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The Effects of Magnetic Water on Growth Performance and Blood Parameters of Nile Tilapia (*Oreochromis niloticus*) under Different Stocking Densities

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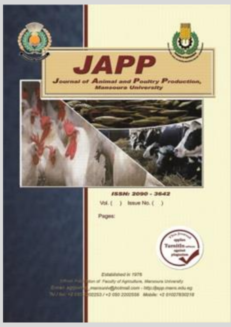

ABSTRACT

The present study was designed to investigate the effects of magnetic water and different stocking densities on water quality parameters, growth performance, feed utilization, chemical composition and Blood biochemical of Nile tilapia (*Oreochromis niloticus*). A total of 180 healthy monosex Nile tilapia fingerlings with an average initial body weight of 33.24 ± 0.47 g were randomly distributed into 18 glass aquaria. The experiment was based on a 2 × 3 factorial design with three stocking densities; (5, 100, and 150 fingerlings/m^3), and two types of water, normal water (NW) and magnetic water (MW). Experimental fish were fed on the commercial diet (30.11% protein) based on a feeding rate of 3% from body weight for all groups. Water quality parameters, growth performance parameters, feed utilization, chemical composition and blood parameters were calculated in all groups at the end of the experiment after eight weeks. The results indicated that water quality, growth performance, feed utilization, and chemical composition improved significantly in magnetic water groups compared to normal water groups at the three stocking densities. As for blood parameters, there were no significant differences in all groups. In conclusion, applying magnetic water on aquaculture of Nile tilapia farming improves water quality parameters, fish growth performance, feed utilization, and chemical composition at different stocking densities.

Keywords: Nile tilapia, Magnetic water, Stocking density.

INTRODUCTION

Aquaculture production is a rapidly evolving area that meets a significant amount of human protein needs. Tilapia species, particularly Nile Tilapia (*Oreochromis niloticus*), are the most important in world fish production among all cultured freshwater fish, since they are considered the second most farmed finfish species of aquaculture in the world (FAO, 2018).

The usage of the electromagnetic field has increased in recent years in a variety of sectors, including agriculture, food processing, wastewater treatment, aquaculture, and others. Magnetic treatment's potential in several domains of environmental management has been recognized (Ali *et al.*, 2014). Magnetic water treatment is a simple and efficient approach where the water flows through a magnetic field or combination of magnetic fields. It is a nonchemical treatment of water that does not require any filtration substitutes Mabrouk *et al.* (2016). The biological technique using magnetic field to purify water is considered as a simple simulation of what happens in nature, when water is subjected to a magnetic field and as a result, becomes more biologically active (Mushattat *et al.*, 2009).

According to (El Katcha *et al.*, 2017; Sedigh *et al.*, 2019), exposing water to a magnetic field changes the physiochemical characteristics of the water, which affects the biological properties of the organisms that consume the water. Furthermore, Magnetic water treatment stimulating the activity of proteins, enzymes, movement of free radicals and enhancing the overall biochemical processes inside the living cells (Mahmoud *et al.*, 2019).

Magnetic biological technology offers several advantages over traditional chemical treatments and has been shown to improve growth rates and reduce the mortality rate in cats (Rosen, 2010). Tang *et al.*, (2015) reported the enhancing effect of exposure to magnetic field on growth, immune and digestive enzyme levels in juvenile sea cucumbers (*Apostichopus japonicus*). Furthermore, Mabrouk *et al.*, (2016); Hassan *et al.*, (2018 a & 2019); Irhayyim *et al.*, (2020) and Abdelkhalek *et al.*, (2021) studies the effect of magnetic field treated water on improving water quality, growth parameters, feed utilization and immunity. However, the field application of the magnetic treatment in tilapia reared under different stocking densities is still new and needs further research.

Therefore, the main aim of the present study was to evaluate the effect of magnetic water treatment under different stocking densities and how it affects water parameters, fish growth performance, feed utilization, body composition, and some blood parameters of Nile tilapia (*O. nilolicus*) fingerlings.

MATERIALS AND METHODS

Experimental Design

This experiment was carried out at the Fish Experimental Unit of the Department of Fish Production, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. Tilapia (*O. niloticus*) with an average initial weight of 33.24 ± 0.47 g were randomly distributed into 18 glass aquaria (60

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× 42 × 40 cm – 101 L^3 of water) in three treatments (3 replicates per treatment). Each aquarium was filled with water up to level of 42 cm and the level was maintained throughout the experimental period. The experiment was based on a 2 × 3 factorial design with three stocking densities; (5, 10, and 15 fish/ aquarium –50, 100 and 150 fingerlings/m^3) and two types of water, normal water (NW) and magnetic water (MW). Magnetic source device was from Delta water Co. for water treatment (Japan), with magnet strength of 11.000 Gauss (1.1 Tesla). This device is composed of an inner magnet surrounded by a copper housing and an outer magnet protected by a steel shield from outside with in and out one-way openings for water current.

All experimental aquaria were supplied with dechlorinated tap water through a water pipeline system and were supplied with an air through air pipeline using an air blower (2 HP). The water was renewed at a rate of 50% every 24 hours. Fish feces and feed wastes were removed everyday by siphoning. The study lasted for 8 weeks after two weeks of adaptation.

Experimental Fish

Apparently healthy sex-reversed (all male) (*O. niloticus*), fingerlings were purchased from aCommercial hatchery, Sharkia Governorate, Egypt. The fingerlings were transported in the morning using a special fish transport car with aeration tools. Fingerlings were adapted to the experimental conditions for 15 days before starting the experiment.

Water Quality Parameters

Water temperature was measured in each aquarium daily using a mercury thermometer of 0 to 100ºC range. Dissolved oxygen was measured directly using an oxygen thermometer apparatus (XSI model 58, Yellow Spring Instrument Co., Yellow Springs, Ohio, USA). Ammonia (NH_4-N mg/L), Nitrate (NO_3 -N mg/ L), Nitrite (NO_2 – N mg/L) and pH were measured monthly during the experimental period by Hanna Instrument 83205 Boiler and cooling tower photometer. Ammonia (NH_4 –N mg/L) was measured using Ammonia MR reagent Hi 93715-01. Nitrate (NO_3 –N mg/L) was measured using Nitrate reagent Hi 93728-01. Nitrite (NO_2 –N mg/L) was measured using Nitrite reagent Hi 93708-01. Hydrogen ion (pH) was measured using pH reagent Hi 937110-01.

Experimental Diet

All fish groups were fed on Commercial diet. The ingredients and chemical composition of the commercial diet used in this experiment are shown in Table (1).

Table 1. Diet formulation and proximate analysis (g/kg)

Diet ingredients%	
Fish meal	18.0
Soybean meal	29.0
Yellow corn	20.0
Wheat bran	15.0
Alfalfa hay	12.0
Sunflower oil	3.0
Minerals mixture	1.0
Vitamin mixture	1.0
Carboxymethyl cellulose	1.0
Total	100
Chemical composition (g kg^{-1})	
Crude protein	30.11
Ether extract	12.35
Ash	14.34
NFE[1]	43.20
GE[2]	4600 Kcal/kg

[1]NFE, nitrogen free extract = 100 - (CP+ EE+ Ash %).
[2]GE (gross energy), calculated according to Jobling (1983), using the 5.65, 9.45, and 4 for CP, EE and NFE, respectively.

Fish were fed at the rate of 3% of wet body weight per day and were offered three times at 8.00, 12.00 and 15.00 hours. The fish in each aquarium were weighed biweekly, and the feed weight was adjusted after each fish weighing.

Measurement of Fish Growth and Feed Utilization

All fishes were separately weighed to the nearest 0.1 g at the beginning of the experiment and once every two weeks throughout the experimental period. The mortality of fish was recorded biweekly at the time of weighing. The growth performance and feed utilization efficiency were calculated as follows:

Weight gain (WG) = final weight (g) – initial weight (g)
Daily weight gain (DWG) = body weight gain (BWG) / period (day).
Survival rate (SR) % = (No. of fish survived at the end of the experiment / whole number of fish at the beginning) ×100.
Feed conversion ratio (FCR) = feed intake (g) / body weight gain (g)
Feed efficiency ratio (FER,%) = body weight gain (g) / feed intake (g)) x100
Protein efficiency ratio (PER) = body weight gain (g) / protein intake (g)

Diet and carcass composition

Diet and fish samples were oven- drying at 60c˚to the constant weight and kept at 20c˚ for further analysis. A standard method used for chemical composition (Moisture, ash, Fiber, lipids and crude protein) of the whole fish body and the nutritional profile of test diets (AOAC,2007). The moisture content was measured by oven-drying at 110 c˚ to constant weight, while the crude protein by the kjeldahl method. The crude lipid was also determined by the soxhlet extraction method and ash by combustion in muffle furnace at 550 c˚ for 6 h.

Blood Parameters

At the end of the trial, fish were not fed for 24 hrs., immediately prior to blood sampling. Fish per aquarium were anesthetized with buffered tricaine methane sulfonate (30 mg/L) Three fish were taken from each aquarium and prepared for blood analysis. The blood samples were obtained from the heart of the fish with a hypodermic syringe and were collected in sterilized tubes, then kept in the state position at room temperature for 30 minutes, and then in the refrigerator overnight. The separation of blood serum was completed by centrifugation for 20 minutes at 3000 rpm, blood Hemolysis was avoided. Serum total protein, albumin, triglycerides, cholesterol, glucose, serum aspartate aminotransfears, AST (u/ml) were determined (Reitman, 1957). Serum total protein (g/dL), albumin (g/dL), cholesterol (mg %) and glucose (mg %) were determined colorimeterically using kits supplied by El-Nasr Pharmaceutical Chemicals Co. (Egypt) (Henery, 1974). Serum globulin (g/dL) levels were obtained by differences between total protein (g/dL) and albumin (g/dL) according to Sundeman (1964). Serum triglycerides (mg/dl) were determined colormetrically using commercial kits from Bio-diagnostic Co. (Egypt).

Statistical Analyses

The data were statistically analyzed with SAS (2002) according to the following model:

$$Y_{ijk} = \mu + D_i + M_j + DM_{ij} + e_{ijk}$$

Where, **μ is the overall mean, D is the fixed effect of stocking density (i = 1 …3), M is the fixed effect of magnetic water (j = 1 … 2), DM_{ij} is the interaction effect of stocking density and magnetic water, and $e_{ijk}$is random error. Differences between treatments were tested with Duncan's multiple range test (Duncan, 1955).**

RESULTS AND DISCUSSION

Results

Water Quality Parameters

As presented in Table (2), averages of ammonia (NH_4), nitrate (NO_3), nitrite (NO_2), hydrogen ion (pH) and dissolved oxygen (DO) as affected by stocking density show that NH_4, NO_3 and NO_2 in the 150 fish/m^3 group recorded high significant (P<0.001) values (0.045, 0.052 and 0.055 mg/L, respectively), while their values in 50 fish/m^3 group were the lowest values (0.016, 0.017 and 0.018 mg/L, respectively). As for pH, it didn't record significant differences between all groups. While DO recorded a high significant value (P<0.001) 6.75 mg/L in 50 fish/m^3 group compared to the other groups. Regardless of stocking density, averages of water quality parameters of NH_4, NO_3, NO_2, pH and DO as affect with the effect of type of water; magnetic water were presented in Table (2). Results of this table reveal that the values of NH_4, NO_3 and NO_2 decreased significantly (P<0.001) in MW group (0.022, 0.025 and 0.027 mg/L, respectively) compared to the NW group (0.033, 0.032 and 0.030 mg/L, respectively). As for pH, there were non-significant differences between its values in the MW and NW group, while DO record a highly significant increase (P<0.001) in the MW group at 6.75 mg/L compared to the NW group at 5.65 mg/L.

As presented in Table (2), results of water quality parameters as affected by the interaction between the stocking density and the type of water showed that the NH_4, NO_3 and NO_2 recorded low significant decreases in all 50 fish/m^3 + MW groups (0.011mg/L for all), while the highest values were recorded in the 150 fish/m^3 + NW group (0.052, 0.052 and 0.053 mg/L, respectively). As for pH, there were no significant differences between all groups. While DO recorded high significant increase (P<0.001) in MW group with 50, 100 and 150 fish/m^3 (7.34, 6.75 and 6.12 mg/L, respectively) in comparison with NW group with 50, 100 and 150 fish/m^3 (6.14, 5.51 and 5.30 mg/L, respectively).

Table 2. Effect of stocking density, magnetic water and their interaction on water quality parameters of Nile tilapia.

Item	NH_4 mg/L	NO_3 mg/L	NO_2 mg/L	pH ppm	DO. mg/L
Stocking density (SD, fish/m^3)					
50	0.016^c	0.017^c	0.018^b	7.68^a	6.75^a
100	0.025^b	0.028^b	0.027^b	7.61^a	6.13^b
150	0.045^a	0.052^a	0.055^a	7.54^a	5.88^b
Standard error	±.002	±.002	±.003	±0.033	±.143
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Type of water					
NW	0.033^a	0.032^a	0.030^a	7.60	5.65^b
MW	0.022^b	0.025^b	0.027^b	7.57	6.75^a
Standard error	±0.002	±0.002	±0.002	±0.002	±0.002
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Interaction between stocking density and type of water					
50 +NW	0.014^d	0.016^{fe}	0.017^d	7.60	6.14^c
100 +NW	0.032^b	0.034^c	0.026^b	7.62	5.51^d
150 +NW	0.052^a	0.052^a	0.053^a	7.58	5.30^e
50 +MW	0.011^d	0.011^f	0.011^e	7.55	7.34^a
100 +MW	0.018^c	0.022^d	0.022^c	7.58	6.75^b
150 +MW	0.033^b	0.045^b	0.049^a	7.57	6.12^c
Standard error	±0.003	±0.003	±0.004	±0.046	±0.202
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Means in the same column of each parameter having different letters are significantly differ (*P* < 0.05).

Growth performance

When fish are exposed to high stocking density in different stages of culture, this leads to a decrease in growth performance. After 8 weeks of treatment applied, final weight (FW), weight gain (WG) and daily weight gain (DWG) were significantly (P<0.001) affected by stocking density. In 50 fish/m^3 stocking density group FW, WG and DWG recorded higher values102.66, 69.45 and 1.24 g/ fish, respectively in 50 fish/m^3 stocking density group as shown in Table (3). As for magnetic effect, groups treated with magnetic water recorded higher significant values (P<0.001) in FW, WG and DWG; 103.44, 70.22 and 1.25 g /fish, respectively. As shown in Table (3) FW, WG and DWG as affected with the interaction between the stocking density and magnetic water treatment showed that the highest value was recorded in the 50 fish/m^3MW group (111.06, 77.80 and 1.39) g/fish, respectively followed by the 100 fish/m^3 MW group (104.02, 70.73 and 1.26) g/fish, respectively. It was noticed that there were non-significant differences between 50 fish/m^3 NW and 150 fish/m^3 MW groups. While the groups of 100 fish/m^3 NW and 150 fish/m^3 NW recorded the lowest values.

Table 3. Effect of stocking density, magnetic water and their interaction on growth performance of Nile tilapia

Item	IW (g)	FW (g)	WG (g)	DWG(g/fish/day)
Stocking density (SD, fish/m^3)				
50	33.21	102.66^a	69.45^a	1.24^a
100	33.31	95.83^b	62.51^b	1.16^b
150	33.20	89.83^c	56.63^c	1.01^c
Standard error	±0.05	±1.15	±1.13	±0.020
P-value	<.0.0001	<.0.0001	<.0.0001	<.0.0001
Type of water				
NW	33.26	88.77	55.51	0.99
MW	33.22	103.44	70.22	1.25
Standard error	±0.038	±0.95	±0.93	±0.016
P-value	<.0.0001	<.0.0001	<.0.0001	<.0.0001
Interaction between stocking density and type of water				
50 +NW	33.23	94.33^c	61.10^c	1.09c
100 +NW	33.36	87.66^d	54.30^d	0.97d
150 +NW	33.20	84.33^d	51.13^d	0.91d
50 +MW	33.20	111.06^a	77.80^a	1.39a
100 +MW	33.26	104.02$^{b.}$	70.73^b	1.26b
150 +MW	33.20	95.33^c	62.13^c	1.11c
Standard error	±0.06	±1.63	±1.61	±0.02
P-value	<.0.0001	<.0.0001	<.0.0001	<.0.0001

Means in the same column of each parameter having different letters are significantly differ (*P* < 0.05).

Feed utilization

There were no significant differences (P<0.001) in feed intake and protein intake concerning stocking density between all groups (Table 4). The 150 fish/ m^3 recorded the highest FCR value; 2.02 and the 50 fish/ m^3 treatment recorded the best value of 1.66. It was noticed that PER and FER recorded their highest values ;60 and 2.02, respectively in the 50 fish/ m^3 treatment, while 150 fish/ m^3 recorded the least values (0.49 and 1.66), respectively. Concerning the effect of type of water, magnetic water (MW) showed significant increase (P<0.001) in FI, PI, FER and PER (115.44, 34.63, 0.60 and 2.02) compared to Normal water (NW). While FCR recorded the lowest value in MW1.65 in comparison with the NW:2.02. As shown in Table (4) Feed utilization as affected with the interaction between the stocking density and magnetic water treatment showed that the highest value was recorded in the 50 fish/m^{3}MW group (116.00, 34.80, 1.49, 0.67 and 2.23), respectively followed by the 100 fish/m^3 MW group (115.66,34.70, 1.63, 0.6 and 2.03), respectively. It was noticed that there were non-significant differences between 50 fish/m^3 NW and 150 fish/m^{3}MW groups. While the groups 150 fish/m^{3}NW recorded the lowest values in FCR.

Table 4. Effect of stocking density, magnetic water and their interaction on Feed utilization of Nile tilapia.

Item	FI (g)	PI (g)	FCR	FER(%)	PER
Stocking density (SD, fish/m^3)					
50	114.16	34.25	1.66^c	0.60^a	2.02^a
100	113.16	33.95	1.83^b	0.55^b	1.83^b
150	113.50	34.05	2.02^a	0.49^c	1.66^c
Standard error	±0.68	±0.20	±0.03	±0.009	±0.03
P-value	0.0001	0.0001	0.0001	0.0001	0.0001
Type of water					
NW	111.77	33.53	2.02	0.49	1.65
MW	115.44	34.63	1.65	0.60	2.02
Standard error	±0.56	±0.16	±0.02	±0.007	±0.02
P-value	0.0001	0.0001	0.0001	0.0001	0.0001
Interaction between stocking density and type of water					
50 +NW	112.33^{bc}	33.70^b	1.84^c	0.54^c	1.81^c
100 +NW	110.66^c	33.20^b	2.03^b	0.49^d	1.63^d
150 +NW	112.33^{bc}	33.70^a	2.20^a	0.45^d	1.51^d
50 +MW	116.00^a	34.80^a	1.49^e	0.67^a	2.23^a
100 +MW	115.66^a	34.70^a	1.63^d	0.61^b	2.03^b
150 +MW	114.66^{ab}	34.40^{ab}	1.84^c	0.54^c	1.80^c
Standard error	±0.96	±0.29	±0.04	±0.013	±0.04
P-value	0.0001	0.0001	0.0001	0.0001	0.0001

Means in the same column having different letters are significantly (P≤0.05) different.

Chemical composition

Dry matter (DM), crude protein (CP), ether extract (EE), ash and growth energy (GE) as affected by the stocking density showed that the highest DM value (P<0.001) was noticed in 150 fish/m^3 groups (23.77%) compared the other groups. Crude protein recorded high significant increase (P<0.001) in 50 fish/m^3 and 100 fish/m^3 groups (71.92 and 71.67%, respectively) compared to 150 fish/m^3 group. On the other hand, Ash recorded low significant value in both 50 fish/m^3 and 100 fish/m^3 groups compared to 150 fish/m^3 group. As for EE, GE and DE recorded no significant (P>0.001) between all groups.

Chemical composition as affected with the effect of type of water, MW was presented in Table (5). Results of this table reveal that the values of DM and Ash decreased significantly (P<0.001) in MW group (22.51and 14.22%, respectively) compared to the NW group (23.1and 15.62%, respectively). As for CP, it recorded high significant increase (P<0.001) in the MW group (72.01%) compared to the NW group 70.93%.

As presented in Table (5), results of chemical composition as affected with the interaction between the stocking density and the type of water show that DM recorded significant decrease (P<0.001) in 50 fish/m^3 and 100 fish/m^3 + MW groups (21.97 and 21.73%, respectively) compared to the other groups. As for CP and ether extract, are showed high significant value (P<0.001) in 50,100 and 150 fish/m^3 + MW (72.37, 72.83 and 71.37%) and (13.57, 13.77 and 14.03%), respectively compared to 50,100 and 150 fish/m^3 + NW groups. While Ash % recorded the highest significant (P<0.001) values in 50,100 and 150 fish/m^3 +NW groups (15.03, 16.23 and 16.10%, respectively). As for GE and DE recorded significant increase in 50,100 and 150 fish/m^3 + MW and 50 fish/m^3 + NW compared to the other groups.

Table 5. Effect of stocking density, magnetic water and their interaction on chemical composition of Nile tilapia.

Item	DM %	CP %	EE %	Ash %	GE Kcal/kg	DE Kcal/kg
Stocking density (SD, fish/m^3)						
50	22.65^b	71.92^a	13.48^a	14.61^b	5337^a	4003^a
100	22.43^{ab}	71.67^a	13.52^a	14.82^b	5326^a	3995^a
150	23.77^a	70.95^b	13.71^a	15.35^a	5303^a	3978^a
Standard error	±.364	±.136	±.141	±.131	±11.120	±8.341
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Type of water						
NW	23.31^a	70.93^b	13.44	15.62^a	5278	3959
MW	22.51^b	72.01^a	13.69	14.22^b	5367	4025
Standard error	±.297	±.111	±.115	±.107	±9.08	±6.81
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Interaction between stocking density and type of water						
50 +NW	23.33^a	70.77^b	13.20^b	15.03^a	5349^a	4012^a
100 +NW	23.13^a	70.51^b	13.26^b	16.23^a	5237^b	3928^b
150 +NW	23.71^a	70.53^b	13.37^b	16.10^a	5248^b	3936^b
50 +MW	21.97^b	72.37^a	13.57^a	14.06^b	5325^a	3994^a
100 +MW	21.73^b	72.83^a	13.77^a	13.30^c	5316^a	4062^a
150 +MW	23.83^a	71.37^a	14.03^a	14.60^b	5358^a	4019^a
Standard error	±.515	±.192	±.200	±.186	±15.73	±11.80
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Means in the same column of each parameter having different letters are significantly differ (*P* < 0.05).

Blood Parameters

As presented in Table (6), results of blood parameters [Total protein (TP), albumin (Albu), globulin (Glob), Triglyceride (Trig), glucose (Gluc), and aspartate aminotransferase (AST)] as affected with the stocking density or magnetic water or interaction between the stocking density and the magnetic water treatment show non-significant differences between all groups.

Table 6. Effect of stocking density and magnetic water on Blood biochemical of Nile tilapia.

Item	TP (g/dL)	Albu (g/dL)	Glob (g/dL)	Trig (Mg/dL)	Gluc (Mg/dL)	AST (U/L)
Stocking density (SD, fish/m^3)						
50	6.41	4.61	1.80	142.3	109.3	36.7
100	6.38	4.55	1.83	167.8	107.7	42.5
150	6.35	4.60	1.75	140.2	109.7	44.33
Standard error	±0.09	±0.07	±0.04	± 25	±1.5	±2.5
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Type of water						
NW	6.51	4.65	1.86	140.5	111.5	35.5
MW	6.36	4.56	1.80	169.7	105.5	37.7
Standard error	±0.07	±0.08	±0.03	±2.3	±1.5	±6.1
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Interaction between stocking density and type of water						
50 +NW	6.51	4.70	1.81	114.0	111.3	38.70
100 +NW	6.39	4.50	1.89	150.7	105.3	37.70
150 +NW	6.50	4.62	1.88	167.0	109.7	44.33
50 +MW	6.37	4.47	1.90	168.7	107.7	40.67
100 +MW	6.43	4.60	1.83	134.0	109.7	42.33
150 +MW	6.37	4.47	1.90	168.7	113.3	34.70
Standard error	±0.11	±0.10	±0.04	±4.3	±2.5	±1.8
P-value	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Means in the same column of each parameter having different letters are significantly differ (*P* < 0.05).

TP=Total protein, Albu. = Albumin, Glob.= Globulin, Trig = Triglyceride, Gluc. =Glucose and AST = Aspartate aminotransferase

Discussion

Water Quality Parameters

These results agree with the findings obtained by (Hassan *et al.,* 2018 a,b) who suggested that the ammonium concentration could be reduced by increasing the magnetic intensity. Also, other studies have found that magnetic can significantly improve water quality (AbdelHady, 2011; Hassan *et al*., 2018a). Krzemieniewski *et al.* (2004) found that increasing the magnetic intensity could reduce ammonia-N in the breeding tank. Nevertheless, reduction in ammonia-N was also observed in wastewater from sewage when a constant magnetic field was used. Alkhazan *et al.* (2010) also showed a significant increase in pH as the magnetic intensity increased. Ahmed and Abd El-Hamed (2020) recorded that DO and pH values in magnetic water increased as compared to control water, but ammonia was inversely decreased. Similar results were recorded in previous studies Hassan *et al.,* 2017 Mahmoud *et al.,* 2019), which and pointed that the increase in magnetic intensity led to an increase in dissolved oxygen concentration compared to normal water. And this ensures that magnetic device improve water quality. The increase of DO may be due to the decrease in organic matter in magnetic water (Yacout *et al*., 2015). 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 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 NH4 into NO2 and NO3. While the maximum value of NH4 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. Hassan *et al.* (2018 b) showed significant ($p < 0.05$) increases of the DO and pH.

On the other hand, Irhayyim *et al.* (2020) revealed that the magnetized water had no effects on the concentrations of ammonium nitrogen, nitrite nitrogen and nitrate nitrogen. Hassan *et al.* (2019) conducted that there was a slight improvement in water quality parameters for example DO and Ammonia-N were better to manage in magnetized water compared to the control.

Growth performance and feed utilization

These results with the findings of previous report Zhang *et al.,* (1987) whose experiments showed that the fish in magnetic field grew faster than those in non-magnetized water (ordinary water). Also, Tang *et al.* (2015) found that the effect of magnetic treatment had a positive effect on growth performance and feed utilization in juvenile sea cucumbers.

It has been concluded that magnetized water improved the growth performance of tilapia and common carp (Hassan *et al.,* 2018 a; Irhayyim *et al.* 2020 and Mannan *et al.*, 2012). Hassan *et al.*, (2019) reported that magnetized water improved growth performances of Jade Perch fish. Results of the current study were in agreement with the findings obtained previously Hassan *et al.,* (2018 b) with red hybrid tilapia (*Oreochromis sp.*) in RAS and Nofouzi *et al.,* (2016) with rainbow trout (*Oncorhynchus mykiss*). However, the results were in contrast with the findings obtained by Krzemieniewski *et al.*, (2004) who found no significant difference between the growth of European sheatfish *Silurus glanis L.* larvae reared in the system modified by the constant magnetic field and the control group.

According to Tyari *et al.*, (2014) magnetic water eventually improves the transfer of nutrients to all parts of the body. Irhayyim *et al.* (2020) revealed that the use of magnetized water in the RAS improved the growth performance and feed utilization in common carp. Mabrouk *et al.* (2016) recorded that applying magnetic water on aquaculture, definitely on Nile tilapia farming improved growth performance and feed utilization.

Chemical Composition

The results are in accordance with the study of Hassan *et al.* (2019) who reported that in magnetic water, the fish were more efficiently converting food into muscle and energy.

Blood Parameters

The obtained results concerning stocking density are in agreement with the findings of Ibrahim (2000) who found that TP, and AST of Nile tilapia were not significantly affected by increasing stocking density. Also, Mahmoud (2012) showed that TP, Albu, ALT and AST were significantly increased with increasing stocking density, while globulin concentration was non-significantly affected. On the other hand, Ayyat *et al.* (2011) found that TP, Albu decreased in fish groups reared at high stocking density compared to those reared at low stocking density. Generally the elevation in some parameters may be due to the crowding effect in groups stocked at higher level which may lead to completion on space, feed and aggression.

The obtained results concerning magnetic water are in agreement with the findings of Sargolzehi *et al.* (2009) who indicated that conditioning the magnetic water did not affect blood metabolites (glucose and urea). On the other hand, Zhao *et al.* (2015) who reported that the effect of magnetic treatment had an immune status in juvenile sea cucumbers. . Also, Sallam and Awad (2008) who evaluated the effect of static magnetic field on some liver function tests in rats. Magnetic fields were observed to influence enzyme action. Behari *et al.* (1997) reported a decrease in glucose level in rats exposed to magnetic fields. Gordon and Gordon (1981) who demonstrated that the blood cholesterol, glucose and triglyceride levels of diabetic rats were lowered by acute exposure to magnetic field.

CONCLUSION

Results of the present study indicated that the water quality, growth performance, and feed utilization of the magnetic water treatments showed significant improvement compared to normal water with different stocking densities. The present study also recommends that the use of magnetic water generally improves the production of Nile tilapia.

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تأثير إستخدام المياه الممغنطة على أداء النمو ومقاييس الدم في البلطي النيلي تحت كثافات التخزين المختلفة

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صممت الدراسة الحالية لدراسة تأثير تعرض المياه للمغنطة ومعدلات التسكين المختلفة على أداء النمو، والإستفادة من الغذاء، ومقاييس جودة المياه، والتركيب الكيميائي ومقاييس الدم في البلطي النيلي. تم توزيع ١٨٠ إصبعية من أصبعيات البلطي النيلي وحيد الجنس بمتوسط وزن ابتدائى يبلغ ٣٣,٢٤ ± ٠,٤٧ جم بشكل عشوائي في ١٨ حوض زجاجي. تم إستخدام ثلاث كثافات تخزين (٥٠ ، ١٠٠ ، ١٥٠ إصبعية / م٣) ونوعين من الماء ، ماء عادي(NW) ومياه ممغنطة. تم تغذية الأسماك فى التجربة علي علف تجاري (٣٠,١١٪ بروتين) بمعدل تغذية ٣٪ من وزن الجسم لجميع المجموعات. تم قياس مقاييس جودة المياه - مقاييس أداء النمو - الإستفادة الغذائية - التركيب الكيميائي ومعايير الدم في جميع المجموعات في نهاية التجربة بعد ثمانية أسابيع. أشارت النتائج إلى أن جودة المياه، وأداء النمو، و الإستفادة الغذائية ، والتركيب الكيميائي تحسنت معنويا (P <0.01) في مجموعات المياه الممغنطة مقارنة بمجموعات المياه العادية عند كثافات التخزين الثلاثة. أما بالنسبة لمعايير الدم فلم تكن هناك فروق معنوية (P <0.01) في كل المجموعات. وتتلخص نتائج البحث فى أن إستخدام المياه الممغنطة في استزراع البلطي النيلي يحسن من معايير جودة المياه ، وأداء نمو الأسماك ، والإستفادة الغذائية، والتركيب الكيميائي للأسماك عند كثافات التخزين المختلفة.

الكلمات الدالة: البلطي النيلي، المياه الممغنطة، معدلات التسكين.