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UTILIZATION OF MAGNETIC WATER TECHNOLOGY TO IMPROVE WATER QUALITY AND GROWTH PERFORMANCE OF FISH

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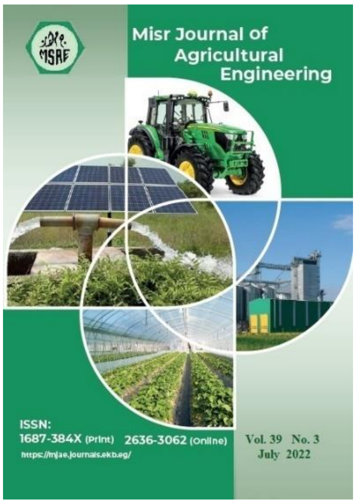

Keywords:
Nile tilapia; Common carp; Stocking density; Magnetic water; Growth performance.

ABSTRACT

The present study was designed to investigate the effect of magnetic water technique and different stocking density on water quality parameters and growth performance of Nile tilapia (Oreochromis niloticus) and Common carp (Cyprinus carpio). Magnetic water at 14500 gausses (1.45 Tesla) was used compared with normal water (0 gauss) for experimental groups of fish which reared with three different levels of stocking density 12, 25, 50 fish/m^3 and each group was replicated with an average initial weight 10 g/fish. Experimental fish were fed on commercial diet (25 % protein). The fish tanks were supplied with aeration and filtration systems. At the end of the experiment, the results indicated that water quality and growth performance improved significantly ($P<0.05$) in magnetic water treatment compared to the normal water with different stocking densities. The results recorded that dissolved oxygen, pH and total hardness values in magnetic water increased in comparison with the normal water, but ammonia was inversely related to magnetic field, while total alkalinity and water temperature were not affected by treatment. The data revealed that growth performance, water quality improved and significantly in magnetic water treatment between different stocking densities, and pointed that, the stocking density of 12 fish/m^3 with magnetized water was the best treatment. Results indicated that fish reared in magnetic water treatment improved significantly ($P<0.05$) compared to those in the normal water with different stocking densities. In shortly, applying magnetic water on aquaculture definitely on Nile tilapia and Common carp farming improves growth performance.

1. INTRODUCTION

Water quality is paramount in aquaculture. Excellent water quality is necessary for the optimal growth of fish, as it reduces the stress the fishes experience and prevent the proliferation of diseases. Important water quality parameters in aquaculture include temperature, dissolved oxygen, pH, ammonia, and nitrate and nitrite content (Carbajal-Hernandez et al., 2013), Loraine et al., 2014). The theory of magnetic field impact on technological processes for water treatment falls into two main categories, crystallization at magnetic water preparation and impurity coagulation of water systems (Fadil et al., 2001). El-Hanoun et al. (2017) found that magnetic treatment improved the quality of the well water and affected the reproductive traits. The potentials of magnetic treatment in different fields of environmental management have been highlighted in different studies (Ali et al., 2014). Magnetic field transfers water from dead to live (Hussein et al., 2015). Several researches proved the positive effect of magnetized water on all living cells and suggested that contact of water with a permanent magnet for a considerable time produced magnetic charges and magnetic properties. (Yacout el al., 2015). The use of magnetic field to improve water quality is significant interest due to low cost compared to chemical and physical treatment (Ebrahim and Azab, 2017). Water and water-based solutions that pass through magnetic fields acquire a finer and more homogeneous structure as various minerals are dissolved and removed, this increases fluidity and improves the biological activity of these solutions which positively affect the performance of humans, animals and plants that consume or absorb them (Al Hilali, 2018). Rosen, 2010 reported that magnetic biological technology offers a number of advantages over traditional chemical treatments and has been shown to improve growth rates and reduced the mortality rate. Zhao et al. (2015) evaluated the effect of exposure to magnetic field on growth and immune and digestive enzyme levels in juvenile sea cucumbers Apostichiopus japonicus. Thus, magnetic treatment had a positive effect on growth, immune status, and digestive enzyme levels in juvenile sea cucumbers. Studies revealed that exposing water to magnetic field influences the water's physiochemical properties which affect the biological properties of the organisms that consume the water (Sedigh et al., 2019).

Mosin and Ignatov (2014) said that in water exposed after magnetic treatment is possible the change of the hydration of ions, salts solubility, pH value, which results in changing the rate of corrosion processes. Thus, magnetic water treatment causes a variety of related physical and chemical effects. Magnetic water treatment method requires no chemical reagents, and is therefore environmentally friendly.

Today Aquaculture is considered an important source of production for meeting the worlds increasing demand for protein. Aquaculture development projects are being initiated in many parts of the world, especially in the developing countries. Aquaculture production is a highly progressive field and it covers large portion of the requirements of protein for human. Among all cultured freshwater fish, Tilapia species specially Nile Tilapia (*Oreochromis niloticus*) has the greatest importance in global fish production, since it is considered the most widely farmed type of aquaculture in the world. Since protein is the most expensive component of feed items, inclusion of protein in its optimum amount will enable us to develop cost-effective dietary formulations. To optimize the protein level in fish diets, data on the essential amino acids requirements and bioavailability are needed. Therefore, the overall goal of our studies is to set up and evaluate new ways to increase the productivity of Tilapia and Common carp fish. However, the application of the magnetic treatment in aquaculture sector is still a new approach of several studies have been conducted to test the effect of magnetic field on aquaculture as Hassan et al. (2018b); Hassan et al. (2019). Therefore, the objective of the present study was to investigate the effects of using magnetic water technique and stocking density on water quality and growth performance of Nile tilapia (*Oreochromis niloticus*) and Common carp (*Cyprinus carpio*).

2. MATERIALS AND METHODS

The present study was carried out at the Central Laboratory of Aquaculture Research Abbassa, Abu-Hammad, and Sharkia Governorate, Egypt. During the summer season of 2017 in tanks with three treatments and two replicates for treatments.

Fish and experimental Design

The study was designed to investigate the effect of magnetic water technique on water quality and growth performance of Nile tilapia and Common carp in tanks with volume 1 m^3 of water each were used with three different levels of stocking densities (12, 25 and 50 fish/m^3) for each other and two water treatments ((Control) normal water and magnetic water) with initial average weight 10 g/fish from the hatchery of Central Laboratory for fish research. Fish were fed on commercial diet (25% protein). Magnetic water at 14500 gausses was used compared with normal water (0 gauss) for the three groups of fish. The magnetic device was used in the experimental period for 4 months.

The experimental fish Nile tilapia and Common carp with Initial weight 10 g/fish after two weeks acclimation under normal laboratory conditions were randomly distributed into tank (1 m^3 of water) in 3 treatments (2 replicates per treatment). Each tank was filled with water up to level of 90 cm and the level was maintained throughout the experimental period.

Magnetic device

The magnetization device was a magnetic rod of 2 inches in diameter, with a magnetic capacity of 14500 Gauss (1.45 Tesla), Delta water Co. for water treatment. When water passes through the magnetic field it becomes magnetized, which causes some physical changes to the composition and shape of water molecules.

Water quality parameters

Water quality measurements were taken daily: dissolved oxygen (DO), temperature and pH values using pH meter. Water temperature was measured in each tank daily using a mercury thermometer of 0 to 100^{o}C range. Other measurements such as total alkalinity, total hardness and ammonium were determined according to American Public Health Association (APHA, 2000). Dissolved oxygen was measured directly by using oxygen-thermometer apparatus.

Growth performances parameters

Every two weeks fishes were collected from each tank and were put in bucket filled with water and weighed on a scale in order to get the individual weight. The weight gain (g/fish) was calculated using the following equation: Body weight gain (BWG) (g/fish) = Final weight (g) - Initial weight (g). Total body length (BL) was measured at the end of experimental period by the ruler (cm). Condition factor (K) was calculated using the following equation according to Schreck and Moyle (1990). $K= (W / L^3) \times 100$, Where, W= body weight (g), and L= total length (cm). Feed conversion ratio (FCR) and specific growth rate (SGR) were determined by using the following equations: FCR = Feed intake (g) / Weight gain (g), $SGR=100 \times (\ln W_2-\ln W_1) / T$, Where W_1 is initial weight and W_2 is final weight (g), T is the number of days in the feeding period and survival rate (%): Survival rate (%) = {(total number - dead number)/total number} x 100.

Statistical Analysis

The data obtained from each trial were subjected to the analysis of variance of a factorial in completely randomized design using computer program. The differences among treatments were compared using Duncan's multiple range test (Duncan, 1955).

3. RESULTS AND DISCUSSION

The impact of stocking density and magnetic treated water on water quality parameters:

The values of water quality parameters were presented in Table (1). The dissolved oxygen significantly increased ($P<0.05$) from 8.28 ± 0.16 mg/l to 8.70 ± 0.34 mg/l for Nile Tilapia and increased from 6.5 ± 0.09 mg/l to 7.9 ± 0.30 mg/l for Common Carp in normal and magnetic water, respectively in fish treatment stocking at 12 fish/m^3, which were more than in fish groups reared at 25 and 50 fish/m^3. Similar results were recorded by Ebrahim and Azab (2017); Hassan *et al.* (2018a) pointed that the increase in magnetic intensity led to an increase in dissolved oxygen concentration compared to normal water (control) this insure that magnetic device improve water quality. The increase of dissolved oxygen may be due to the decrease in organic matter in magnetic water (Yacout *et al.* 2015).

The obtained results concerning there were no significant differences in the temperature and total alkalinity between the magnetic water and normal water in different stocking treatments (Table 1). The differences between these results and the results of the other studies could be related to the differences in magnetic intensity. These results are in agreement with the findings of Irhayyim *et al.* (2019).

Hydrogen ion concentration (pH) is the master control parameter in aquatic environment and affects the metabolism and other physiological processes. The data indicated that the pH increased slightly from 6.70±0.06 to 8.10±0.28 in control and magnetic water, respectively for Nile Tilapia and from 6.70±0.16 to 7.20±0.15 for Common Carp were in fish groups reared at12 fish/m^3 in two treatments. There was a significant difference in pH measurement. This was supported by Hasson and Bramson (1985) who reported an increase of 12 % in water pH post-magnetization. High pH value probably related to the increase in free carbonate content in water according to the salt dissociate due to magnetic field (Alabdraba et al., 2013).

The difference in ammonium concentrations between normal and magnetic water was shown in Table (1). There was significant decrease in NH_4 concentration in magnetic water (0.11±0.003 mg/l) compared to normal water 0.30±0.006 mg/l in fish groups reared at12 fish/m^3. The results are in accordance with the studies of Hassan *et al.* (2018c). The magnetic field increased the free radical formation while the high reactivity and oxidation potential of those chemical compounds may have reduced the concentration of organic matter contained in the analyzed liquids (Krzemieniewski *et al.*, 2003). The lowest value of ammonium may be as the result of oxidizing ammonia into NO_2 and NO_3 (Abdo, 1998). While the maximum value of ammonium in fish groups reared at 25 and 50 fish/m^3 may be attributed to higher pH and high stock of fish. The results are in agreement with

Konsowa (2007) who reported that ammonia concentration was correlated with the amount of stocked fish population.

Total hardness, the minimum values were found in normal water and magnetic water were 163± 6.52 mg/l and 160± 3.20 mg/l for Nile Tilapia and were 166±6.30 mg/l and 164±2.46 mg/l for Common Carp, respectively in fish treatment reared at12 fish/m^3. The maximum values were recorded in magnetic water treatment in different fish stocking groups. There was a significant variation in total hardness concentration. This is coincided with findings of Hassan and Abdul Rahman (2016). The high value due to the magnetic exposure which leads to increasing soluble salts which concurred with the conductivity (Ycout et al., 2015).

The results indicated that the magnetic field has an influence on certain parameters of water as dissolved oxygen, pH, total hardness and ammonium which cause improvement of water quality. Similar results were recorded by El Hanoum et al., (2017). Many studies reported that when water is exposed to a magnetic field, its molecules will be arrange in one direction due to the relaxation of bonds and decrease in their angle to less than 105^o (Lowe 1996), which affects the molecular and chemical properties of water (Cai et al., 2009).

The impact of stocking density and magnetic treated water on growth performance parameters of Nile Tilapia *(Oreochromis niloticus)* and Common carp (*Cyprinus carpio*): The values of the growth performance parameters were presented in Table (2). The highest final body weight were 83.15±1.66 g and 93.25±3.73 g, respectively were recorded in normal water and magnetic for Nile Tilapia and were 90.95±2.28 g and 124.9±4.75 g for Common Carp in fish groups reared at 12 fish/m^3 and the lowest values were recorded in magnetic and normal water in fish groups reared at 25 and 50 fish/m^3 this may be due to density and competition**.** There were significant differences ($P<0.05$) observed among the body weight values of the treatments. Similarly, the body length recorded was relatively high in magnetic water with value of 16.3±0.65 cm for Nile Tilapia and 18.6±0.70 cm for Common Carp, the lowest value was 15.2±0.30 cm and 18.5±0.27 cm respectively for Nile Tilapia and Common Carp in normal water in fish groups reared at 12 fish/m^3.

Condition factor (K) and specific growth rate (SGR) exhibited the same trends in its variations where increase in magnetic water and decrease in normal water in different treatments of stocking density. The values SGR and condition factor (K) of fish reared in magnetic water were significantly higher ($P<0.05$) than in the normal water (Table 2). The best feed conversion ratio (1.49±0.05) was found in fish of magnetic water in treatment reared at12 fish/m^3 for Nile Tilapia and Common Carp and was significantly better than normal water. Various factors can influence growth and feed intake in fish and some of these can include feed palatability, digestible energy intake, water quality and stress as stocking density (Houlihan *et. al*., 2001). Similarly, Mannan *et. al*. (2012), Hassan *et. al*. (2018a) & Irhayyim *et. al*. (2019) concluded that magnetized water improved the growth performance of Tilapia and common carp.

The best survival ratio % 91.0±0.03 and 89.0±0.01 were found in fish of magnetic water in treatment reared at 12 fish/m^3 for Nile Tilapia and Common Carp and was significantly better than normal water.

Table 1: The impact of stocking density and magnetic treated water on water quality parameters (means ± standard deviations).

Water Parameters	Nile Tilapia							Common Carp						
	Control (Normal water)			Magnetic water			L.S.D	Control (Normal water)			Magnetic water			L.S.D
	Stocking density, fish/m^3							Stocking density, fish/m^3						
	12	25	50	12	25	50		12	25	50	12	25	50	
DO (mg/l)	8.28±0.16	7.70±0.23	7.60±0.07	8.70±0.34	8.13±0.20	8.0±0.28	0.42	6.5±0.09	6.7±0.21	6.8±0.17	7.9±0.30	7.6±0.13	7.5±0.16	0.34
Temp (C°)	28.7±0.57	28.7±0.86	28.7±0.28	28.7±1.14	28.7±0.71	28.7±1.004	1.45	28.7±0.43	28.7±0.91	28.7±0.71	28.7±1.09	28.7±0.51	28.7±0.63	1.34
pH	6.70±0.06	6.80±0.20	6.90±0.13	8.1±0.28	8.7±0.21	8.90± 0.35	0.41	6.70±0.16	6.80±0.21	6.80±0.10	7.20±0.15	7.40±0.13	7.60±0.28	0.33
NH4(mg/l)	0.3±0.006	0.4±0.01	0.6±0.006	0.11±0.003	0.12±0.003	0.12 ±0.004	0.01	0.31±0.004	0.22±0.007	0.31±0.007	0.11±0.004	0.12±0.002	0.11±0.002	0.01
T.alk.(mg/ l)	142±2.84	155±4.65	169±1.69	146±5.84	157±3.92	172±6.02	7.90	147±2.20	160±5.12	167±4.18	149±5.66	158±2.84	170±3.74	7.36
T.H (mg/l)	163±6.52	170±4.25	174±6.09	160±3.20	166±4.98	168±1.68	8.46	166±6.30	167±3.006	170 ±3.74	164 ±2.46	165±5.28	168±4.21	7.77

Table 2: The impact of stocking density and magnetic treated water on growth performance parameters (means ± standard deviations).

Growth performance	Nile Tilapia							Common Carp						
	Control (Normal water)			Magnetic water			L.S.D	Control (Normal water)			Magnetic water			L.S.D
	Stocking density, fish/m^3							Stocking density, fish/m^3						
	12	25	50	12	25	50		12	25	50	12	25	50	
Body weight	83.15±1.66	72.46±2.17	61.50±.61	93.25±3.73	83.6±2.09	73.6±2.58	4.16	90.95±2.28	77.2±1.16	61.27±1.96	124.9±4.75	82.3±1.48	93.3±2.05	4.55
Body length	15.2±0.30	15.0±0.45	14.2±0.14	16.3±0.65	16.1±0.40	15.2±0.53	0.79	18.5±0.27	18.0±0.57	16.6±0.41	18.6±0.70	18.0±0.32	14.55±0.31	0.82
K factor	2.14±0.02	2.10±0.06	1.26±0.02	2.99±0.10	2.18±0.05	1.96±0.07	0.12	2.53±0.08	2.22±0.05	1.96±0.02	2.64±0.05	2.20±0.03	2.0±0.07	0.11
FCR	1.56±0.03	1.62±0.04	1.66±0.01	1.49±0.05	1.53±0.03	1.54±0.05	0.08	1.54±0.02	1.58±0.05	1.61±0.04	1.49±0.05	1.53±0.02	1.54±0.03	0.07
SGR	1.73±0.31	1.56±0.84	1.18±0.5	1.82±1.10	1.70±0.77	1.32±1.03	1.45	1.82±.87	1.66±.90	1.28±.83	1.92±0.69	1.80±0.50	1.42±0.95	1.34
Survival rate	84.10±0.02	73.90±0.04	73.0±0.06	91.0±0.03	90.0±0.05	88.33±0.02	1.025	82.13±0.02	78.11±0.05	79.0±0.03	89.0±0.01	86.0±0.04	84.15±0.04	1.09

Moreover, the highest growth parameters were found in fish treatment reared in 12 fish/m^3 it could be due to comparatively lower stocking density and good water quality than other treatments (25 and 50 fish/m^3). According to Tyari *et. al*. (2014) magnetic water changes physical, chemical biological properties of water, and it increases the solubility of minerals which eventually improves the transfer of nutrients to all parts of the body. These results are coincided with the study of Mannan *et. al*. (2012) who reported that if the physico-chemical parameters of water will be in the describe range, stocking density and feeding will be probably maintained then the production will be raised.

The final yield has effected and improved organism performance. Also, other studies revealed that the magnetic field can change the water's surface tension, density, viscosity, hardness, conductivity and solubility of solid matter, which changes the properties of water and improve the biological activities of the water, affecting positively the performance of animals (Khudiar and Ali, 2012).

4. CONCLUSIONS

The present work concluded that water quality and growth performance parameters of the magnetic water technique showed significant improvement compared to the control groups in high and low stocking density. The present study recommends using magnetic water technique in Nile tilapia and Common Carp fish production.

The results from the present study indicated that the magnetic field affects certain physico-chemical properties of water. However, pH, DO and T.H. water values increased but NH_4 was inversely related to magnetic field. The use of magnets to improve quality is of significant interest due to low cost compared to chemical and physical treatments. Magnetic water improves some water quality parameters and growth performance of Nile Tilapia and Common Carp.

Using magnetic force has a vital role in treatment of the polluted water and positive implication for aquaculture. This encourages more researches in this field to overcome negative effects of water pollution.

The present study also recommends that using of magnetic water generally improved the production of Nile Tilapia and Common Carp.

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استخدام تكنولوجيا الماء الممغنط لتحسين جودة المياه وأداء نمو الأسماك

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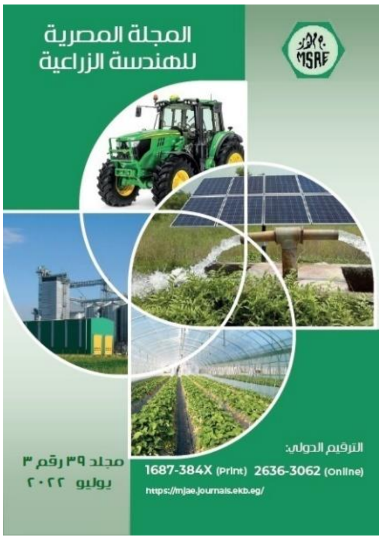
[٤] أستاذ مساعد هندسة الري والصرف - قسم الهندسة الزراعية - كلية الزراعة –جامعة الزقازيق – مصر

الملخص العربي

صممت الدراسة الحالية لمعرفة تأثير تقنية الماء الممغنط وكثافة التخزين المختلفة على معايير جودة المياه وأداء نمو البلطي النيلي والكارب الشائع (اسماك المبروك). تم استخدام الماء الممغنط عند ١٤٥٠٠ جاوس (١,٤٥ تسلا) مقارنة بالمياه العادية (٠ جاوس) للمجموعات التجريبية من الأسماك التي تمت تربيتها بثلاثة مستويات مختلفة من كثافة التخزين ١٢ ، ٢٥ و٥٠ سمكة / م٣ وتم تكرار كل مجموعة بمتوسط وزن ابتدائي ١٠ جم/ سمكة. تم تغذية الأسماك التجريبية على العلف التجاري (٢٥٪ بروتين). تم تزويد خزانات الأسماك بأنظمة تهوية وترشيح. في نهاية التجربة ، أشارت النتائج إلى تحسن جودة المياه وأداء النمو بشكل ملحوظ في معاملة الماء الممغنط مقارنة بالمياه العادية مع الكثافة التخزينية المختلفة. سجلت النتائج أن قيم الأكسجين المذاب ودرجة الحموضة والصلابة الكلية في الماء الممغنط زادت بالمقارنة مع الماء العادي، لكن الأمونيا كانت مرتبطة عكسياً بالمجال المغناطيسي ، بينما لم تتأثر القلوية الكلية ودرجة حرارة الماء بالمعاملة. أوضحت البيانات أن أداء النمو وتحسين جودة المياه تحسن بشكل ملحوظ في معاملة الماء الممغنط بين كثافات التخزين المختلفة ، وأشارت إلى أن كثافة التخزين البالغة ١٢ سمكة / م٣ المعاملة بالمياه الممغنطة كانت أفضل معاملة. وأشارت النتائج إلى أن الأسماك التي تم تربيتها في المياه الممغنطة تحسنت معنويا ($P < 0.05$) مقارنة بتلك الموجودة في المياه العادية ذات الكثافة التخزينية المختلفة. باختصار، يؤدي استخدام الماء الممغنط في مزارع الاستزراع السمكي لأسماك البلطي النيلي والكارب الشائع إلى تحسين أداء النمو.



الكلمات المفتاحية:
البلطي النيلي؛ الكارب الشائع؛ كثافة التخزين؛ الماء الممغنط؛ أداء النمو.