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The Effect of Magnetic Water on Feed Conversion Ratio, Body Weight Gain, Feed Intake and Livability of Male Broiler Chickens

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The Effect of Magnetic Water on Feed Conversion Ratio, Body Weight Gain, Feed Intake and Livability of Male Broiler Chickens

An Honors Thesis in partial fulfillment of the requirements of Honors Studies in Animal Science

By

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ABSTRACT

Passing water through a magnetic field has been shown to have positive effects in agricultural activities such as crops, cattle and poultry production (Ali, Samaneh and Kavakebian, 2014). Several experiments performed in Middle Eastern countries have evaluated the effect of magnetizing drinking water on poultry performance, but results are inconsistent. The current project was conducted to evaluate the effect of magnetizing the drinking water on key aspects of poultry production such as Feed Conversion Ratio, Body Weight Gain, Feed Intake and Livability. Four hundred and forty-nine male Cobb-500 chicks were randomly placed in 6 replicate pens for each of 3 treatments (25 chicks per replicate pen). The treatments were T1 (Control-non-magnetized water), T2 (water magnetized with large N52 magnet at a distance greater than 15 feet from consumption point) and T3 (water magnetized with individual small N52 Magnet less than one foot from water consumption point). The drinking water was continuously exposed to an 1850 gauss magnetic field for both treatments. Birds and feed were weighed weekly from day 0 to 42. No significant improvements were observed for any of the parameters measured for either treatments as compared to the performance of birds consuming the untreated water. Results indicate that magnetizing the water for broiler chickens receiving a dietary regimen which meets their nutritional requirements was not beneficial.

INTRODUCTION

Water is the primary fluid necessary for human life. About 60% of the human body composition is water and life would not be possible without it (Chaplin, 2001). Not only is water important for the optimal functioning of the human body, but also it is the most important nutrient in the diet of some animals and the development of plants. A significant percentage of the water in the world is used in agriculture practices. In the United States, 80% of the national water consumption is used in agriculture (USDA, 2016). As we move towards a growing population not only will we need more water for human consumption, but also to produce food. To illustrate, to produce 1kg of beef in California, it requires 13.5 m^3 of water (Rijsberman, 2005).

Currently, there are several techniques used to improve water quality, and one of them involves the use of magnetic forces to magnetize the water. Magnetic water has been used for several decades in different fields. Some of the main benefits attributed to magnetic water in agricultural practices are that it increases soil and water quality, crop yields, germination rate, and eliminates scale formation in pipelines (Ali, Samaneh & Kavakebian, 2014). In addition, Yacout (2015) found in his study that sheep significantly increased their milk fat and yield when consuming magnetized water. Besides that, he also found that magnetized water is beneficial to the environment because it reduced the production of methane and the levels of ammonia-N-concentration in the excreta of lambs (Yacout, 2015).

Another important area in which magnetic water has had positive results is in poultry production. Gholizadeh, Arabshahi, Saeidi and Mahdavi (2008) found in their study that by magnetizing water with an instrument of 6000 gausses, the mortality and morbidity rate of broilers were reduced, and chickens reached the desired weight in a shorter time (Gholizadeh et al., 2008).

LITERATURE REVIEW

Water quality plays an important role in poultry production. While chickens can survive for up to three weeks without food, they cannot survive for more than a few days without water. Poultry need water to help soften food for digestion and it is essential for all aspects of digestion and nutrient absorption metabolic processes as well as body temperature regulation and immune system function. Williams, Tabler and Watkins (2013) found that the 2010-2011 commercial broiler had a 2.02 water to feed ratio. The ratio was higher during the first few weeks of life and became more efficient as the birds aged. Water availability and water quality are factors that have a significant impact on the overall performance of the flock (Jacob, 2015).

The magnetic flux density of magnets refers to strength of a magnetic field in a specific area straight to the direction of the magnetic strength. Magnetic fields can be measured in teslas (T) or gauss (G), and one tesla is equivalent to 10,000 gauss (Grissom, 1995). Cai, Yang, He and Zhu (2009) conducted a study to determine the effect of magnetic water on the physicochemical characteristic of water. They used a static magnet with a power of 1,000 millitesla. Their results showed that magnetic water decreased the surface tension of water, and water viscosity increased. They also found that while the magnetization process was occurring there was an increase in the amount of hydrogen bonds in water. Hydrogen bonds are broken down using energy of vaporization. Furthermore, more energy to vaporize was required by magnetic water.

Previous research about the effect of magnetically treated water on the performance of broiler chickens has exhibited significant results. Al-Fadul (2007) evaluated magnetically treated water and magnetized feed. One hundred and twenty-eight chicks were placed in 16 pens (eight chicks/pen). The magnetic field to which water and feed were exposed is unknown. The results of this study showed that chickens consuming magnetized water had a better feed conversion ratio and higher body weight gain. However, the magnetically treated feed did not have any impact on broiler performance. It is important to highlight that the difference between the control group and the magnetic water group was more significant during the last three weeks of the experiment (Al-Fadul, 2007).

The quality of water provided to the chicks plays an important role in terms of flock performance. One of the main areas of water contamination in poultry production barns is in the water lines because if they are not properly cleaned and disinfected, biofilm can form inside the pipeline, and if pathogens incorporate into the biofilm, this increases the risk of health challenges for the chicks. Gholizadeh et al. (2008) conducted research using 100 birds with half consuming magnetized water and half consuming tap water. Water was magnetized as it passed through a magnetic device delivering 6,000 gauss. One of the most significant results of this study was the reduction of scale formation in the pipeline. Birds that consumed the magnetized water experienced lower mortality and disease incidence, and chickens reached optimal weight earlier than the control group.

Al-Mufarrej, Al-Batshan, Shalaby and Shafey (2005) conducted research on the effect of magnetically treated water on the performance and immune system of broiler chickens. In their experiment, they used a magnetic funnel consisting of seven pairs of successive magnets for a total of 500 gauss surrounding the pipe. The water was re-magnetized every 12 hours. The experiment had twelve replicate pens of six males and six females housed in battery cages for 32 days and provided ad libitum access to water and feed. Their results showed that magnetic water did not influence the performance and immune system of broiler chickens.

A significant percentage of the poultry industry is eliminating antibiotic use during production due to growing concerns that antibiotic use in food animals leads to antibiotic resistant human pathogens. Several antibiotics such as bacitracin methicillin disalicylate have traditionally been used at non-therapeutic levels to promote feed efficiency and health. Loss of these tools creates the risk of significant increases in morbidity, mortality rate and reduced feed efficiency. Cervantes (2015) stated that companies that produce antibiotic free chickens will have higher cost of production, and this economic increment will affect not only the producers but also the consumers. Therefore, tools which can be implemented within the production cycle that promote optimal performance without significantly increasing costs will be essential for the industry if chicken is to remain a viable, abundant and affordable protein source for a growing world population.

Alhassani and Amin (2012) conducted a study where they used 300 unsexed Cobb-500 chicks to determine the effect of magnetic water on some reproductive traits. Ten liters of water were used to establish the speed at which water was passed through a magnetic field. Treatment 1 (T1) had water magnetized at a rate of (5 minutes), T2 (10 minutes), T3 (15 minutes) and T4 was the control group. Their results showed that T3 gave significantly superior results for feed conversion and production index when compared to the control group. In regard to body weight gain, T3 had higher body weight gain than the control group, but it was not statistically significant.

Another study conducted by Jassim and Aquil (2017) used a total of 160 Ross 308 chicks to determine and compare the effect of alkaline water and magnetic water on some physiological traits of broilers. There were three treatments: T1 was the control group, T2 chicks were provided alkaline ionized water and T3 was a combination of magnetized and alkaline water, while for T4, the chicks were provided only the magnetized water. Birds receiving T2 showed benefits such as a decrease in cholesterol, blood glucose and triglycerides when compared to the other groups. Magnetic water (T4) and the mix of alkaline water and magnetic water (T3) did not have significant effect on the chickens.

Overall, the literature shows mixed results about the effect of magnetized water on broiler chickens. A possible cause for the difference in results could be the type and power of the device the researchers used to magnetize the water or could be linked to dietary deficiencies such as calcium which could potentially be provided by the magnets through the descaling of the water lines. Another explanation could be the lack of sufficient information about the length that the water stayed magnetized after passing through the magnetic field. Therefore, the current trial was conducted to further evaluate the effect of magnetizing drinking water on the growth and feed efficiency of broiler chickens raised under conditions simulating commercial production conditions and receiving a dietary regimen which met or exceeded their nutritional requirements.

MATERIAL AND METHOD

This research was conducted in house 232 West at the University of Arkansas Poultry Science Research Farm under IACUC protocol #18023. The experimental design consisted of three water treatments which evaluated the use of two magnet treatments for magnetizing the drinking water supplied to broiler chickens from day of age to 42 days of age. Untreated municipal water supply served as the control. The type of magnets used for this trial was N52 neodymium purchased from Magnetic Water Technology. The large magnet was 10 1/2" long and each side had 3 neodymium N52 magnets with a dimension of 2" x 1" x 1/4". The small magnet was 4” long with a 2" x 1" x 1/4" for each side. (Photos of magnets are located in the appendix). The magnetic field strength of the magnets was measured with a 2 axis Magnetic field sensor (PASCO scientific) and was found to be 1850 gauss. For Treatment 2 (T2), the larger magnet was attached to the polyvinyl chloride water line so that the magnet treated the water prior to distribution to all 6 replicate pens. This meant that the magnet was anywhere from 12 to 60 feet from the point of water consumption by the birds. For treatment 3 (T3), a single magnet was attached to the water line hose for each individual pen so that the water was magnetized less than one foot from the point that the water would be consumed by the birds. The treatment summary is as follows:

The treatments were:

- **Treatment 1:** Control group (non-magnetized water)
- **Treatment 2:** Magnetized water using a Large N52 grade Neodymium Magnet.
- **Treatment 3:** Drinking water magnetized by using a Small N52 Neodymium Magnet.

The treatments were randomized across 18 pens to give 6 replicate pens per treatment in a complete block design. Four hundred and forty nine-day old Cobb-500 male broiler chickens were randomly allocated to one of 18 pens. Seventeen pens received 25 chicks/pen while one replicate of T3 received 24 chicks/pen because of an error counting birds on placement day. Each pen was equipped with a pen sheet where mortality, feed added, and weekly adjustments and measurements milliliter per minute flow rate through the nipple drinkers was recorded.

Daily activities consisted of checking all pens twice daily (am and pm checks), adjusting the drinker water line height so that birds slightly tilted their heads upward to drink, shaking feeders and picking up mortality. Any birds which could not reach food or water were humanely euthanized. Weight of all mortality and culled birds was recorded and this weight was used to calculate an adjusted feed conversion. Prior to placement of the chicks, flow rate of water through the individual pen drinker lines was adjusted to 25 ml/min, on week 2, drinker flow rates were increased to 35ml/min and during week 4 it was increased to 45ml/min where it remained till the end of the trial.

Table 1. Schedule of events by pen

Event	**Day of trial**
Group weighed and placed 25 male chicks	0
Birds and remaining starter feed weighed	7
Birds and remaining starter feed weighed/feed removed, and diet changed to grower feed	14
Birds and remaining grower feed weighed	21
Birds and remaining grower feed weighed/feed removed, and diet changed to finisher	28
Birds and remaining finisher feed weighed	35
Birds and remaining finisher feed weighed	42

The pen served as the experimental unit and birds were group weighed by pen weekly. All feed added was weighed as well as any feed removed from the pen. Feed remaining was weighed at each bird weigh day. For each weigh event, a verification of the accuracy of the electronic scale was conducted by placing a 1 kg test weight on all four corners of the scale as well as the middle of the scale. Remaining feed and birds were weighed on days 0, 7, 14, 21, 28, 35, 42.

Each pen provided 22 square feet (SF) of space (.88 SF/chick) and was equipped with a Choretime Easy flow drinker line with 4 nipple drinkers and a Choretime feed pan with a 30-pound capacity hopper. A commercial diet regime based on the Cobb-Vantress nutrient requirements for the Cobb 500 broiler were used. Diets are shown in Table 2. Diets were corn-soy based and consisted of a pelleted and crumbled starter diet fed from 0-14 days and a pelleted grower diet fed from 14-28 days and a pelleted finisher diet fed from 28-42 days of age. Water and feed were provided at libitum.

Table 2: Feed ingredients of starter, grower and finisher diets

Ingredient	Starter	Grower	Finisher
		%	
Corn	58.35	63.70	68.20
Soybean meal 48% CP	27.24	22.47	18.70
ProPlus 54% CP	6.93	5.31	5.00
DDGS	5.00	5.00	4.63
Poultry fat	0.86	1.94	2.01
Calcium carbonate	0.58	0.57	0.62
MetAMINO	0.30	0.30	0.28
NaCl	0.25	0.24	0.18
L-Lysine HCl 78.8%	0.25	0.23	0.17
ThreAMINO	0.09	0.07	0.05
Mineral premix	0.05	0.05	0.05
Selenium	0.03	0.03	0.03
Choline Chloride 60%	0.03	0.03	0.03
Vitamin premix Poultry	0.03	0.03	0.03
Phytase	0.02	0.02	0.02
Total	100.01	100.00	100.00

RESULTS

Overall, there were no significant results observed in weight gain, feed conversion or livability for birds receiving magnetized water as compared to birds receiving the control or untreated water.

Feed conversion Ratio

The average feed conversion is calculated as a cumulative value for each weigh period and is determined by dividing the feed consumed up to that day by the total group weight of the pen plus the weight of any dead or culled birds up to that day. The feed conversions were calculated for days 0-7, 0-14, 0-21, 0-28, 0-35 and 0-42. The feed conversion ratio (kg of feed per kg of gain) remained similar among treatments during the 42 days of trial (Table 3). With the exception of the period 0-7 days, feed-to-gain ratios did not differ more than 1 point (second decimal place) throughout the trial. By day 42, the feed-to-gain ratios were 1.5722 to 1.5825.

Table 3. Effect of magnetic water on feed conversion ratio (kg:kg)

Treatment	Day 0-7	Day 0-14	Day 0-21	Day 0-28	Day 0-35	Day 0-42
T1	1.0704	1.1960	1.3285	1.4021	1.4882	1.5825
T2	1.1041	1.1918	1.3272	1.3963	1.4880	1.5734
T3	1.0617	1.1976	1.3368	1.4025	1.4885	1.5722
SEM	0.0211	0.0103	0.0088	0.0051	0.0056	0.0044
P-Value	0.3487	0.9199	0.7105	0.6405	0.9983	0.2218

Average Body Weight

Table 4 shows the average weight of birds by week for each treatment. Initial placement weights were statistically similar which indicates chicks were uniformly distributed across the treatment replications. Average weights for all treatments were similar for days 7 through 42 for all the treatments.

Table 4: The effect of magnetic water on average weights of male broiler chickens

Average Body Weight (kg)							
Treatment	Day 0	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42
T1	0.0437	0.1768	0.4906	1.0085	1.7684	2.5143	3.1886
T2	0.0440	0.1715	0.4926	1.0074	1.7786	2.5302	3.1998
T3	0.0435	0.1773	0.4981	1.0160	1.7766	2.5300	3.2102
SEM	0.0003	0.0027	0.0066	0.0116	0.0186	0.0237	0.0318
P-Value	0.4696	0.2614	0.7144	0.8506	0.9189	0.8645	0.8919

Feed Intake (Kg)

Table 5 shows the comparison of average feed intake for the treatments as a cumulative value up to the day shown. Feed intake was calculated by multiplying the average weight at a certain age by the accompanying feed conversion.

Table 5: The effect of magnetic water on feed intake of male broiler chickens (kg/bird)

Average Feed Intake (kg)						
Treatment	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42
T1	0.1892	0.5867	1.3397	2.4790	3.7421	5.0459
T2	0.1893	0.5871	1.3370	2.4837	3.7648	5.0338
T3	0.1879	0.5962	1.3575	2.4915	3.7657	5.0470
SEM	0.0036	0.0070	0.0128	0.0239	0.0376	0.0451
P-Value	0.9547	0.5623	0.4820	0.9329	0.8821	0.9739

Mortality

For each week, mortality was calculated as a cumulative percentage by dividing the number of dead birds that had died to date by the initial number of chicks placed and then multiplying by 100 to convert it to a percentage. Therefore, mortality was calculated for 0-7, 0-14, 0-21, 0-28, 0-35 and 0-42 days**.** There was a total of 19 dead birds from day 0-42 of the trial. There were no significant differences in the mortality for all treatments across all the times measured.

Table 6: Effect of magnetic water on the mortality (%) of male broilers

	% Mortality				
Treatment	Day 0-7	Day 0-14	Day 0-21	Day 0-28	Day 0-35-42
T1	1.3333	2.0000	2.6667	2.6667	3.3333
T2	0.6667	2.0000	4.0000	4.0000	4.0000
T3	2.0000	2.0000	4.6667	4.6667	4.6667
SEM	1.1675	1.6055	1.7971	1.7971	1.7722
P- Value	0.7267	1.0000	0.7302	0.7302	0.8692

DISCUSSION

The results from this trial showed that magnetic water does not influence feed conversion ratio on male broiler chickens. The feed conversion ratio remained similar among treatments during the entire trial, and the statistical analysis showed not significant results. This result differs from the ones found by Alhassani and Amin (2012) who reported that birds that drank water magnetized for a longer period had a lower feed conversion ratio than control birds. Al-Fadul (2007) observed improved feed conversion of birds provided magnetic water compared with those in the control group.

Magnetic water did not have a significant effect on body weight gain. From day 7 up to day 42, treatment 2 and 3 had higher average body weight gain than the control group; however, the statistical results were not significant. These results share similarities to the ones obtained by Alhassani and Amin (2012), where birds treated with water magnetized for a longer time had a slightly higher body weight gain than the control group, but the results were not statistically significant.

Feed intake was not affected by magnetic water in this trial. This finding agreed with Al-Mufarrej et al. (2005) who reported no significant effect of magnetic water over feed intake as well as feed conversion ratio and body weight gain.

There were not significant results in the livability of birds. Seven birds out of the 19 dead birds of the trial, had to be culled. One bird from treatment 3 had to be humanly euthanized because it had an impacted crop. The other 6 birds had to be culled due to angular bone deformity problems that prevented them from reaching feed and water. This finding agrees with the one found by Al-Mufarrej et al. (2005) who stated that magnetic water did not have a significant effect in the immune system of broiler chickens.

Heat stress may have affected the performance of some birds during the first two weeks. Even though the house temperature was in the desired range, about 10% of the flock was panting, which is an indicator of high body temperature. Additionally, during week 4, about 70% of birds were observed to have diarrhea, but this problem resolved with 2 days of adding new shavings to the pens.

Water quality and mineral content probably had an effect in the differences between results of this research and previous research. Most of the previous work addressing magnetized water in poultry has been conducted in Middle Eastern countries. Perhaps, magnets would change water quality water based on the mineral content and how clean the water is before passing through the magnetic device.

CONCLUSION AND RECOMMENDATION

The results from this research lead to the conclusion that water magnetized with a magnetic device of 1850 gauss power does not influence feed conversion ratio, body weight gain, feed intake or livability. Furthermore, the size and distance of the magnets from the drinking point did not influence performance of the birds. Based on these results, it is recommended that further research is conducted using higher magnet power. It is highly recommended to analyze mineral content of water before and after it passes through the magnetic device to see if any changes occur.

The N52 neodymium magnet used in this research did not cover the entire surface of the pipeline as shown in image 3, which probably influenced the results. As such, further research should use a circular magnet that encased the water flow or use a smaller hose. It would also be interesting to process birds that have been provided magnetic water to determine if it changes the meat and yield quality in a positive way.

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Appendix

Table 1: Treatment assignment to pens

Pen 18 T3	Pen 9 T2
Pen 17 T1	Pen 8 T1
Pen 16 T2	Pen 7 T3
Empty Pen	Empty pen
Pen 15 T2	Pen 6 T2
Pen 14 T1	pen 5 T3
Pen 13 T3	Pen 4 T1
Empty Pen	Empty pen
Pen 12 T1	Pen 3 T3
Pen 11 T3	Pen 2 T1
Pen 10 T2	Pen 1 T2

Image 1: 2 axis Magnetic field sensor used to measure gauss power of magnets

Image 2: Attachment of small N52 Neodymium magnet used to magnetize water for treatment 3

Image 3: Large N52 Neodymium attached to the main pipe

Image 4: Interior of house 232 west

Image 5: Treatment 3 pen