daviss, 2004). Also, the magnetic field of water makes improve blood picture (Milewski *et al.,* 2001), and improves blood circulation, oxygen, and transport of feed in the blood (Al-Nuemi *et al.,* 2015).

Antioxidant enzymes activities:

The results of the antioxidant enzymes as affected by drinking oxygenated and magnetic water are presented in Table (3). The values of total antioxidant capacity (TAC), glutathione (GSH), sodium dismutase (SODs), and catalase (CAT) showed a significant increase (P≤0.05) in the antioxidant enzymes

in treated groups, where T3 recorded a higher significant value in TAC, SODs and CAT flowed by T4 and T2 respectively compared to the control group (T1). The improvement observed in the antioxidant enzymes results by oxygenated or magnetic water in this study could keep the treated chicks healthy and gain more body weight than untreated birds. These results agree with those obtained by Khudiar and Ali (2012) who found that serum GPx concentration was significantly increased in rabbits treated with magnetic water daily for 60 days. Also, Shin *et al.* (2016) found that oxygenated water supplementation significantly enhanced the TAC, GPx, and SOD of broiler chickens.

The improvement in activities of TAC, GPx, SOD, and CAT in treatment groups drinking oxygenated and magnetic water could be considered as a protective system preventing or delaying the onset of oxidative stress. Such antioxidant effects would be expected to improve the bird's health (Newsholme *et al.*, 2003). Indeed, several studies reported that magnetized water could effectively influence the oxidant-antioxidant balance for instance, the activity of SOD increases in the magnetic water (Buyukuslu *et al.*, 2006). In studies with broilers or mice, magnetized water had a substantial impact on antioxidant capacity and decreased oxidative stress as shown by an increase in SOD activity in the heart, liver, and kidney and a reduction in malondialdehyde and nitric oxide levels (Soliman *et al.*, 2021).

Table (3): Antioxidant enzyme of Arbor Acres chicks affected by oxygenated and magnetic water at 42 d of age (Means ± SE).

Antioxidant enzymes	T1	T2	T3	T4	Sig.
Total antioxidant capacity (TAC) (U/ml)	345.67±8.19 [b]	509.67±11.55[a]	561.33±5.20[a]	533.33±6.64 [a]	*
Glutathione (GSH) (U/ml)	46.00±7.02[b]	61.33 ±1.20[a]	60.66±1.20[a]	65.00±1.52[a]	*
Sodium dismutase (SODs) (U/ml)	11.93±0.83[c]	14.43 ±0.39[b]	17.90±0.20[a]	16.03 ±0.39 [ab]	*
Catalase (U/ml)	41.97±3.18 [c]	49.80±0.70 [b]	56.46 ±1.13 [a]	52.43±2.39 [ab]	*

[a, b, c……] means within a row that do not share common superscript differ significantly (P≤0.05)

*T1- Control group, chicks received plain water without any treatment. T2- chicks received oxygenated water. T3- chicks received magnetic water. T4- chicks received oxygenated and magnetic water. * Refer to significance level.*

Intestinal bacterial count:

The results of the effect of both oxygenated and magnetic water in the intestinal total microbial (total colony count and coliform count) were shown in Table (4). The analysis of variance indicated that total colony and coliform counts were almost significantly (P≤0.05) decreased due to the treatment in the drinking water compared with the control group.

Table (4): Intestinal bacterial count of Arbor Acres chicks affected by oxygenated and magnetic water at 42 d of age (Means ± SE).

Parameters	T1	T2	T3	T4	Sig.
Total colony count	5.45±0.19 [a]	2.75±0.15 [b]	3.04±0.12 [b]	2.67±0.16 [b]	*
Coliform count	3.96±0.13 [a]	1.94±0.11 [c]	2.48±0.07 [b]	1.56±0.23 [c]	*

[a, b, c……] means within a row that do not share common superscript differ significantly (P≤0.05)

*T1- Control group, chicks received plain water without any treatment. T2- chicks received oxygenated water. T3- chicks received magnetic water. T4- chicks received oxygenated and magnetic water. * Refer to significance level.*

These findings could be attributed to that water directly exposed to a magnetic field may prevent *E. coli* from growing (Anne *et al.*, 2016). In vitro, the survival of *Salmonella typhimurium and E. coli* could both be reduced by magnetized water by 54.91% and 39.89%, respectively (Soliman *et al.*, 2021). El-Katcha *et al.* (2018) found that magnetic water reduced pathogenic bacteria when birds challenged with *Salmonella enteritidis*, broiler chickens displayed superior performance, health, and immunity. Furthermore, Soltan *et al.* (2018) reported that a significant increase was observed in the lactic acid bacterial count (44.4%) and *Lactobacillus* bacteria (14.6%) when comparing broilers treated with magnetized water to those in the control group. Moreover, there was a more significant reduction in the total intestine bacterial count (39.3%) and coliform count (40%). Soliman *et al.* (2021) found that the broilers were given magnetic water (13200 gausses) for six hours daily from the fifth day till day 35 of age

resulting in a significant decrease in the total bacterial count and *E. coli* count in the digestive tract, indicating the low resistance and neutralization of pathogenic microorganisms. On the other hand, Zimmerman *et al*. (1991) indicated that dissolved oxygen concentration (DO) in oxygen-enriched drinking water (10.3:14.2) was found to decrease the microbial count in water, which confirmed the toxic impact of high DO (10.3:14.2) content on the microorganism.

Antibody titer response:

The results of antibody titer as affected by oxygenated and magnetic water are presented in Table (5). The analysis of variance showed that antibody titer response significantly (P≤0.05) increased in T3 that received magnetic water compared with other groups. Whereas other treatments (oxygenated water or mixed H_2O with oxygen and magnetic) did not improve antibody titer response against Newcastle disease. These results are convenient with the findings of El-Hanoun *et al.* (2017), who discovered that when Egyptian male geese drank magnetized water with a 6000-gauss magnetic field, serum IgM, IgG, and IgA were significantly increased. El-Katcha *et al.* (2017) concluded that phagocytosis was greatly enhanced in the Pekin duckling group that received magnetic water compared to the control group. Moreover, Soliman *et al.* (2021) found that treating broiler chickens with magnetic water resulted in a significant increase in the total IgG and IgM antibodies against the live ND virus. In addition, magnetized water significantly enhanced antibody titer against live ND virus vaccine in broiler chickens infected with *Salmonella enteritidis* (El-Katcha *et al.*, 2018). Further, according to an in vitro study, the ND virus vaccination titer significantly decreased when administered in water, saline, and magnetized water at levels of 94.13 %, 84.5 %, and 10.31%, respectively (Soliman *et al.*, 2021). On the other hand, these results disagreed with those of Al-Mufarrej *et al.* (2005) who showed that the exposure of water to a magnetic field did not influence antibody responses to the antigen of sheep red blood cells in broiler chickens.

Table (5): Antibody titer against Newcastle of Arbor Acres chicks affected by oxygenated and magnetic water (Means ± SE).

Parameters	T1	T2	T3	T4	Sig.
Antibody titer (log2) at 42 days	5.33±.03 ^{b}	5.00±0.57 ^{b}	7.00±0.57 ^{a}	5.00± 0 ^{b}	*

$^{a, b, c\ldots\ldots}$ means within a row that do not share common superscript differ significantly (P≤0.05)

*T1- Control group, chicks received plain water without any treatment. T2- chicks received oxygenated water. T3- chicks received magnetic water. T4- chicks received oxygenated and magnetic water. * Refer to significance level.*

Thyroid (T3, T4) hormone assay:

The results of oxygenated and magnetic drinking water effects on the thyroid hormones (Total and free T3 and T4) in broiler chicks at the end of the experimental period are outlined in Table (6). The analysis of variance showed that there were no differences in total or free T3 hormone in all treatment groups, but there were significant differences in total and free T4 between the experimental groups. T2 and T4 groups were significantly (P≤0.05) higher in the total T4 hormone, but there was no difference between T1, T2 and T4 groups in the free T4 hormone.

Table (6): Effect of oxygenated and magnetic water on thyroid hormone levels of Arbor Acres chicks at 42 d of age (Means ± SE).

Parameters	T1	T2	T3	T4	Sig.
Total T3 (ng/dl)	131.83±5.1	134.57±3.85	125.47±3.82	123.27±3.07	NS.
Free T3 (ng/dl)	4.20±0.15	4.06±0.06	4.05±0.10	4.03±0.18	NS.
Total T4 (ng/dl)	8.33±0.26^{ab}	9.00±0.15^{a}	7.36±0.58^{b}	9.20±0.17^{a}	*
Free T4 (ng/dl)	1.92±0.04^{a}	1.68±0.13^{ab}	1.48±0.09^{b}	1.69±0.08^{ab}	*

$^{a, b, c\ldots\ldots}$ means within a row that do not share common superscript differ significantly (P≤0.05)

*T1- Control group, chicks received plain water without any treatment. T2- chicks received oxygenated water. T3- chicks received magnetic water. T4- chicks received oxygenated and magnetic water. * Refer to significance level.*

It is well known that thyroid hormones (T3 and T4) play a vital role in controlling thermoregulation and nutrient metabolism, which is influenced by internal and external factors, including exposure to various

stressors (Mancini *et al.*, 2016 and Garasto *et al.*, 2017). Regulation of thyroid functions such as T3 and T4 hormone concentrations is essential for the maintenance of body temperature via energy metabolism in homeothermic animals including chickens (Jiang *et al.*, 2020).

Unfortunately, there is no available review regarding the effect of oxygenated and magnetized water on the concentration of thyroid hormones in the serum of broiler chickens.

CONCLUSION

the use of oxygenated water 28 mg/l and magnetized water with magnetic field 14500 Gauss in the poultry production system could be regarded as an alternative strategy to improve the production traits of broilers. In addition, oxygenated and magnetized water could improve all studied parameters such as antioxidant enzymes, thyroid hormones, intestinal bacterial count, and immunity, which could have reflected in improved nutrient absorption and increased growth rate. Therefore, further research in this area is needed and encouragement of poultry farmers to treat birds with magnetized water is recommended.

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تأثير الماء المؤكسج والماء الممغنط على الأداء الإنتاجي ونشاط الأنزيمات المضادة للأكسدة والحمل الميكروبي المعوي في دجاج اللحم.

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أجريت هذه الدراسة بهدف دراسة تأثير استخدام الماء المؤكسج والماء الممغنط أو الخليط منهما على الأداء الإنتاجي والمناعة وحالة مضادات الأكسدة في دجاج اللحم. استخدم في هذه الدراسة عدد 240 كتكوت تسمين عمر أسبوع من سلاله أربور آيكرز، حيث تم وزنها وتوزيعها عشوائياً إلي أربع مجموعات كل مجموعة بها ثلاث مكررات بواقع 20 طائر في كل مكررة وكانت المجموعات كالتالي: -

المجموعة الأولى مجموعة الكنترول، والمجموعة الثانية اتيح لها الماء المؤكسج والذي يحتوي على 28 مليجرام أكسجين/ لتر ماء، والمجموعة الثالثة اتيح لها الماء الممغنط، بقوة 14500 جاوس والمجموعة الرابعة أعطيت مزيج من الماء المؤكسج والماء الممغنط (خليط من المجموعة الثانية والثالثة).

أظهرت النتائج أن المجموعة الثالثة والرابعة كانتا أعلي معنوياً في وزن الجسم وكذلك في العلف المأكول من المجموعة الأولي (الكنترول) والمجموعة الثانية اتيح لها الماء المؤكسج والذي يحتوي على 28 مليجرام أكسجين/ لتر ماءكما لوحظ زيادة معنوية في تركيز إنزيمات مضادات الأكسدة (مثل القدرة الكلية المضادة للأكسدة (TAC) الجلوتاثيون (GSH) والكتاليز (CAT) والسوبر أكسيد ديسميوتاز (SOD) في المجموعات المعاملة بالماء المؤكسج والممغنط أو الخليط بينهما (المجموعة الثانية والثالثة والرابعة) مقارنة بمجموعة الكنترول.

أوضحت النتائج أن المجموعة الثالثة والتي أعطيت الماء الممغنط كانت أعلي معنوياً في تركيز الأجسام المضادة ضد مرض النيوكاسل مقارنة مع المعاملات التجريبية الأخرى. علاوة على ذلك أظهرت النتائج أن المجموعة الثانية والرابعة كانت منخفضة معنوياً فيما يتعلق بالعد الميكروبي مقارنة بالمجموعات التجريبية الأخرى. ومن خلال نتائج هذه الدراسة يمكن أن نستنتج أن استخدام الماء المؤكسج والماء الممغنط أو الخليط بينهما أدى إلى تحسن النمو والمناعة وقلل من الحمل الميكروبي في أمعاء الطيور، علماً بأن هذا الموضوع يحتاج إلى مزيد من الأبحاث والدراسات.