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Effect of drinking magnetized water on immunity and carcass quality of broiler chicken

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Target audience: *Broiler chicken farmers, poultry farmers keeping layers, aquaculture farmers, dairy producers,*

Abstract

This study was conducted to determine the effect of drinking Magnetized Water (MW) on the immunity of broiler chicken. The problem which this study focused on was the mortality rate of broiler chicken which is common in some poultry farms in Nigeria due to some factors that could lead to loss of income. There is a need for economical methods for boosting the immunity of Broiler Chicken (BC) in order to reduce the mortality rate. BC (Arbor Acres breed) was given MW. The magnetized water was produced by passing water through the magnetic field in a pipe. The treatments were MW treated for 33s by passing the water through pipe surrounded with magnets one time(T_1), MW treated for 66 s by flowing twice through the magnetic unit (T_2), T_3 was MW treated for 99 s and control (Non-Magnetized Water, NMW, T_0). A total of 80 BCs (day old) with 20 BC for each treatment were given MW (T_1, T_2 and T_3), NMW and monitored for 7 weeks. Blood samples were collected for hematology and analyzed using standard methods. The values of white blood cell for T_0, T_1, T_2 and T_3 were 153.61×10^{-9}/L, 133.20×10^{-9}/L, 134.78×10^{-9}/L and 101.12×10^{-9}/L and for lymphocytes, were 137.08×10^{-9}/L, 120.79×10^{-9}/L, 125.49×10^{-9}/L and 96.12×10^{-9}/L, respectively. MW T_1, T_2 and T_3 increased body weight gain of the BC by 410, 320 and 210g/broiler. Protein contents of the carcass for T_1, T_2, T_3 and T_0 were 13.13%, 13.23%, 13.18% and 12.80%, respectively. MW can therefore enhance production of healthy broiler chickens.

Keywords: *animal protein, broiler chicken, hematology, immunity, magnetized water, poultry*

Description of Problem

Production of broiler chicken in Nigeria is a good business that could have positive impact on the economy of the country and income for the investors. One of the problems of broiler chicken in Nigeria especially rearing of day-old chickens to maturity stage is high mortality rate in some areas. This high mortality rate normally results to loss (death) of high percentage of the broiler chickens due to certain diseases such as Coccidiosis, Newcastle, Gumboro, Salmonellosis as reported by (1). There is a need for economical methods for boosting the immunity of the broiler chickens in order to reduce the high mortality rate in poultry farms in addition to the available chemical methods (drugs) for curing the diseases. Water is a compound and natural resource that supports life. Water is indispensable for both plant and animal, it is essentially required for normal healthy growth and development. Water is needed for almost all the metabolic processes of animals. Magnetized water and magnetization of other substances have been used in agriculture, engineering, wastewater treatment and it has also been used in health for curing and prevention of some diseases (2, 3 and 4). It was pointed out by (5) that drinking magnetized

water had positive effect on the performance of the broiler chicken.

Magnetized water which is called magnetically treated water or magnetic water, it is produced when water is allowed to flow through the magnetic field in a pipe or hose but the flow of water must cut the magnetic field at right angle based on the Fleming's right-hand rule so that the water could be magnetically treated, otherwise, there would be no effect of magnetic field on the water. The technology of giving broiler chickens magnetized water is to accelerate the growth rate, improve the feed conversion ratio and boost the immunity of the broiler chickens (6). The bonding angle of magnetized water is reduced from 104° to 103°, reduction of the surface tension, increased solubility of magnetized water and plant could easily absorb magnetized water (2). Magnetized water improved the immunity of the broiler chicken (6). Magnetized water also improved the nutritional quality of tomato (7). Magnetized water increased the body weight and feed conversion efficiency of the broiler chicks (8).

Magnetized water is produced by allowing water to flow for 15 s through magnetic field (9) but (10) stated that 1-10 minutes is required for effective production of magnetized water using circulation flow method. Water becomes magnetized water (magnetic water) when water passes through the magnetic field. Magnetized water would not attract magnetic materials like iron rod but the molecular structure, the surface tension, the bonding and the solubility power of the magnetized water would be modified (2). The objectives of this study were to determine the effect of magnetized water on the immunity of broiler chickens, body weight and to determine the protein content of the carcass (carcass quality) of the broiler chicken.

Materials and Methods

Location of the study

The study was carried out at the Department of Agricultural and Biosystems Engineering, University of Ilorin, Ilorin, Nigeria. Ilorin lies on latitude 8°30^{1}N and longitude 4°35^{1}E, with about 340 m above the mean sea level (11). Ilorin is located in the Southern Guinea Savannah of Ecological Zone of Nigeria with mean annual rainfall of about 1,300 mm with wet season begins at the end of March and ends by the ending of October while the dry season starts in November and ends in March (12). The mean maximum temperature of Ilorin is 38°C with mean relative humidity of 77.50% and daily mean sunshine hour of 7.1 h.

Magnetic treatment unit and production of the magnetized water

The magnetic treatment unit was fabricated from 10 × 25 × 50 mm neodymium magnet. Neodymium magnet is a permanent magnet that is produced by adding Neodymium (Nd), Iron (Fe) and Boron (B) together to form NdFeB magnet. It is the strongest magnet available globally with magnetic flux density ranging from 1.0-1.5 Tesla (1 T = 10,000 G) and above. The neodymium magnet is effective at room temperature and can work effectively at high temperature up to 80 °C without demagnetization. Magnetic field from other permanent magnets or electromagnet with magnetic flux density ranging from 2000 - 5500G could also be used to produce magnetized water but the residence time for treating the water could be increased to 55 - 120 s. The magnetic treatment unit consists of a pipe 20 by 60 mm rectangular transparent pipe and 960 mm long fabricated from Perspex glass which is surrounded with 12 pieces of the neodymium magnet. Three (3) pieces of neodymium magnet were arranged on the sides of 320 mm long rectangular plastic pipe (transparent made of Perspex glass). The 3 layers of the rectangular plastic pipe were connected together using 12.7 mm (0.5 inch) elbow pipe. This was done to maximize the available pieces of 12 neodymium magnets and to make it compact without taken too much space for the magnetic treatment unit. The

magnetic treatment unit is connected to a 50 litres bucket with 25.4 mm pipe and control tap for regulating the flow of water. The isometric view and pictorial view of the magnetic treatment unit are shown in Figures 1 and 2.

The water given to the broiler chickens was obtained from borehole in the poultry farm and allowed to flow through the magnetic treatment unit one (1) time for 33 s as T_1, T_2 for 66 s when the water was allowed to pass through the magnetic treatment unit 2 times and T_3 for 99 s when the water was allowed to pass through the magnetic treatment unit 3 times. T_0 is the control (Non-Magnetized Water, NMW). When water flows through the magnetic field and become magnetized water or magnetically treated water, the magnetic field changed the molecular structure of the magnetized water. Figure 3 shows the Scanned Electronics Microscope (SEM) of the molecular structure of the water before and after passing through the magnetic field with magnification of 27,000.

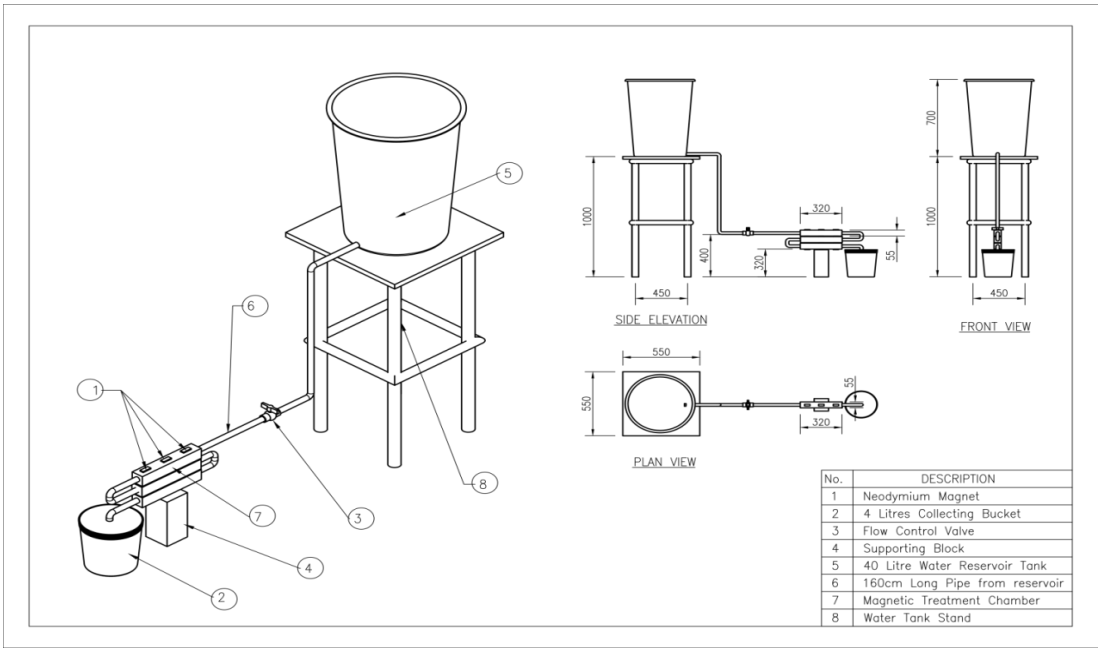

Figure 1 Isometric view of the magnetic treatment device for producing magnetized water

Figure 2 Pictorial view of the magnetic treatment unit for producing magnetized water

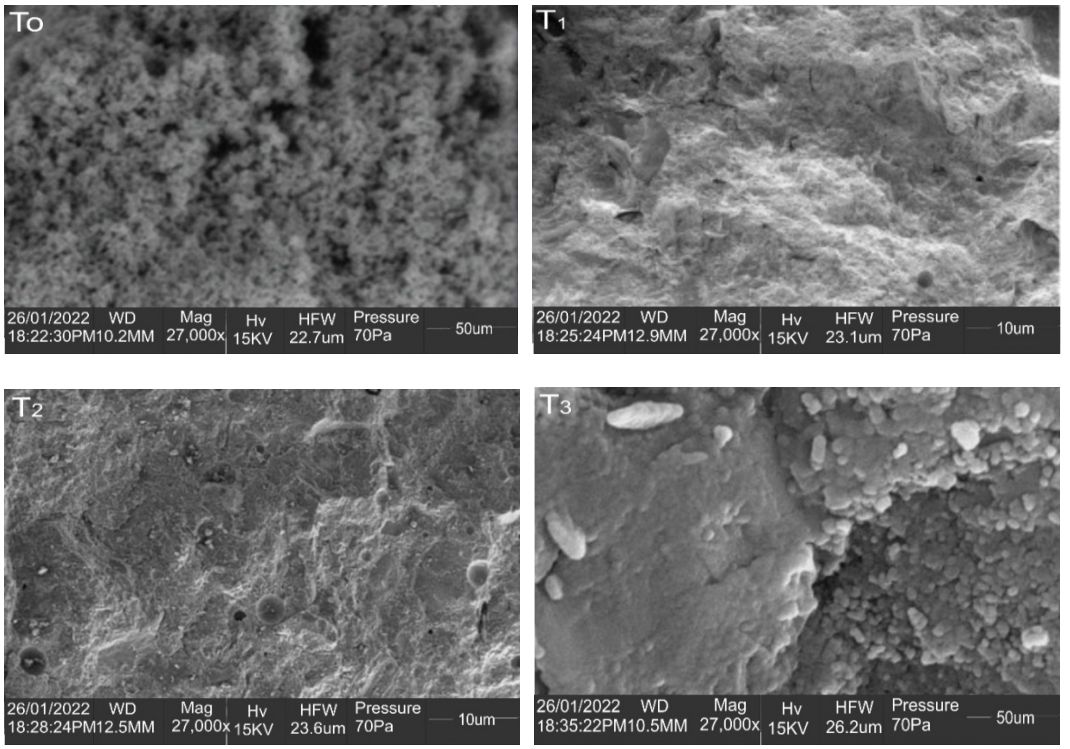

Fig. 3: Scanned Electronics Microscope (SEM) of the molecular structure of the water (Magnification = 27000×)
T_0 = Non-magnetized water (Control) before magnetized
T_1 = Magnetized water treated for 33 s (Water flows once through the magnetic treatment unit)
T_2 = Magnetized water treated for 66 s (Water flows twice through the magnetic treatment unit)
T_3 = Magnetized water treated for 99 s (Water flows times through the magnetic treatment unit)

Magnetized water for the broilers

A total of 80 broiler chickens were used in this study but 20 broiler chickens for each water treatment. The broiler chickens for each treatment (T_1, T_2, T_3 and T_0) were fed with same type of feed (starter and grower feeds) and the same quantity of feed for each treatment but the quantity of the feed varied from week 1 to week 7. The quantity of magnetized water for each treatment (T_1, T_2, T_3 and T_0) given to the 20 broiler chickens in a black plastic bowl was 5 litres per day (24 hours). Two stones (3 kg each) were put inside the plastic bowl to hold the plastic bowl firmly on the ground and to prevent the broiler chickens from pouring it down but the stone would not react with the water. The water was changed every 24 hours because the properties of magnetized water could be reduced after 24 hours (13).

Measurement of growth rate of the broiler chicken

The birds were individually weighed on treatment basis every week so as to determine the growth rate and calculate the body weight gain per week. The electric weighing machine was used. The quantity of feed given to the birds in each treatment was measured on the electric weighing machine and recorded.

Collection of blood sample and meat for analysis

Four (4) female birds were selected on uniform average weight on group basis at the end of 7 weeks for blood evaluation. A syringe and needle were used to collect 2.5 ml blood sample from the vein of each bird. The blood

samples collected were stored in bottles containing anticoagulant (ethylene diamine tetra acetic, ETDA)acid and were taken to the laboratory of the University of Ilorin Teaching Hospital, Ilorin for the determination of Hemoglobin ((Hb), total number of White Blood Cells (WBC) and Red Blood Cells (RBC) using RAYTO heamatology.

The meat sample (50 g) was taken from the chest region which contain mainly flesh from the four (4) female birds selected for blood samples. The meat after collection was immediately taken to the Central laboratory of the University of Ilorin, Ilorin for the determination of the percentage protein content in the carcass of the broiler chicken. The crude protein was determined using Kjedahi method by measuring the Nitrogen content of the carcass (meat) as given by (14).Percentage Nitrogen and protein present in the meat sampled were determined from Equations (1) and (2), respectively.

$$\%\, Nirogen = \frac{0.014 \times 0.01M\ HCl \times (250-5) \times Titre\ Value}{Weight\ of\ sample\ used\ for\ digestion} \times 100 \quad (1)$$

$$\%\, Protein = \%\, Nitrogen \times 6.25 \quad (2)$$

Determination of Paired t-test for the body weight gain and blood parameters

Paired t-test was used to check if the effect of magnetized was significant on the body weight gain of the broiler chicken or not. The Paired t-test was also used to know if the effect was significant on the blood parameters (immunity). The mean difference between the results of magnetized water and that of control was determined. The mean, the standard deviation, the standard error and the t-test values were determined using Equations (3), (4a) or (4b), (5) and (6), respectively as given by (15). The data of the body weight gain used for the computation of the paired t-test as an illustration was obtained from Table 3 and presented in Table 1 for illustration.

$$\overline{d} = \frac{\sum d}{n} \quad (3)$$

$$\delta = \sqrt{\frac{\sum d^2 - n(\overline{d})^2}{n-1}} \quad (4a)$$

$$\delta = \sqrt{\frac{\sum (d-\overline{d})^2}{n-1}} \quad (4b)$$

$$\delta_{Er} = \frac{\delta}{\sqrt{n}} \quad (5)$$

$$t_{cal} = \frac{\overline{d}}{\delta_{Er}} \quad (6)$$

where $\overline{d}$ = mean of the difference from x_1 and x_2, Σd = summation of d, n = number of the observations, δ = standard deviation, δ_{Er} = standard error and t_{cal} = calculated value of t at $\alpha = 0.025$ % significant level.

Table 1: Data of body weight gain extracted from Table 3 for computation of the Paired t-test

Body weight MW (T_1)	Body weight NMW(T_0)	$d = T_1 - T_0$	d^2
1000	780	220	48400
1300	1100	200	40000
1700	1420	280	78400
2100	1660	440	193600
2250	1840	410	168100
n = 5		**$\sum d = 1,550$**	**$\sum d^2 = 528,500$**

T_0, T_1, T_2, and T_3, were as defined in Figure 3

$$\overline{d} = \frac{1550}{5} = 310 \quad (3)$$

$$\delta = \sqrt{\frac{528500 - 5(310)^2}{5-1}} = 109.545 \quad (4a)$$

$$\delta_{Er} = \frac{109.545}{\sqrt{5}} = 48.990 \quad (5)$$

$$t_{cal} = \frac{310}{48.990} = 6.328 \quad (6)$$

Similarly, T_0 versus T_2, calculated value of t (t_{cal}) = 4.282 and T_0 versus T_3, t_{cal} = 5.734

The table value of t-test (t_{Table}) is 3.495 at

$\alpha \leq 0.025$ and degrees of freedom is 4. The calculated values of t were greater than the table value at $\alpha \leq 0.025$ and degrees of freedom is 4. The effect of magnetized water on the body weight was significant at $\alpha \leq 0.025$.

Paired t-test for the blood parameters

The Paired t-test was also used to check if the blood parameters that are responsible for normal healthy growth, development and immunity of the birds were considered as a unit of treatment for magnetized water (MW) or Non-Magnetized Water (NMW). The data extracted from Table 4 and presented in Table 2.

$$\overline{d} = \frac{42.02}{12} = 3.502 \quad (3)$$

$$\delta = \sqrt{\frac{705.0092 - 12(3.502)^2}{12-1}} = 7.121 \quad (4a)$$

$$\delta_{Er} = \frac{7.121}{\sqrt{12}} = 2.056 \quad (5)$$

$$t_{cal} = \frac{3.502}{2.056} = 1.703 \quad (6)$$

Similarly, T_0 versus T_2, calculated value of t (t_{cal}) = 1.966 and T_0 versus T_3, t_{cal} = 1.812

The table value of t (t_{Table}) is 2.201 at $\alpha \leq 0.05$ and degrees of freedom is 11. The calculated values of t were less than the table value at $\alpha \leq 0.05$ and degrees of freedom is 11. The effect of magnetized water on the overall blood parameters was not significant at $\alpha \leq 0.05$.

Table 2: Data of blood parameters extracted from Table 4 for computation of the Paired t-test

Blood parameters NMW (T_0)	Blood parameters MW(T_1)	d = T_1 - T_0	d^2
153.61	133.20	20.41	416.5681
2.34	2.38	-0.04	0.0016
137.08	120.79	16.29	265.3641
43.00	44.00	-1.00	1.0000
91.54	92.57	-1.03	1.0609
8.00	9.05	-1.05	1.1025
0.03	0.04	-0.01	0.0001
117.69	114.93	2.76	7.6176
27.49	27.31	1.85	3.4225
9.10	6.83	2.27	5.1529
7.43	5.53	1.90	3.6100
12.80	13.13	-0.33	0.1089
n = 12		**$\sum d$ = 42.02**	**$\sum d^2$ = 705.0092**

Results and Discussion

Results

The growth rate which was measured in term of the body weight gain was presented in Table 3. The body weights by the broiler chickens were higher for the birds given magnetized water as shown in Table 3 but bird given magnetized water treated for 33 s and passed through the magnetic treatment unit once (T_1) had the highest body weight gain at the end of week 7. The results of blood parameters (Heamatology) and the protein content of the carcass for the broiler chicken were presented in Table 4. The white blood cell, red blood cell, lymphocyte, platelet blood, mean cell heamoglobin were presented in Table 4. The broilers that were given non-magnetized water had the highest value of white blood cell while the birds given magnetized water had low values of white blood cell. The mean body weight (growth rate) at the end of week 7 when the birds are ready sale was shown in Figure 4.

Table 3 Mean body weight (growth rate) of the broiler chicken

Week	Feed per week for 10 birds (g)	Mean body weight gain (g/bird)			
		T_0	T_1	T_2	T_3
3	7000	780	1000	900	870
4	8000	1100	1300	1200	1180
5	9250	1420	1700	1800	1572
6	10500	1660	2100	2000	1800
7	11500	1840	2250	2160	2050

T_0 = Non-Magnetized Water (Control); T_1 = water magnetized treated for 33s; $T_{2:}$ = magnetized treated for 66 s; $T_{3:}$ = magnetized water treated for 99 s.

The Red Blood Cell (RBC) transports oxygen from the lungs to the rests of the body and taking carbon dioxide back to the lungs to be exhaled. It gives the blood the distinctive red colour. The highest level of Platelet was found in birds given magnetized water treated for 33 s (T_1). Birds given magnetized water treated for 33s had the highest Red Blood Cell compared to other treatments which showed that the birds were less prone to fatigue, dizziness and other symptoms. Lymphocyte is the type of White Blood Cell that plays a key role in immunity and protects the body from infections.

The protein contents of the carcass for the magnetized water treated for 33 s(T_1), magnetized water treated for 66 s (T_2), magnetized water treated for 99 s (T_3) and control (T_0)were 13.13%, 13.23%, 13.18% and 12.80%, respectively as presented in the Table 4.Magnetized water enhanced a better red blood cell for the broiler chicken compared to broiler chicken given non-magnetized water. Given broiler chicken magnetized water improved the white blood cell and lymphocyte to boost the immunity of the broilers compared to the broilers given non-magnetized water Magnetized water increased the platelets of the broiler chicken. It also improved the carcass quality (protein content) by 2.58-3.36%.

Table 4 Blood parameters (Hematology) of the broiler chicken

Blood parameters	T_0	T_1	T_2	T_3
White Blood Cell (WBC) (10^{-9}/L)	153.61	133.20	134.78	101.12
Red Blood Cell (RBC) 10^{-12}/L	2.34	2.38	2.36	2.22
Lymphocyte (10^{-9}/L)	137.08	120.79	125.49	96.29
Lymphocyte (%)	91.54	92.57	94.53	96.07
Platelet (PLT)	43.00	44.00	35.00	32.00
Mean Platelet Volume (MPV) fl	8.00	9.05	7.45	8.62
Platelet Volume Distribution Width (PDW) %	14.01	11.44	15.72	12.38
Platelecrit (PCT) %	0.03	0.04	0.03	0.03
Mean Cell Heamoglobin (MCH) pg	0.00	0.00	41.03	0.00
Mean Cell Heamoglobin Concentration (MCHC) g/L	0.00	0.00	349.92	0.00
Mean Cell/ Corpuscolar Volume (MCV) fl	117.69	114.93	117.27	116.77
Heamoglobin (HGB) g/dl	0.00	0.00	9.7	0.00
Heamotocrit (HCT) %	27.49	27.31	27.72	25.92
Granulocyte (GRA) 10^9/L	9.10	6.83	4.69	2.05
Granulocyte %	1.72	1.74	0.81	0.36
MID	7.43	5.58	4.60	2.78
MID %	6.74	5.69	4.66	3.57
Protein of the carcass (%)	12.80	13.13	13.23	13.18

T_0, T_1, T_2 and T_3 were as defined in Figure 3 and Table 3

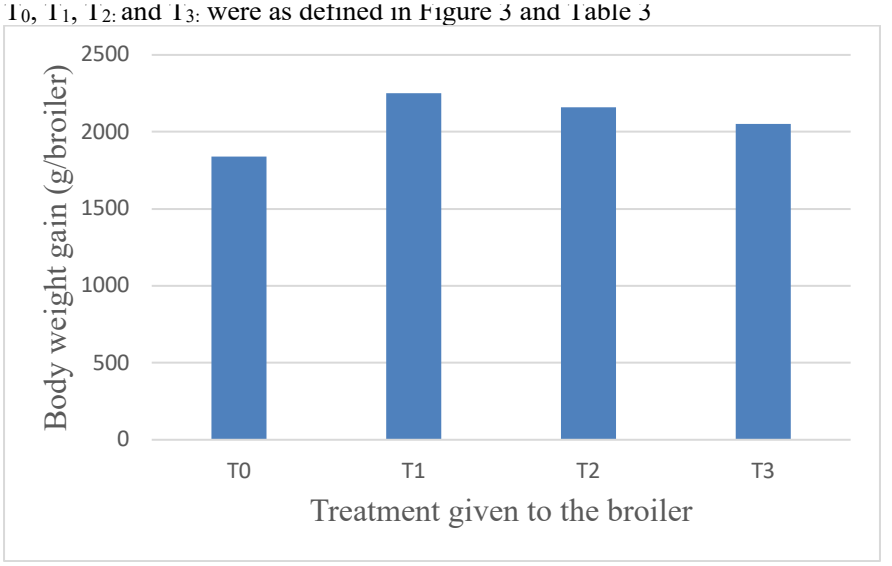

Figure 4 Mean body weight (growth rate) of broiler chicken at the end of week 7
T_0, T_1, T_2 and T_3 were as defined in Figure 3 and Table 3

Discussion

From Table 3, magnetized water increased the growth rate and body weight gain of the broiler chicken compared to the control (birds that were given non-magnetized water). The magnetized water enhanced the rate of digestion and improved the digestibility of the feed which could accelerate or stimulate the growth rate of the birds. The body weight gain of the broiler chickens that were given magnetized water T_1, T_2 and T_3increased by 410 g/broiler, 320 g/broiler and 210 g/broiler, respectively. This was in agreement with study of (5) that magnetized water improved the growth rate of broiler. The magnetized water (MW)T_3 that was treated for 99 s was expected to have a higher body weight gain than T_1 (MW treated for 33 s) and T_3 (MW treated for 66 s) but probably by passing the water through the magnetic field for the second time or the third time was revising or reducing the impact of the magnetic field on the water after it has passed through the magnetic field once before. The effect of magnetized water was statistically significant on body weight gain (growth rate) of the broiler for T_1, T_2 and $T_3$with the calculated values of t were 6.328, 4.282 and 5.734, respectively which is greater than the table value of 3.495 at $\alpha \leq 0.025$.

The broiler chickens that were given non-magnetized water had more white blood cells than the broiler chickens given magnetized water as presented in Table 4. White blood cell protects the body from infections as pointed out by (16) and high value of white blood cell indicated that the broiler chickens must have experienced stress and had more infections or fighting more infections than the broiler chickens given magnetized water with low values of white blood cell. The broiler chickens that were given magnetized water that was treated for 99 s (T_3) had a balanced white blood cell with lowest value which indicated that the birds given T_3had less tendency of having infections compared to the control and other two treatments of magnetized water. Magnetized water enhanced better immunity of the broiler chickens and reduced mortality rate as reported by(16).

The Red Blood Cell (RBC) transports oxygen from the lungs to the rests of the body and taking carbon dioxide back to the lungs to be exhaled. It gives the blood the distinctive red colour. A low red blood cell count could

and other symptoms (17). Birds given magnetized water treated for 33 s had the highest Red Blood Cell presented in Table 4 compared to other treatments which showed that the birds were less prone to fatigue, dizziness and other symptoms. This was in agreement the study by (16) that animals given magnetized water had a significant increase in red blood cell count.

Platelet is the blood cell that helps blood to clot and avoid excessive bleeding. Platelets are blood cells that control bleeding in case of injury and could prevent mortality (18). The highest level of Platelet was found in birds given magnetized water treated for 33 s (T_1) as shown Table 4. Lymphocyte is the type of White Blood Cell that plays a key role in immunity and protects the body from infections. A high lymphocyte indicated that the body was dealing with an infection or inflammatory condition as stated by (16). Broiler chickens given magnetized water (T_1, T_2 and T_3) had low values of lymphocyte but T_3 treated for 99 s had the lowest value of lymphocyte. Birds given magnetized water had a higher immunity compared to control birds given non-magnetized water. Mean platelet Volume (MPV) measures the average size and number of the platelets in the blood. T_4 had the highest value of MPV which indicated that the birds had the highest number of platelets as shown in Table 4. The effect of magnetized water was not significant on the blood parameters of the broiler(considered as a unit) with the calculated values of t for T_1, T_2 and T_3were 1.703, 1.966 and 1.812, respectively which were less than the table value of 2.201 at $\alpha \leq 0.05$.

Conclusion and Applications

1. Magnetized water was produced by allowing the water to flow through magnetic field for 33 s, 66 s and 99 s,
2. Magnetized water was found to have positive impact on the growth rate and the immune system of broiler chickens,
3. Broiler chickens given magnetized water treated for 33 s had a better immunity than the birds treated with 66 s (that flow 2 times through the magnetic treatment unit) and 99 s (that flow 3 times through the magnetic treatment unit),
4. Water magnetized for 33 s and 99s had the lowest level of lymphocyte which plays a major role in immunity and protects the body from infections,
5. Magnetized water increased the carcass quality (protein content) by 2.58 - 3.36% and higher red blood cells count for healthy growth and development,
6. Magnetized water is recommended for the production of broiler chicken for healthy growth and development, high immunity and low mortality rate of broiler chickens,
7. More research is needed to understand the principles and impact of magnetized water on broiler chickens and other domestic animals.

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