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The Magnetic Technology in Drinking Water of Laying Hens

Filoza Marwi[1], Osfar Sjofjan[2], Adharul Mutaqin[3], Muhammad Halim Natsir[2*]

[1]Postgraduate Program, Faculty of Animal Science Universitas Brawijaya
[2]Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Brawijaya
[3]Department of Electrical Engineering, Faculty of Engineering, Universitas Brawijaya,
Jl. Veteran, Malang 65145, Indonesia

*Corresponding author: emhanatsir@ub.ac.id

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ABSTRACT

The experiment was conducted to know the best level of magnetic technology for improving water quality and to compare the use of magnetic technology (MT) and non-magnetic technology (NMT) in drinking water of the laying hens. This study had 2 experiment steps. The first step studied 3 levels (1350 Gs, 2700 Gs, 5400 Gs) of magnetic technology. The results showed that MT had a significant effect (p<0.05) on total dissolved solids (TDS), alkalinity, acidity, dissolved oxygen (DO), *Escherichia coli*, and no significant effect (p>0.05) on biochemical oxygen demand (BOD) and pH of drinking water. 2700 Gs used in the second step was the best result to improve water quality. Magnetic technology was used to treat drinking water of 288 ISA Brown birds aged 57-week assigned to 2 treatments (NMT and MT). MT showed no significant effect (p>0.05) on hen day production (HDP) but improved (p<0.05) the feed conversion ratio (FCR) of laying hens.

Keywords: laying hens, magnet, production, water quality

INTRODUCTION

The production of laying hens is affected by numerous influencing factors. Management, facilities, feed, and water quality are the factors that affect the production. Water quality had a specific concern because the major diseases of laying hens are transmitted by poor water quality. Water that is directly used for laying hen drinks without going through the process before it is given to laying hens has diverse mineral content. It is necessary to manage the water quality of laying hens. The provision of drinking water using magnetic technology is the solution to improve the water quality given to laying hens. Magnetic technology relies on the electric charges moving in the form of ions and a magnetic field. Drinking water with magnetic technology treatment for a long time produces magnetic properties and charge. Drinking water with magnetic technology reduces the microbial population and increases the immune system of laying hens. The strong magnetic field that is exposed to water affects the mineral content of the water, the effect depends on the time of exposure and the magnitude of the magnetic field strength. Using magnetic technology to improve water quality is in great option due to the low cost compared to physical and chemical treatments. Mg^{2+}, Ca^{2+}, CO_3^{2-} and HCO_3^- are the mineral contents of drinking water. Ca^{2+} and CO_3^2 form the dissolved ions. Ca^{2+} (antibacterial compound) is released by using magnetic technology and decreases the bacterial population in drinking water. The mineral contents (Ca and Mg) had an effect significantly on the blood profile, antioxidants, and health status of laying hens (Attia et al., 2015; Ebrahim & Azab, 2017).

Magnetic technology with specific levels in drinking water improved the reproduction hormone, production performance, and egg quality of laying hens (El Sabry et al., 2018; Mitre, 2018; El Sabry et al., 2020). Using 1200 Gs and 3600 Gs increase total dissolved solids (TDS), pH, total hardness, conductivity (EC), salinity, dissolved oxygen (DO) and decrease the evaporating temperature in water (Yacout et al., 2015).

The magnetic technology (4000 Gs) resulted in improving the quality of water (Attia et al., 2015). The exposure of 7000 Gs magnetic technology for a long time period increases the pH level to 9.2 and affects the hydrogen form of the water molecules and conformation changes (Kudiar & Ali, 2012).

Drinking water with magnetic technology had greater concentrations of total hardness, Na^+, K-, Ca2+, Cl-, HCO3- and salinity compared to water control (El-Sabrout & Hanafy, 2017). Magnetic technology increased the body weight and feed conversion of poultry and improved liver and kidney function, production performance, egg quality and hatchability, reproductive hormones (estrogen and progesterone), and antioxidants in the blood (El-Hanoun et al., 2017; Abobatta, 2019). Feed efficiency, immune response, mortality, sick cases, and intestinal health of poultry were improved by magnetic water treatment (El-Katcha et al., 2017; Moosa et al., 2015). The use of magnetic technology improves the quality of drinking water and optimizes production performance of the laying hens.

MATERIALS AND METHODS

Water Quality

The laboratory test used a completely randomized design. The treatment had water as control and 3 levels (1350 Gs, 2700 Gs, 5400 Gs) of magnetic technology that was replicated by 5 replicates. The level of magnetic technology was counted by gaussmeter in the electro engineering laboratory. This experiment had bar magnets (5 cm x 10 cm x 20 cm) as magnetic power sources. Water samples were analyzed in laboratory of Jasa Tirta II Malang for counting the variables (total dissolved solids (TDS), alkalinity, acidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), *Escherichia coli* and pH).

Production Performance

The two hundred eighty-eight 57-week-old ISA Brown were conducted in this *in vivo* research. The laying hens randomly were divided into 2 treatments: magnetic technology (MT) and non-magnetic technology (NMT). This experiment used battery cage (30 cm x 35 cm x 40 cm) containing 1 hen/cage. The magnetic technology applied in drinking water was presented through nipples.

The ingredients and nutrient contents of feed of laying hens were shown in table 1. The feed was presented by the restricted feeding method once a day for 120 g/hen/day. Recording research data was conducted twice a day. Hen day production (HDP) and feed conversion ratio (FCR) were the variables that were counted in this experiment.

Statistical Analysis

The data of the water quality experiment were tested using one-way analysis of variance (ANOVA). The significant differences used Duncan's multiple range tests. Performance production data were statistically assessed by the unpaired T-test. All the tests used the statistical package for social sciences (SPSS version 26).

Table 1. Ingredients and nutrient contents of feed

Ingredients	Value (%)	Nutrient Contents	Value (%)
Corn	52.7	Dry Matter	90.28
Rice brain	13.95	Metabolism Energy (kcal/Kg)	2959
Soybean meal	24.5	Crude Protein	19.44
Meat bone meal	4.7	Crude Fiber	2.95
Grit	3.1	Crude Fat	4.93
Lysine	0.1	Ash	7.99
Methionine	0.15		
Premix [a]	0.2		
Salt	0.2		
Monocalcium Phosphate	0.4		
Total	100		

[a]) Premix from PT. MITRAVET (Composition/1kg: vitamin A = 2.000.000 IU, vitamin D3 = 400.000 IU, vitamin E = 3.000 mg, vitamin K = 400 mg, vitamin B12 = 4 mcg, thiamin HCI/B1 = 400 mg, riboflavin HCI/B2 = 1.200 mg, pyridoxin HCI/B6 = 800 mg, Ca-d-pantothenate = 2.160 mg, niacinamide = 8.000 mg, folic acid = 200 mg, biotin = 4 mg, L-Carnitine = 10.000 mg, copper sulphate = 4.000 mg, cobalt sulphate = 300 mg, ferro sulphate = 10.000 mg, Mn oxide = 20.000 mg, sodium selenite = 150 mg, carrier ad = 1.000 mg.

RESULT AND DISCUSSION

Water Quality

The result shows significant effect (p<0.05) of magnetic technology on total dissolved solids (TDS), alkalinity, acidity, dissolved oxygen (DO), *Escherichia coli*. There is no effect (p>0.05) of using magnetic technology on biochemical oxygen demand (BOD) and pH of drinking water. The quality of water statistically was shown in Table 2.

The standards of water quality based on TDS, DO and BOD contents are shown in table 3. Total dissolved solids (TDS) less than 300 indicate the highly great quality of water. Using 2700 Gs and 5400 Gs levels of magnetic technology is the greater result than other levels. It agrees with previous research that reports the influence of magnetic field 5000 Gs showed a great result than others (Moosa et al., 2015). The magnetic technology shows a successful result to eliminate TDS of water by adsorption (Ubale et al., 2016; Alimohammadi & Sedighi, 2018). Alkalinity is a buffer for pH water. There are 3 ions (bicarbonate, carbonate and hydroxide) that have interaction with hydrogen ions to decrease water acidity and increase pH water. Better quality water is more alkaline. Control treatment is the greatest result of alkalinity variable. The magnetized water decreased alkalinity compared to normal water (Abedinpour & Rohani, 2017; Venkatesh et al., 2020). Another research reports that magnetized water had more alkaline and greater salinity compared with water as control (El-Sabrout & Hanafy, 2017). The difference between the reports may be affected by different methods of experiments. Acidity and pH variables have interaction one-another, the raised pH is affected by the reduced acidity. The best pH for drinking water of laying hens is almost 6.8-7.0.

Magnetic technology generally decreases the numerical number of water acidity. Calcium carbonate and alkaline form hydroxide bond (OH) on applying magnetic technology, which reduces the acidity (Hassani et al., 2015; Mohammadi et al., 2019). 1350 Gs and 2700 Gs are the nearest value of magnetic technology for the great pH of drinking water. Magnetic field strength to 2000 G and 15 minutes magnetic treatment time increasing pH water (Esmaeilnezhad et al., 2017). pH water is important for laying hens because treatments in drinking water such as supplements and vaccines through water treatment are affected by pH water. The use of magnetic technology increases the dissolved oxygen (DO) of drinking water. Water that is treated by electromagnetic field had higher DO compared to the control sample (Mohammed et al., 2020). Biochemical oxygen demand (BOD) shows inconsistent results, decreasing number on 1350 Gs and increasing number on 2700 Gs and 5400 Gs levels. The use of magnetic fields was able to reduce chemical oxygen demand (COD) and biochemical oxygen demand (BOD) in the water (Yusuf et al., 2020). This contrast circumstance may due to the different levels of magnetic fields that were treated.

Table 2. The level of magnetic technology on water quality

	Control	1350 Gs	2700 Gs	5400 Gs
Total dissolved solids (TDS) *	325^{b}	330^{ab}	287^{a}	270^{a}
Alkalinity (ppm $CaCO_3$) *	160^{c}	148^{c}	119^{b}	99^{a}
Acidity (ppm CO_2) *	18.84^{b}	15.42^{a}	16.20^{ab}	14.50^{a}
pH	7.2	7.3	6.6	6.2
Dissolved Oxygen (DO) (ppm O_2) *	3.90^{a}	6.85^{b}	12.20^{c}	12.60^{c}
Biochemical Oxygen Demand (BOD)	2.4	2	5.4	4
Escherichia coli (log CFU/mL) *	2.95^{a}	2.91^{a}	2.90^{a}	2.70^{b}

[a-c] Different letter indicate significant differences between the means

* Superscript showed significant difference (p<0.05).

Table 3. Standard of water quality based on contents in drinking water

Total Dissolved Solids (TDS) level based on water quality		Dissolved Oxygen (DO) criteria based on water quality		Biochemical Oxygen Demand (BOD) standard based on water quality	
< 300	: Very Good	> 6.5	: Unpolluted	< 2	: Unpolluted
300 - 600	: Good	4.5 - 6.5	: Slightly Polluted	2 – 3	: Slightly Polluted
600 - 900	: Acceptable	2 – 4.4	: Moderately Polluted	1 -6	: Moderately Polluted
900 - 1200	: Bad	< 2	: Severely Polluted	> 6	: Severely Polluted
> 1200	: Danger				

Table 4. The magnetic technology effect on production performance of laying hens

Samples	Hen Day Production (HDP)		Feed Conversion Ratio (FCR) *	
	NMT	MT	NMT	MT
1	83.33	89.67	2.43	2.08
2	91.67	88.67	2.17	2.15
3	91.67	91.67	2.22	2.07
4	83.33	83.33	2.34	2.24
5	78.57	91.71	2.46	1.96
6	90.48	90.86	2.10	1.96
7	85.71	88.10	2.19	2.05
8	83.33	80.95	2.18	2.21
9	71.43	90.48	2.69	2.01
10	85.71	88.86	2.27	2.13
11	88.24	88.10	2.17	1.97
12	85.71	73.81	2.17	2.43
13	85.71	88.24	2.24	2.05
14	83.33	89.62	2.24	2.08
15	85.24	90.48	2.21	1.91
16	85.71	85.71	2.12	2.03
17	89.62	90.62	2.14	1.98
18	85.71	87.62	2.06	2.02
19	92.86	92.86	2.01	1.96
20	87.62	83.33	1.96	2.08
21	88.10	88.10	2.18	1.96
22	88.24	88.48	2.14	2.13
23	87.24	95.24	2.16	1.95
24	90.48	80.95	1.98	2.24
SUM	2069.05	2107.43	52.81	49.65
AVERAGE	86.21	87.81	2.20^{b}	2.07^{a}
STDEV	4.56	4.60	0.16	0.12

[a-b] Different l3tter indicate significant differences between the means

* Superscript showed significant difference (p<0.05).

Escherichia coli number is reduced from control treatment to magnetic technology with specific levels. Static magnetic field (SMF) inhibited the *Escherichia coli* growth and even killed during 60 min exposure (Filipic et al., 2012). Based on all results of the variables, using magnetic technology with 2700 Gs level is the greatest treatment to treat the laying hens.

Production Performance

The results of production performance variables were shown in table 4. There was no significant effect (p>0.05) of using magnetic technology on hen day production (HDP) of laying hens. The magnetic technology improved significantly (p<0.05) feed conversion ratio (FCR) of the laying hens. Magnetic technology (MT) has better results than non-magnetic technology (NMT). The ratio between using MT and NMT is shown in figure 1. Treating the drinking water of laying hens increases the HDP even though as statistically showing no improvement. This result indicates that a better quality of drinking improves the production of laying hens. The absorption of energies and nutrients from the presented feed has been increased by the gut system. Optimal absorption in the gut system affects better egg production. This circumstance agrees with previous studies that report the use of magnetized water as drinking water improved the productivity, growth performance and health immunity of poultry (EL-Katcha et al., 2017; El-Sabrout & El-Hanoun, 2019).

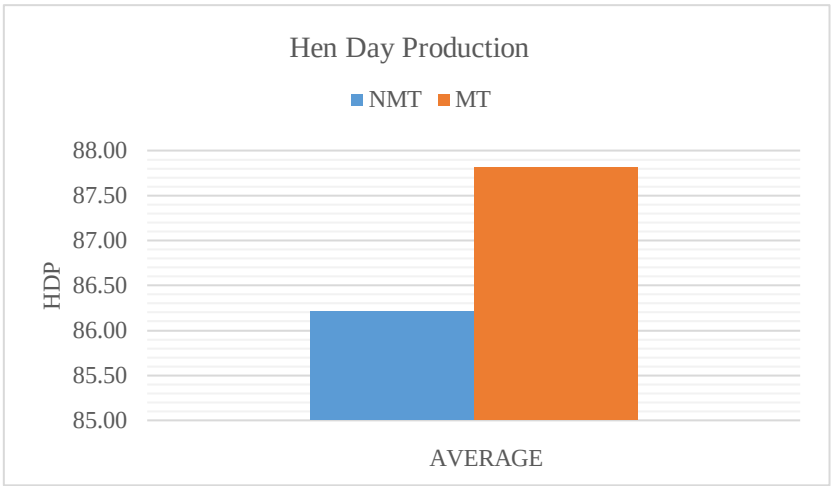

Figure 1. Ratio of using NMT and MT on HDP

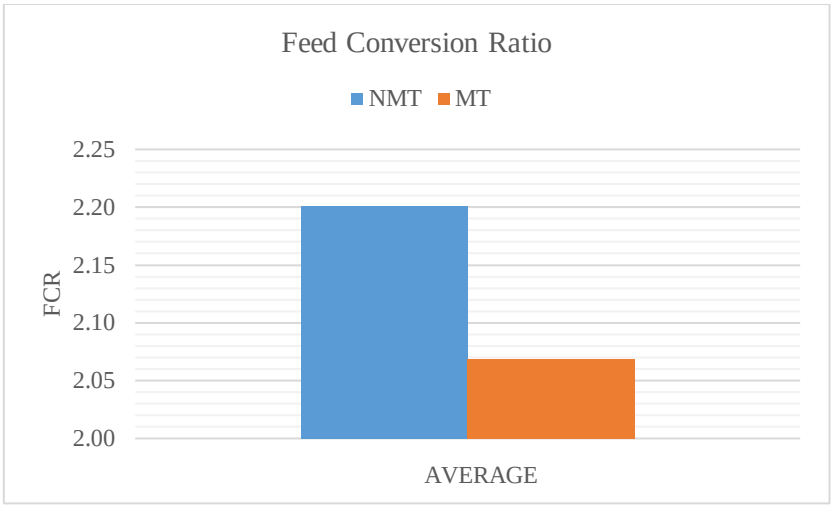

Figure 2. Ratio of using NMT and MT on FCR

The use of magnetic technology (2700 G) in drinking water improves (p<0.05) the feed conversion ratio of laying hens. The ratio between using MT and NMT is shown in figure 2. Improving FCR values means the decrease of feed intake in another hand the increase of egg production of laying hens. Feed intake is decreased by better absorption of feed nutrients and energy. The high quality of drinking water improves the gut system of laying hens. Energy and nutrient that are absorbed by the gut system provide a faster fullness feeling. It treats the laying hens for less feeding. The good quality of nutrient absorption improves the reproductive process of laying hens to increase egg production. This circumstance shows an improvement of FCR by optimizing the egg mass value and streamlining the feed intake amount. The experiment of using specific strength of magnetic water treatment on poultry showed an improvement of feed conversion compared to the control water (El-Katcha et al., 2018; Mustafa, 2019; Tantawy et al., 2020).

CONCLUSION

2700 Gs is a great level of magnetic technology to treat in drinking water. The use of magnetic technology improves water quality. In the applied experiment, magnetic technology increases egg production and feed efficiency of laying hens.

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