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Effect of Using Magnetic Water on Growth, Physiological, Reproductive and Hatchery Performance of Japanese Quail

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Abstract | The study was conducted to investigate the impact of magnetized water on the productive, physiological, reproductive, and hatching traits of Japanese quail birds (*Coturnix Japonica*). For this purpose, a total of 300 unsexed quail chicks were randomly assigned to four treatment groups, with three replicates per group (25 birds per replicate). The treatments include control group (T1), drinking water magnetized at 500 gausses (T2), drinking water magnetized at 750 gausses (T3), and drinking water magnetized at 1000 gauss T4). A comprehensive performance analysis demonstrated significant improvements in productive characteristics, total protein, albumin, and globulin levels, along with a notable reduction in cholesterol and malondialdehyde concentrations. Additionally, reproductive traits and fertility rates were significantly enhanced in bird offered magnetized drinking water compared to the other treatments and the control group. In conclusion, the use of magnetized water in feeding quail birds led to improved production performance, which positively influenced their overall health.

Keywords | Magnetic water, Productive, Physiological, Reproductive, Hatchery

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INTRODUCTION

Water is a fundamental component of life, playing a vital role in maintaining cellular structure and integrity by transporting compounds through the bloodstream. It also helps regulate temperature and supports various biological functions. Ancient Greeks recognized the therapeutic potential of magnetic fields, and modern research has since confirmed that magnetic fields can restore the balance of living cells. This demonstrates a biological impact of magnetic fields on the health of humans and animals (Minser *et al*., 2023).

When water passes through a magnetic field, its structure becomes more homogeneous and precise, enhancing its ability to dissolve and remove minerals. Additionally, magnetized water becomes more fluid and flexible, making it easier for humans and animals to absorb and utilize (Alhazmi *et al*., 2021). Numerous studies have highlighted the positive effects of magnetized water on the health and productivity of animals and birds. For instance, poultry treated with magnetized water have shown increased production. Magnetized water has also been linked to improved protein and fat metabolism and altered blood glucose levels (Studenic *et al*., 2024).

Recent studies reveal that magnetized water significantly alters water molecules by breaking the Van der Waals bond

between oxygen and hydrogen. This leads to changes in surface tension, viscosity, and electrophoretic conductivity (Mohammadnezhad *et al*., 2022). Magnetized water has been found to enhance growth performance and increase productivity in animals (Dobránszki, 2023). For example, its use has resulted in higher milk yields and better growth performance in cows, increased wool and meat production in sheep, and improved egg production in chickens (Hassan *et al*., 2024; Badawi *et al*., 2023).

Furthermore, previous study (Pinto *et al*, 2020) have shown that magnetized water affects the behavior of dissolved inorganic salts, alters ion shapes, and changes the chemical and physical properties of water. Passing regular water through a magnetic field increases its conductivity, reduces surface tension, enhances evaporation rates, and lowers boiling points (Boufa, 2021). These findings underscore the potential benefits of magnetized water on the productive and physiological performance of quails and other animals.

MATERIALS AND METHODS

The study included two experiments, where 300 days old unsexed chicks were used in the first experiment one up to 42 days old quail, with a starting weight of 8.14 g per chick, prepared from one of the hatcheries. Civility in Wasit Governorate. According Completely Randomized Design (CRD). The birds were randomly distributed into 4 treatments, 3 replicates for each treatment (25 birds per replicate) in a dwelling containing a two-story battery Equipped with cages with dimensions (75cm length x 70cm width x 45cm height) respectively. The cages were provided with all supplies, including feeders, manholes, and temperature provision The percentage is within ideal limits. In the second experiment (production period) when the birds are 42 days old. 15 birds were kept for each replicate (10 females, 5 males). All necessary administrative procedures for breeding were provided, such as ventilation and temperature. The temperature was regulated using an electronic thermometer to be within the optimum limits. Electric heaters were used to heat the hall during the experimental period in order to maintain the temperature at around 33˚C in the first week of life. After that, the temperature was reduced by 2˚C weekly until it reached 23˚C at the end of the sixth week. As for the lighting, it was continuous for 24 hours, while the tunnel ventilation system was used in the experiment through the presence of window openings at the beginning of the hall with the use of exhaust fans at the end of the hall.

The sex ratio becomes 2:1 (Ahmad, 2023). For providing water and fodder, was free throughout the experiment and two types of water were used. The growth diet (1-42 days) contained 23.02% crude protein and the metabolic energy was 2918.5 calories/kg, and the production diet used after the age of 42 days contained 21.69% crude protein and the metabolic energy was 3095.8 calories/kg according to NRC (National Research Council, and Subcommittee on Poultry Nutrition, 1994).

Magnetized water device

Device components

A main pipe for the water to flow through, a magnetic coil to generate the magnetic field, electrodes to measure the voltage generated by the flow, a processing unit that converts the voltage into a readable electronic signal, and a display screen to read the data.

The device's working principle

It measures the flow of conductive liquids, such as water, based on the principle of electromagnetic induction. When water passes through a pipe containing a magnetic field, an electrical voltage is generated that is directly proportional to the water flow. The voltage is captured by electrodes installed on the sides of the pipe, which convert this voltage into electronic signals that calculate the water flow (Hassan, 2020).

Treatment of birds

This research was conducted to investigate the effect of magnetized water exposed to a magnetic field at three different intensities: 500, 750, and 1000 Gauss, using a laboratory magnetic device (Hassan, 2020). The treatments included four groups: a control group (T1) that consumed normal water, and three groups that consumed water magnetized at 500 Gauss (T2), 750 Gauss (T3), and 1000 Gauss (T4), respectively.

Studied attributes

The study evaluated productive characteristics such as weekly and cumulative live body weight, weekly and cumulative weight gain, weekly and cumulative feed intake (Torki *et al*., 2024), and feed conversion efficiency (Adaszyńska-Skwirzyńska *et al*., 2025). Additionally, physiological traits were assessed, including cellular and biochemical blood parameters (Bishop, 2020). Reproductive parameters such as age and weight at puberty (Shakeel *et al*., 2022), reproductive traits (Ahmad *et al*., 2023; Lobato *et al*., 2025), and hatchery characteristics (Reda *et al*., 2024; Abou-Kassem *et al*., 2024; Choi, 2025) were also measured.

Statistical analysis

The research data was analyzed using a completely randomized design (CRD) using the ready-made statistical program SPSS, (Pallant, 2020). To test the significance of the differences between the studied means, (Duncan, 1955) multinomial test was used, at the level of significance ($p<0.05$), and the mathematical model was used in data analysis.

RESULTS

It is clear from Table 1 that there is a significant effect ($p<0.05$) of providing magnetized water to quails on their live body weight rates in weeks (4, 2, 6 and cumulative). The fourth treatment, T4, recorded the highest significant difference compared to the other treatments, and the control group, T1, which recorded the lowest differences.

Table 2 indicates that there is a significant effect ($p<0.05$) of magnetic water on the rate of weekly weight gain of quail in weeks (2, 4, 6 and cumulative), where all treatments outperformed the control group. The fourth treatment, T4, recorded the highest significant difference compared to the other treatments, and the control group, T1, which recorded the lowest differences.

Table 3 shows that there is a significant difference ($p<0.05$) in the amount of feed consumed by the quails for the control group in weeks 2, 4, and 6 and in the cumulative amount compared to the rest of the experimental treatments that consumed magnetized water, which recorded the lowest significant difference.

The results of Table 4 showed a significant ($p<0.05$) superiority in the feed conversion factor for quails for the groups treated with magnetic water in weeks 2, 4, 6 and cumulative compared to the control group, which recorded the least significant difference.

Table 1: Effect of magnetized water on body weight during growth period (Mean ± Standard Error).

Group/ Week	T1 (Control)	Magnetized water group			Sig. 0.05
		T2 (500 Gauss)	T3 (750 Gauss)	T4 (1000 Gauss)	
2 Week	53.15^{c} ±2.02	56.95^{b} ±0.81	58.75^{b} ±1.55	62.51^{a}±1.96	*
4 Week	126.21^{d} ±4.11	134.65^{c}±5.06^{c}	139.65^{b} ±3.13	146.43^{a} ±9.73	*
6 Week	207.61^{c}±6.82	213.82^{c}±8.43	220.47^{b}±6.39	228.62^{a}±8.74	*

Small letters referred to significant difference among groups at ($p\leq0.05$). N.S referred to no significant difference. * Referred to significant difference.

Table 2:

Group/ Week	T1(Control)	Magnetized Water Group			Sig. 0.05
		T2 (500 Gauss)	T3 (750 Gauss)	T4 (1000 Gauss)	
1-2 Week	44.79^{d} ±2.24	48.57^{c} ±0.78	50.54^{b} ±1.56	54.31^{a} ±1.07	*
3-4 Week	70.03^{d} ± 2.66	74.67^{c} ± 4.51	77.89^{b} ± 6.73	80.89^{a} ±7.85	*
5-6 Week	78.42^{b} ± 3.79	76.14^{b} ± 4.69	76.69^{b} ±6.36	80.05^{a} ±4.45	*
(1-6) Week (Accumulative).	199.25^{c}±6.70	205.60^{c}±8.41	212.24^{b}±6.36	220.44^{a}±8.75	*

Small letters referred to significant difference among groups at ($p\leq0.05$). N.S referred to no significant difference. * referred to significant difference.

Table 3: Effect magnetized water on feed consumption of during growth period (Mean± Standard Error).

Group/ Week	T1(Control)	Magnetized Water Group			Sig. 0.05
		T2 (500 Gauss)	T3(750 Gauss)	T4(1000 Gauss)	
2 Week	117.09^{a}±10.46	114.39^{b}±6.52	105.49^{b}±4.66	101.90^{c}±2.84	*
4 Week	195.48^{a} ±11.10	194.69^{a}±6.65	189.63^{b}±1.82	181.86^{c}±7.72	*
6 Week	304.95^{a}±14.14	304.61^{a}±14.18	291.83^{b}±13.03	170.02^{c}.±8.56	*
(1-6) Week (Accumulative	623.58^{a}±35.00	619.75^{a}±28.21	593.01^{b}±24.35	571.00^{b}±13.88	*

Small letters referred to significant difference among groups at ($p\leq0.05$). N.S referred to no significant difference. * referred to significant difference

Table 4: Effect of magnetized water on feed conversion factor during growth period (Mean ± Standard Error).

Group/ Week	T1(Control)	Magnetized Water Group			Sig. 0.05
		T2(500 Gauss)	T3(750 Gauss)	T4(1000 Gauss)	
2 Week	2.17^{c}±0.05	2.07^{a}±0.05	2.14^{b}±0.06	2.09^{a}±0.08	*
4 Week	2.50^{c}±0.3	2.45^{bc}±0.05	2.41^{ab}±0.08	2.36^{a}±0.09	*
6 Week	3.91^{a}±0.09	3.70^{b}±0.14	3.80^{b}±0.03	3.72^{b}±0.27	*
(2-6) Week (Accumulative).	2.81±0.02	2.83±0.02	2.84±0.04	2.79±0.04	N.S

Small letters referred to significant difference among groups at ($p\leq0.05$). N.S referred to no significant difference. * referred to significant difference.

Table 5: Effect of magnetized water on cellular blood traits during growth period (Mean ± Standard Error).

Group/ Week	T1 (Control)	Magnetized water group			Sig. 0.05
		T2 (500 Gauss)	T3 (750 Gauss)	T4 (1000 Gauss)	
RBC	3.03^{c}±0.15	3.12^{b}±0.06	3.18^{ab}±0.08	3.24^{a}±0.08	*
WBC	27.01±0.96	26.51±0.98	26.13±0.92	25.83±0.92	N.S
Hb	15.00^{b}±1.43	15.45^{a}±0.94	15.81^{a}±1.12	15.89^{a}±1.47	*
PCV	38.49^{c}±1.53	39.32^{c}± 2.11	41.20^{b}± 2.61	43.60^{a}± 1.76	*

Small letters referred to significant difference among groups at (p≤0.05). N.S referred to no significant difference. * referred to significant difference.

Table 6: Effect of magnetized water on some biochemical blood traits during Growth period. (Mean ± Standard Error).

Group/ Week	T1(Control)	Magnetized water group			Sig. 0.05
		T2(500 Gauss)	T3(750 Gauss)	T4(1000 Gauss)	
Total protein	4.25^{d}±0.16	4.52^{c}±0.26	5.03^{b}±0.31	5.77^{a}±0.22	*
Albumin	1.60^{c}±0.12	1.78^{c}±0.17	2.15^{b}±0.23	2.64^{a}±0.10	*
Globulin	2.62^{d}±0.03	2.71^{c}±0.09	2.86^{b}±0.07	3.11^{a}±0.10	*
Cholesterol	179.63^{a}±4.19	173.23^{a}± 4.25	166.25^{b}± 5.24	155.66^{c}± 5.49	*
Glucose	175.84±6.72	176.44±7.03	175.31±9.62	176.78±6.27	N.S
ALP	13.19±1.18	13.16±0.89	13.20±0.97	13.04±0.86	N.S
AST	217.55±6.23	214.47± 6.47	212.39± 10.29	215.72± 9.41	N.S
ALT	18.03±0.72	18.25±1.08	18.32±1.09	18.15±1.08	N.S
MDA	0.17^{a}±0.003	0.16^{a}±0.005	0.11^{b}±0.006	0.07^{c}±0.003	*
T3	1.33^{c}±0.03	1.64^{b}±0.00	1.98^{a}±0.00	2.11^{a}±0.13	*
T4	8.44^{c}±0.17	8.82^{bc}±0.15	0.49^{ab}±0.06	10.06^{a}±0.02	*

Small letters referred to significant difference among groups at (p≤0.05). N.S referred to no significant difference. * referred to significant difference.

Table 7: Effect of magnetized water on some reproductive traits during productive period (Mean ± Standard Error).

Group/ Week	T1 (Control)	Magnetized water group			Sig. 0.05
		T2 (500 Gauss)	T3 (750 Gauss)	T4 (1000 Gauss)	
Age at puberty	33.50^{a}±1.44	32.15^{b}±1.24	30.70^{c}±0.97	28.48^{d}±1.26	*
Weight at puberty	136.59^{a}±2.58	133.25^{b}±1.65	131.33^{c}±1.80	134.06^{b}±1.74	*
Relative weight of the right testicle	1.15^{c}±0.03	1.17^{c}±0.04	1.20^{b}±0.01	1.35^{a}±0.02	*
Relative weight of the left testicle	1.22^{c}±0.03	1.24^{c}±0.03	1.27^{b}±0.01	1.42^{a}±0.01	*
Right testicle size	1558.79^{d}±65.08	1618.07^{c}±84.03	1680.22^{b}±29.07	1966.30^{a}±78.30	*
Left testicle size	1638.00^{d}±77.62	1711.00^{c}±72.19	1771.30^{b}±31.07	2060.85^{a}±64.95	*
Relative weight of ovary	2.83^{d}±0.09	2.95^{c}±0.08	3.18^{b}±0.11	3.33^{a}±0.02	*
Relative weight of oviduct	3.61^{c}±0.14	3.65^{c}±0.12	4.00^{a}±0.11	4.18^{a}±0.06	*

Small letters referred to significant difference among groups at (p≤0.05). N.S referred to no significant difference. * Referred to significant difference.

In Table 5, there was a significant superiority (p<0.05) in the cellular blood characteristics, which included RBC, Hb, and PCV, for quail birds in the groups treated with magnetized water in weeks 2, 4, 6, and cumulative compared to the control group, which recorded the least significant. While the WBC characteristic did not record any significant difference for all transactions.

We note from Table 6, that there are no significant differences in the biochemical characteristics of Glucose, ALP, ALT, and AST for the treatments treated with magnetized water, while the traits of total protein, albumin, globulin, T3 and T4 recorded a significant increase(P<0.05), except for the traits of cholesterol and MDA, which recorded a significant decrease for the treatments treated with magnetized water compared to the control group

Table 7 indicated that there was a significant superiority (P<0.05) in the reproductive characteristics of treated quail birds that were given magnetized water compared to the control group.

Table 8: Effect of magnetized water on some hatchery traits during productive period. (Mean ± Standard Error).

Group/ Week	T1 (Control)	Magnetized water group			Sig. 0.05
		T2 (500 Gauss)	T3 (750 Gauss)	T4 (1000 Gauss)	
Fertility rate	66.47^{d}±4.97	68.64^{c}±4.41	72.72^{b}±3.74	75.64^{a}±3.86	*
Hatching rate	75.66±4.44	77.00±4.40	78.73±4.34	76.68±4.10	N.S
Fetal deaths	22.31±4.43	21.00±5.39	19.21±4.34	21.26±4.11	N.S
Weight of the hatched chick	8.59±0.16	8.68±0.08	8.68±0.12	8.67±0.10	N.S

Small letters referred to significant difference among groups at (p≤0.05). N.S referred to no significant difference. * referred to significant difference

Table 8 shows that there are no significant differences in the hatching characteristics, except for the fertility rate, which recorded a significant increase in the treatments to which magnetized water was added.

DISCUSSION

It is clear from Table 1 that there is a significant effect (p<0.05) of providing magnetized water to quails on their live body weight rates in weeks (4, 2, 6 and cumulative), The fourth treatment, T4, recorded the highest significant difference compared to the other treatments, and the control group, T1, which recorded the lowest differences, The reason for the superiority in bird weight rates may be attributed to the fact that the birds that consumed the magnetized water improved the process of blood circulation and its access to all tissues and cells of the body, because the magnetized water is characterized by more activity than regular water, and this activity works to reduce the process of catabolism and increase the activity of construction within the cells (Ibrahim and Hassan, 2023). The other reason is that magnetized water increases the permeability and surface tension of cells while reducing the surface tension of water, and as a result allows the digestive tract to expand and increase the efficiency of food utilization (Ibrahim and Hassan, 2023; Alattar *et al*., 2022), The results of this research agreed with the findings of (Abdalla *et al*., 2023; Hassan *et al*., 2024), who showed that giving magnetized water to broilers increased the weights of the birds compared to the control as a result of the role of magnetized water in increasing the activity of the pituitary gland, which works to support the activity of the thyroid gland. Through the secretion of the hormone thyroxine, which increases protein metabolism and thus leads to increased absorption.

There is a significant effect (p<0.05) of magnetic water on the rate of weekly weight gain of quail in weeks (2, 4, 6 and cumulative), where all treatments outperformed the control group. The fourth treatment, T4, recorded the highest significant difference compared to the other treatments, and the control group, T1, which recorded the lowest differences. The reason for the significant superiority may be attributed to the ability of magnetized water to decompose food materials and increase their ability to be absorbed. Also, the reason may be due to the ease of absorption of food as a result of the increased permeability within the cells due to the magnetized water (Baker *et al*., 2024). The results of this research agreed with the findings of (Ibrahim and Hassan, 2023; Hassan *et al*., 2024) who indicated an increase in the weekly weights of broilers in transactions. Magnetic water treatment compared to the control treatment.

There is a significant difference (p<0.05) in the amount of feed consumed by the quails for the control group in weeks 2, 4, and 6 and in the cumulative amount compared to the rest of the experimental treatments that consumed magnetized water, which recorded the lowest significant difference. The results of the current research agreed with the findings of (Ibrahim and Hassan, 2023; Hassan *et al*., 2024; Baker *et al*., 2024), who noted a significant decrease in the feed consumed in the treatments that consumed magnetized water compared to the control group, which recorded a significant superiority. The reason for the significant decrease in the treatments provided with magnetized water may be due to the ability of magnetized water to increase the permeability and surface tension of the cells and reduce the surface tension of the water. Increasing the surface tension of the cells works to expand the digestive tract, which facilitates the process of digesting nutrients and increasing their absorption (Hassan, 2020).

The results of Table 4 showed a significant (p<0.05) superiority in the feed conversion factor for quails for the groups treated with magnetic water in weeks 2, 4, 6 and cumulative compared to the control group, which recorded the least significant difference. The results of the current research agreed with the results of (Hassan *et al*., 2024; Baker *et al*., 2024) who observed a significant decrease in the food conversion factor in the control group compared to the treatments that were provided with magnetized water, which recorded a significant superiority. The reason for the improvement in the feed conversion coefficient in the treatments treated with magnetized water may be due to the ability of magnetized water to increase the amount of oxygen entering the cells and reduce the surface tension of the water, which leads to increased benefit from the

consumed feed and improved food absorption (Baker *et al*., 2024).

Cellular traits showed significant superiority ($p<0.05$) in the cellular blood characteristics, which included RBC, Hb, and PCV, for quail birds in the groups treated with magnetized water in weeks 2, 4, 6, and cumulative compared to the control group, which recorded the least significant. While the WBC characteristic did not record any significant difference for all transactions. The results of the current research agreed with the results of (Hassan, 2020; Hassan *et al*., 2024) who noticed a significant increase in RBC in the treatments treated with magnetized water compared to the control group. And increase RBC In the blood, it is due to the direct proportion between the number of RBC and body weight (Velleman *et al*., 2024), as well as to the role of magnetized water in increasing the number of RBC (Lin *et al*., 2020). As for the reason for the superiority of HB and PCV in the blood to the treatments treated with magnetic water, it is due to the direct proportion between the concentration of HB and the number of RBC in the blood (Taylor, 2021). As well as the direct proportion between the size of the PCV and the number of RBC With blood (Velleman *et al*., 2024). The results of the research in this regard were consistent with what was found (Hassan, 2020; Hassan *et al*., 2024; Kirkpinar *et al*., 2023).

We note from Table 6 that there are no significant differences in the biochemical characteristics of Glucose, ALP, ALT, and AST for the treatments treated with magnetized water, while the traits of total protein, albumin, globulin, T3 and T4 recorded a significant increase ($P<0.05$), except for the traits of cholesterol and MDA, which recorded a significant decrease for the treatments treated with magnetized water compared to the control group. Perhaps the reason for the significant superiority in the concentration of total protein in the blood serum of the treatments treated with magnetic water is the role of this water in the protein synthesis process and reducing the catabolism process (Dibakoane *et al*., 2025). Increasing the concentration of globulin in the blood has increased the number of primitive lymphocytes that are responsible for manufacturing this protein, which means activating the immune system in the body (Hassan, 2020). The results of the research were consistent with the results reached by everyone (Abdalla *et al*., 2023), who indicated an increase in the concentration of total protein in the blood serum as a result of the use of magnetized water. As for the reason for the decrease in cholesterol concentration due to the ability of magnetized water to activate the thyroid gland, which secretes thyroxine, which affects cholesterol metabolism (Ghoneim *et al*., 2020), the results of this research agreed with the results of (Alsereah, 2019), who indicated a decrease in the concentration of cholesterol in blood serum Broilers. This may be due to the low concentration of MDA when introduced Magnetized water to quails indicates that there is an inversely proportional relationship between body weight and the antioxidant compound malondialdehyde. The reason for the rise in the T3, T4 hormones is attributed to increased activity of the pituitary gland, which increases its secretions in the blood (Mahdi *et al*., 2023).

There was a significant superiority ($P<0.05$) in the reproductive characteristics of treated quail birds that were given magnetized water compared to the control group. The reason may be the early age of sexual maturity in birds. To increase testicle weight, which leads to an increase in testosterone, as there is a direct relationship between testicle weight and the hormone (Gunuza, 2020). While the reason for the increase in testicle weights in the treatments to which magnetized water was provided is attributed to the release of the hormone - GnRH, which stimulates the hormones FSH and LH from the pituitary gland, and thus increases the secretion of testosterone from the testes (Shah-Alam *et al*., 2022). The increase in the size of the testicles in the treatments that were given magnetized water is due to the positive correlation between the size of the testicles and their weight. As the weight increases, it leads to an increase in size (Hassan, 2020). As for the superiority achieved by the relative weight of the ovary and the oviduct in the treatments to which magnetized water was provided, it is due to the direct relationship between the body weight and the number and size of the ovarian follicles and oviduct (Castro *et al*., 2020).

There are no significant differences in the hatching characteristics, except for the fertility rate, which recorded a significant increase in the treatments to which magnetized water was added. Perhaps the reason is due to the wave relationship between the increase in egg production and the fertility rate. The higher the egg production rate, the higher the percentage with it.

CONCLUSION

The use of highly magnetized water of 1000 Gauss led to an improvement in the production characteristics and some physiological, reproductive and hatching characteristics of quail compared to the use of ordinary water.

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sample collection and management to results analysis.

NOVELTY STATEMENT

The current study explored the simultaneous link between physiological improvements, reproductive efficiency, and hatchability, providing a deeper understanding of how magnetized water works. It highlighted its potential as a cost-effective and environmentally friendly approach to enhancing quail productivity, unlike previous studies that focused on limited productivity or physiological parameters.

AUTHOR'S CONTRIBUTION

The study was designed by the researcher who oversaw all its requirements and was conducted at the animal farm of the Public Health Branch at the College of Veterinary Medicine, University of Basra. The researcher randomly assigned birds to groups and administered different levels of magnetized water, recording their productive, physiological, and reproductive performance, as well as hatchability characteristics.

Statement of developments

In this research, we studied the productive, physiological, reproductive, and hatching characteristics within a single experimental design. The results showed improved fertility when treated with high-density magnetized water (1000 gauss), as well as improved protein content. Conversely, signs of oxidative stress decreased in quail.

Generative AI and AI-assisted technology statement

While working on this manuscript, the authors did not use generative artificial intelligence tools to assist with the scientific content or the interpretation of results; rather, they bear full responsibility for the integrity and rigor of the scientific manuscript. The use of these tools was limited to enhancing the readability and linguistic quality of the text.

Conflict of interest

The researcher acknowledges that the preparation, design, and analysis of this study were conducted without any conflict of interest, and that there were no external influences that could affect the results of the experiment, which was conducted solely for research purposes.

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