Effects of Using Magnetic Water on Egg Quality and Biochemical composition in Commercial Layers

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Abstract. This study was conducted to investigate the effect of using different powers of magnetic field technology (0, 1000, 1500, 2000 gausses) of well water treatment on, egg quality (external and internal properties of egg and Biochemical internal egg composition) of (Brown Lohman classic) layers. A total of two hundred and fifty-six (256) commercial Brown Lohman Classic strain 48 week’s age and nearly similar body weight were randomly assigned of commercial-type caged layer divided into four groups of 64 hens for each group, with (8) replicates per treatment. The birds housed in an environmentally controlled building with a density of eight (8) hens per replicate (cage). The results showed that using magnetic water had significantly (P≤0.05) increasing in accumulative results of external egg improving in eggshell thickness, egg shape index, egg soft shell percentage, undesirable egg percentage) in groups that used magnetic water compared with the control group but eggshell percentage and shell strength and broken egg percentage had not affected significantly (P≤0.05) by using magnetic water. Accumulative results of internal egg quality showed a significant increase (P≤0.05) in yolk index, albumen index, albumen high, haugh unit by groups that used magnetic water compared with the control group, also, revealed that yolk percentage and albumen percentage had not been affected significantly (P≤0.05) by different level of magnetic water. Also Results showed that using magnetic water with different powers caused a significant (P≤0.05) increasing in chemical egg composition (egg moisture percentage, protein percentage, calcium and sodium ppm) compared with the control group, Fat percentage and ash percentage decreased significantly (P≤0.05) by all groups that used magnetic water comparing with the control group.

1. Introduction
Water is one of the major and cheapest nutrients in nature, almost required double than amounts of feed consumed for, maintaining the body cells shape, body temperature, digestion, absorption, elimination of body wastes and production also, it considered as a crucial source for life and any living creature needs it to hydrate every cell [1, 2]. It is a critical nutrient for poultry, because it makes about (55-85%) of a chicken’s body according to bird’s age and about (65-74%) of an egg. The quality of drinking water for poultry and its effect on performance has been of concern to poultry producers and topics of research for many years. Evaluation of water quality is important because water is normally overlooked as a source of nutrients specifically the minerals that may be dissolved in it [3].
Magnetic fields considered as a new alternative (good replacement) were developed for the treatment of hard water (well water), magnetic water is, the water that treated by the magnetic field or passes through a magnetic device called magnetized water [4, 5, 6]. It has been changed some of the chemical properties of water molecules, mainly hydrogen bonding, polarity, conductivity, and solubility of salts which becomes more energized, active, soft and high pH toward slight alkaline and free of germs [7, 8]. Also, the strong magnetic field effect the physical properties of water such as: infrared spectrum, refractive index, viscosity, melting temperature and increase in the water surface tension [9, 10, 11]. Magnetic water showed improvement in the poultry performance, increased daily weight gain, generally improved health, a greater economic return to the farmer and an increase in production of layers [12]. In the commercial layer industry, many production units supply drinking water from drilled wells. The quality of water from these wells may be poorer than that of water from a city water source due to increased mineral deposits in the water [13].

2. Materials and Methods:

2.1 Experimental Location (Site)
A study was conducted on (Brown Lohman classic) layers at the Al-Hayat al-ttayba private poultry project for layers in Sebiran Agha, Shamamnik area in Erbil city. The study was started from the period (15/3 to 5/6/2014) for 11 weeks to investigate the effect of magnetic water treatment on egg quality in layers. The laboratory analysis work was conducted in poultry and nutrition laboratories of Animal resources Dep., and Center Research laboratory of Agriculture College / University of Salahaddin / Erbil / Kurdistan region.

2.2 Experiment Management (Housing)
A total of two hundred and fifty-six (256) commercial Brown Lohman Classic hens, 48 weeks of age, were housed in a commercial-type caged layer facility (metal wire cage). The birds were housed in an environmentally controlled house with a density of eight (8) hens per cage (replicate), the house consisted of four 4 lines each line divided into four (4) rows, each cage row consist of 2 side-by-side cages and the dimension of the cage was (59*59*60 cm). House temperature during the whole study was ranged between (21-23°c). The temperature was measured by mercury thermometers which were fixed at the four sides of the house. House relative humidity was recorded daily and kept at about 60%, birds were exposed to 16 hr. red bulb light. The Feeding system was automatic chain type with a nipple system of watering.

2.3 Magnetic Field Preparation:
Well water which was the only source for drinking birds, was passed through a magnetic funnel, the dipolar magnetic field with three different powers (1000G, 1500G and 2000G), and made locally in the Ministry of Science and Technology –Iraq.

2.4 Water Analysis:
Samples of treated water were collected directly before and after magnetic treatment that used for birds drinking water and the physical, chemical and biological analysis were applied. The analysis was conducted in the laboratories of Soil and Water Dept., Agriculture college\ Salahaddini Unii., Erbil and (Ministry of Municipality & Tourism / Directorate of Water and Sewerage Quality Control Lab. / Kurdistan region).
2.4.1 Physical analysis of water:
Table (1) The Physical analysis of water:

| Properties                          | Control | Water treated magnetically (gauss) |
|-------------------------------------|---------|-----------------------------------|
|                                     |         | 1000     | 1500     | 2000     |
| Ph                                  | 7.46    | 7.9      | 8.1      | 8.38     |
| Turbidity                           | 1.3     | 0.5      | 0.3      | 0.3      |
| Total digestible solubility (mg/L)  | 307     | 283      | 270      | 255      |
| Electrical conductivity (EC dS.m-1) | 436     | 448      | 451      | 460      |
| Hardness (mg/L)                     | 166     | 135      | 124      | 115      |

2.4.2 Chemical analysis of water:
Table (2) Chemical analysis of water:

| Properties | mg/L | Control | Water treated magnetically (gauss) |
|------------|------|---------|-----------------------------------|
|            |      | 1000    | 1500    | 2000    |
| Dissolved O2| 845  | 925     | 970     | 1130    |
| Calcium    | 38   | 44      | 43      | 47      |
| Potassium  | 1.3  | 1       | 1       | 0.93    |
| Sodium     | 19   | 23      | 24.5    | 26      |
| Chloride   | 6    | 3.5     | 2       | 1.2     |
| Magnesium  | 8.64 | 13.2    | 13.8    | 11.2    |
| Nitrate    | 7    | 6.2     | 6       | 5.7     |
| Sulphate   | 8.7  | 7.9     | 7       | 6       |

2.4.3 Biological analysis of water:
Water biological analysis was conducted in biology laboratories of the Ministry of Municipality & Tourism / Directorate of Water and Sewerage Quality Control Lab., Kurdistan region, and Food Industry Department, Agriculture college, Salahaddin Uni., Erbil. The result of water analysis for 1000G, 1500G and 2000G was satisfactory, the results of water analysis showed low number of bacteria (Total account bacteria and E.coli) in T1 (Control), lower and clear (clean) in T2, T3 and T4, this is due to UV ultraviolet radiation filter and the water was treated with magnetic field especially with power 2000 gauss.

Table (3) Biological analysis of water:

| Treatment | Total account of bacteria | E. coli |
|-----------|---------------------------|---------|
| T1 Control| 43/ml                     | 23/ml   |
| T2 1000 G | 34/ml                     | 9.5/ml  |
| T3 1500 G | 25/ml                     | 8.1/ml  |
| T4 2000 G | 15/ml                     | 3/ml    |

2.5 Experimental Design and Statistical Analysis
A (256) commercial Brown Lohman Classic hens, 48 weeks of age, were housed in a commercial-type caged layer facility (metal wire cage). The birds were housed in an environmentally controlled house with a density of eight (8) hens per cage (replicate), the house consisted of four 4 lines each line divided into four (4) rows. The experiments were executed as a Complete Randomized Design (CRD), all data were analyzed using [14]. Duncan’s multiple range tests were used to compare differences among treatment means at 0.05 [15].
2.6 The Measured Traits (Specific qualities of the egg):

During the study, investigate the effect of magnetically treated water technique on egg quality (external and internal) in laying hen, proximate chemical analysis of internal egg component (moisture%, fat%, protein%, ash% and minerals Ca and Na ppm) was studied. On an individual basis, eggs were evaluated for external and internal egg quality traits to measure the external and internal quality of eggs to the four treatments in the experiment by broke 4 eggs from each replicate and 32 eggs for each treatment group, which was at a weekly period selected randomly according to [16].

2.6.1 External egg characteristics:
The external egg characteristics were egg weight (gr), egg dimensions length and width (cm), and shell weight (gr) and shell thickness (mm). The egg dimensions and shell thickness were measured using Gans Gehartet varië Digital vernier calipers:

2.6.2 Internal egg characteristics:
The internal egg parameters included albumen height (mm), yolk height (cm), albumen weight (gr), yolk weight (gr), yolk diameter (cm), yolk index%, albumen index%, and Haugh unit, yolk and albumen %.

2.6.3 Internal Egg Component Analysis:
Before the end of the study, were taken eggs (one egg of every replicate 8 eggs in every treatment group), the eggs were put in the refrigerator and saved at (4 cº), to next day to conduct the chemical analysis for internal egg component (moisture%, fat%, crude protein%, ash %) and mineral (Calcium, Ca and Sodium, Na).

3. Results and Discussion:
3.1 Effect of Magnetic Water on Accumulative External Egg Properties in Laying Hen
The results revealed that there was a significant (P≤0.05) difference in egg shape index. It decreased in all treatment groups that used magnetically treated water compared with T1 (control) that used well water. The egg shape index was reduced in T3 and T4 groups compared with T1, T2 (Table 1).

The result was in contrast with that reported by [17] who showed that using magnetically water with powers (500G, 1000G and 2000G) on broiler breeder caused to improve the egg shape index. The results may be was due to that magnetic water caused increasing egg weight, which may cause an increase in width and length of egg. Also, undesirable egg percentage decreased significantly in all groups that used magnetic treated water compared with T1 (control) group and there was a slight decrease among the T2, T3 and T4 groups. Undesirable egg percentage in the current study is summation of broken egg percentage and soft-shell egg percentage, decrease in both of (broken egg percentage and soft-shell egg percentage) causing a decrease in undesirable egg percentage, which are not desirable by consumers for marketing. The reason may be that magnetic water cause to increase in egg shell thickness and shell strength (Table 4). Also, due to that treated water magnetically work to increasing calcium (Ca) ions in blood [18, 19, 20, 21, 22] rising of calcium in the blood cause to increasing eggshell thickness by taking Ca ions from blood and precipitated in the egg shell [23].

The results showed that there were no significant (P≤0.05) differences between treatments in shell percentage and Shell strength, but there was a slight numerically increase in groups that drank magnetic water (T2, T3 and T4) compared to T1 (control) group where drank well water. (Table 4) also, showed Shell thickness (mm) increased significantly(P≤0.05) in T2, T3 and T4 groups
that used magnetically treated water compare with T1 (control) group when used well water, (Table 4). Increasing shell percentage depended on increase in shell weight, while both of shell strength and shell thickness depended consequently on shell percentage of eggs, also eggshell strength depends on eggshell thickness, in the current study magnetic water caused an increase in eggshell weight, shell strength and shell thickness (Table 4).

The study agreed with [24, 17, 25] that reported using magnetically treated water caused to increase in eggshell thickness and disagreed with their that magnetic water caused an increase in eggshell strength in layers. The reason of increase in eggshell quality was that water passed through the magnetic field caused to increase the fluidity dissolving capability of various constituents like minerals, increased the ion solubility, increasing in the solubility of calcium salt in the water [26], explained that treated water magnetically caused increasing calcium (Ca) ions in blood [18, 19, 20, 21, 22], rising of calcium ions in the blood caused to increase in eggshell thickness by drawing these ions from blood and precipitating in the egg shell [23].

Table (4) Effect of magnetic water treatment on the accumulative external egg properties in layer:

| Treatment Traits | T1(control) | T2 (1000G) | T3 (15000G) | T4 (2000G) |
|------------------|------------|------------|-------------|------------|
| Egg shape index (%) | 77.33±0.28 a | 71.36±0.16 b | 70.67±0.24 e | 70.91±0.17 bc |
| Undesirable egg% | 7.6±0.23 a | 2.3±0.10 b | 1.8±0.06 b | 1.6±0.06 b |
| Shell strength (gr/cm²) | 876.50±39.41 a | 901.11±17.99 a | 943.43±40.14 a | 923.03±30.63 a |
| Shell thickness (mm) | 0.320±0.004 b | 0.361±0.001 a | 0.362±0.001 a | 0.364±0.001 a |
| Shell % | 9.48±0.001 a | 9.58±0.001 a | 9.48±0.001 a | 9.78±0.001 a |

T1= Control (Well water), T2, T3, T4 =Magnetic treated water with different power (1000, 1500, 2000) gauss. Different letters mean presence of significant difference within the rows (P≤ 0.05).

3.2 Effect of Magnetic Water on Accumulative Internal Egg Properties of Laying Hen

The results presented in (Table 5) revealed that there are no significant differences (P≤0.05) among treatments in (Yolk percentage and Albumen percentage but had a slight increase in yolk percentage in the groups that used magnetically. Yolk index and Albumen index increased significantly (P≤0.05) in T2, T3, and T4 that used magnetic treated water with different power1000G, 1500G and 2000G compare with T1 (control) group that used the well water. Also, there was a significant (P≤0.05) difference in yolk index T2 with T3 and T4 compared with T1 control. A significant (P≤0.05) difference that found in Albumen index in T2, T3 and T4 the groups that drank magnetic water with different powers 1000G, 1500G and 2000G comparing with T1 (control) group, (Moreover, albumen height and Haugh unit increased significantly (P≤0.05) in T2, T3 and T4 that used magnetically treated water compare with the T1 control used well water.

The study agreed with the result obtained by [17] that found the effect of using magnetic water with different powers 500G, 1000G and 2000G on broiler breeder egg caused a significant increase in albumen height, Haugh unit and yolk height, diameter and index. Similarly, the result of this study agrees with [25] who showed that magnetic water with different powers 500G, 1000G and 1500G caused improvement in (albumen height, Haugh unit, yolk height, yolk diameter, yolk index).

The reason may be that magnetic water caused a significant increase in egg production and egg weight that caused to increase in (yolk weight, yolk percentage, yolk high, yolk diameter, yolk
index) and albumen quality (albumen weight, albumen percentage, albumen high, albumen index, Haugh unit) that measured for good quality of eggs. Magnetic water work to activate the (thyroid gland) that caused an increase of the thyroxin hormones production [27], that caused an increase in feed consumption and rising of fat metabolism, increase the absorption of the sugars and increased in egg weight and the small size of magnetic water molecular acts to carry a large amount of nutrition component, minerals and vitamins that affected positively on the metabolism and effect on the amino acids to increasing protein synthesis [28, 29].

Table (5) Effect of magnetic water treatment on the accumulative internal egg properties of layer:

| Treatment Traits | T1(control) | T2(1000gauss) | T3(1500gauss) | T4(2000gauss) |
|------------------|-------------|---------------|---------------|---------------|
| Yolk %           | 27.8±0.003 a| 27.9±0.003 a  | 28.1±0.003 a  | 28.5±0.003 a  |
| Yolk index       | 44.56±0.12 c| 45.70±0.11 b  | 46.16±0.09 a  | 46.22±0.07 a  |
| Albumen %        | 62.72±0.004 a| 62.52±0.003 a| 62.42±0.003 a| 61.72±0.003 a|
| Albumen height   | 6.22±0.09 b | 6.58±0.06 a   | 6.63±0.07 a   | 6.62±0.04 a   |
| Albumen index    | 43.53±0.83 c| 47.60±0.60 b  | 50.38±1.11 a  | 48.37±0.71 ab |
| Haugh unit       | 75.03±0.67 b| 77.40±0.55 a  | 76.92±0.49 a  | 77.50±0.30 a  |

Different letters mean presence of significant (P≤ 0.05) difference within the treatment groups

3.3 The Effect of Magnetic Water on the Egg Chemical Composition

The results in (Table 6) showed that there is a significant difference (P ≤ 0.05) in the internal chemical composition percentage of the whole egg (mixture). Moisture percentage and protein percentage were increased significantly (P≤0.05) in groups that used magnetically treated water with different strength 1000G, 1500G to 2000G respectively compared with T1 (control) groups that drank the well water the values of moisture percentage were 73.17%, 75%, 76.6% and 76.1% for T1, T2, T3 and T4, respectively, also, the crude protein percentage of whole egg increased significantly (P≤0.05) in T2 group compared with T1 (control) group the values were (11.83%, 12.05%, 11.85% and 11.9%) for T1, T2, T3 and T4, respectively, that T3 group was the highest result in moisture percentage also, while T2 group showed the highest value in protein percentage.

Moreover, crude fat percentage of whole egg decreased significantly (P ≤ 0.05) in all groups that used magnetically treated water compared to the T1 (control) group and there was a significant decrease of fat percentage in T3 and T4 groups, compare with the T2 group. The values were 10.6%, 9.75%, 9.33%, 9.03% for T1, T2, T3 and T4, respectively. Significant differences pointed in ash percentage between each treatment group. It seems that ash percentage decreased in all treatments where used magnetically treated water compare with the T1 (control) group the values were 3.74%, 3.43%, 3.31% and 3.17% for T1, T2, T3 and T4 respectively.

The result present in (Table 6) showed that sodium Na content of egg increased significantly (P≤0.05) in groups that used magnetically treated water T2, T3 and T4 compared with the T1 (control) group that used well water, the values were 79.88 ppm, 93.13 ppm, 94.50 ppm, 92.75 ppm. Also, the content of calcium Ca in the egg were 24.88 ppm, 29.50 ppm, 27.25 ppm and 29.75 ppm reported in (Table 6) which increased significantly in the groups that used magnetically treated water with different powers T2, T3 and T4 compared with T1(control) group.

This agrees with results of [30][31] who reported that drinking magnetically water caused an increase of the level of cellular moisture by about 20% in bird body this is a basic point of general health in the body, also, [32] explained that hexagonally structured of magnetic water MW molecule work to increase the cell moisture and hydrating the cell and increase the oxygen O2 in
the cells, reduce stress and had important role to remove the free radicals that will be produced from the biochemical reactions in the body and caused to change the body pH to more hydroxyl (OH-) ions were created to form alkaline molecules, and reduce acidity. This change will cause to activate the enzymes, improve immune system, and improve the metabolism processes and increasing the nutrition component absorption. Also, the study agreed with [33] who reported that water treated magnetically affects the metabolism positively, and enhances the protein synthesis in the body. Decreasing in egg fat percentage maybe was due to that magnetic water which caused the increment in egg moisture percentage and egg protein percentage in groups that drank treated water magnetically.

The results about egg ash percentage and egg minerals (Ca and Na) agreed with [20][21] who found the magnetically treated water increases the ion solubility in the water and increase in solubility of calcium salt. [12] mentioned that there is a change in mineral contents of water by magnetizing that causes them to pass biological membranes more easily which will increase the fluidity and dissolving capability of various constituents like minerals [18, 19]. The reason of increasing the egg moisture increasing maybe was due to that magnetic field can break down water cluster and reduce the bond angle and hence increases the solubility and the water become active, soft and improved the taste of water which cause increasing water consumption by the birds and consequently can pass through the cell membrane in the body [34, 29].

Table (6) Effect of magnetic water on the chemical analysis of eggs:

| Treatments Traits | T1 (control) | T2 (1000G) | T3 (1500G) | T4 (2000G) |
|-------------------|-------------|------------|------------|------------|
| Moisture %        | 73.82± 0.177 c | 74.77±0.205 b | 75.51± 0.225 a | 75.89± 0.165 a |
| Crude protein%    | 11.83± 0.059 b | 12.05±0.037 a | 11.85± 0.460 b | 11.91± 0.035 b |
| Crude fat%        | 10.61± 0.084 a | 9.75± 0.154 b | 9.33± 0.113 c | 9.03± 0.065 c |
| Ash %             | 3.74 ± 0.045 a | 3.43± 0.076 b | 3.31± 0.039 bc | 3.17± 0.049 c |
| Total             | 100          | 100         | 100         | 100         |
| Na (ppm)          | 79.88± 4.244 b | 93.13±3.888 a | 94.50± 3.38 a | 92.75± 2.52 a |
| Ca (ppm)          | 24.88± 0.99 b | 29.50±1.34 a | 27.25±1.26 ab | 29.75± 1.10 a |

Different letters means the presence of significant (P≤ 0.05) difference within treatment groups

Conclusion and Recommendations:
In the light of the results of the study, the following points can be concluded:
Using magnetic fields with different powers (1000G, 1500G, and 2000G) improved some physical, chemical and biological properties of water.
Magnetically treated water improved egg quality (external and internal egg quality).
Magnetically treated water caused a significant increase in egg moisture percentage, protein percentage, calcium and sodium and a significant decrease in fat and ash percentages.
The owner of the layer farm was interviewed and discussed evaluate the result of the treatment in order to adopt the technique of magnetic treatment of water. The feedback of the owner of the layer farm confirmed the importance of the water treatment with magnetic field in improving the performance of the layers of his farm which will enhance efficiency and effectiveness of the improvement of productivity of the layers and consequently increase profit.
The following suggestions were recommended using the magnetic field for treating water for a future study in:
Using magnetic water in laying hens farms with different powers especially (1500 and 2000 Gausses) because of the positive effect on the productive, physiological performance and egg quality.
Well water (hardness water) can be treated without chemical treatment, bypassing it through the magnetic field to change some of its physical and chemical properties of water especially to free the water from germs. Such treatment can be promising potential in saving economic cost for providing water resources for poultry farm. Perform more research, in poultry farms as well as other livestock to figure out the optimum range of different magnetic powers in other species.

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