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EFFECTS OF MAGNETIC WATER TECHNIQUE ON GROWTH PERFORMANCE, FEED UTILIZATION, WATER QUALITY AND SOME BLOOD PARAMETERS OF NILE TILAPIA (*Oreochromis niloticus*) FRY UNDER DIFFERENT STOCKING DENSITY

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ABSTRACT

This study was designed to investigate the effect of magnetic water technique on growth performance, feed utilization, water quality parameters and some blood parameters of sex reversed (all-male) Nile tilapia (*Oreochromis niloticus*) fry. Fry were randomly distributed in three experimental groups reared in glass aquaria. The experiment was based on two levels of stocking density [low level 7 fry/aquarium (80 fry /m^3) and high level 14 fry/aquarium (160 fry /m^3)].The same levels were treated with magnetic water at 0.7 Tesla compared with the control groups ordinary water (0 Tesla) and each group was triplicated, with 0.3g / fry an average initial weight. Experimental fish were fed on commercial diet (31.71% protein and 4170.7 Kcal GE/kg diet). At the end of the experiment, the results indicated that growth performance and feed utilization improved significantly (P>0.01) in magnetic water treatment compared to the control groups with high and low stocking densities. The present study recorded that NH_4, NO_3, NO_2 and DO in magnetic water treatment with high and low stocking densities improved significantly (P>0.01) in comparison with the control groups. While there were no significant differences (P>0.05) in pH. As for blood parameters, there were no significant (P<0.01) differences in them between high and low stocking densities. Results indicated that fish reared in magnetic water treatment improved significantly (P>0.01) compared to those in the control groups in high and low densities. In short, applying magnetic water on aquaculture definitely on Nile tilapia farming improves growth performance.

Key words: Magnetic water, Nile tilapia, fry, growth performance, feed utilization.

INTRODUCTION

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). Magnetic water treatment (MWT) is a simple and efficient approach where the water flows through a magnetic field (MF) or combination of magnetic fields which consequently acquires different physicochemical characteristics. Water is a paramagnetic compound with small and positive susceptibility to magnetic fields.The water molecules like other paramagnetic compounds are slightly attracted by a MF and the material does not retain the magnetic properties when the external field is removed (Schwartz and Klassen, 1981; Parsons, 1997). MWT is a nonchemical treatment of water that does not require any filtration substitutes. The biological technique using the magnetic field to purify water was introduced. This technique is considered as a simple simulation of what happens in nature, as when water is subjected to a magnetic field and as a result, becomes more biologically active. The phenomenon of water treatment with an

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applied magnetic field has been known for many years and has been reported as being effective in numerous instances (Balcavage *et al*., 1996). Brower (2005) explained that magnetic systems treat water by passing it through a multi-pole, multi-reversing polarity magnetic field. The dipolar movements of the molecules of dissolved solids and water molecules are affected in such a way that at the instant of crystal formation, the crystal form is divided into thin layers and the ions align according to a single magnetic axis. The magnetic field then influences the production of a much greater number of nuclei. Hence, the solids precipitate as much finer crystals, which tend to remain separated because of the excess similar charge. Magnetic field treatments through stimulating the activity of proteins and enzymes can influence free radicals and overall in biochemical processes (Moon and Chung, 2000 ; Flórez *et al.,* 2007). In normal or non-magnetic water, the water molecule clusters comprising of many water molecules are loosely attracted. This loose and chaotic form of attraction predisposes the water to toxins and pollutants to travel inside the water molecule cluster. The large structure of these water molecule clusters or presence of toxins blocks large portions of these clusters when they pass through the cell membrane. The smaller size of these chaotic clusters, some of them carrying toxins, can enter the cell with consequent harmful effects (Flórez *et al.,* 2007).

Magnetic water technique is an inexpensive, environmentally friendly water treatment that has small installation fees and no energy requirements. Many claim magnetic water gives increased performance in regards to scale reduction (Alim *et al*., 2006) increased crop yields (Lin and Yotvat, 1990) health benefits (Cho and Lee, 2005) and increased cement compressive and tensile strength (Nan *et al.,* 2000). Tai *et al*. (2008) observed that on subjecting water to magnetic field, it leads to modification of its properties, as it becomes more energetic and able to flow which can be considered as a birth of new science called magneto biology. He also pointed out that; it increases the percentage of nutrient elements like phosphorus and potassium.

Zhao *et al.* (2015) evaluated that the effect of exposure to magnetic field on growth and immune and digestive enzyme levels in juvenile sea cucumbers *Apostichopus japonicus*. Thus, magnetic treatment had a positive effect on growth, immune status, and digestive enzyme levels in juvenile sea cucumbers. 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 of juveniles.

The objective of the present study was to investigate the effects of magnetic water treatment (0.7 Tesla) and stocking density on growth performance, feed utilization, physiological and blood parameters and water quality of sex reversed Nile tilapia (*Oreochromis niloticus*), fry.

MATERIALS AND METHODS

The present study was carried out at the experimental fish Wet Lab belonging to the Department of Animal Production, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt. The study lasted for16 weeks from 1st June, 2013 to 21st September, 2013 after two weeks` adaptation.

Experimental Design

The experimental fish (Initial weight 0.3 g after two weeks acclimation under normal laboratory conditions) were randomly distributed into 12 glass aquaria (35 × 70 × 40 cm – 0.074 m^3 of water) in 4 treatments (3 replicates per treatment). Each aquarium was filled with water up to level of 30 cm and the level was maintained throughout the experimental period. The experiment was based on a 2 × 2 factorial design with two stocking densities; low level (7 fish / aquarium – 80 fry/m^3) and high level (14 fish / aquarium – 160 fry/m^3) and two levels of magnetic water.

All experimental aquaria were supplied with dechloronated tap water through a water pipeline system and were supplied with air through air pipeline using air blawer 5 PH. The water was renewed at a rate of 100% every 48 hours. Fish feces and feed wastes were removed daily by siphoning. Water inlet was prepared with a magnetic field apparatus with a magnetic power 0.7 Tesla when the water was continually magnetized during water exchange in aquaria.

The magnetic apparatus is a local model produced by the green desert environment and water treatment technology company.

Experimental Fish

Apparently healthy sex reversed (all-male) Nile tilapia (*O. niloticus*), fry were purchased from Abbasa Research Station, Abo Hammad, Sharkia Governorate, Egypt. The fry were transported at the early morning using a special fish transport car with aeration facilities. Fry were acclimated to the experimental condition for 15 days before starting the experiment. Fry with an average initial weight of 0.3g/fry were randomly distributed in two experimental groups. After adaptation, fry were fed on the commercial diet (31.71% protein and 4170.7 Kcal GE/ kg diet). The diet was purchased from Handrix Misr Factory, Tenth of Ramadan city, El-Sharkia Governorate, Egypt.

Experimental Diet

All fish groups were fed on basal pelleted diet consisted of fish meal 17.0%, soybean meal 30.0%, yellow corn 15.0%, wheat bran 20.0%, alfalfa hay 12.5%, sunflower oil 3.0%, minerals mixture 0.5%, vitamin mixture 1.0% and carboxymethyl cellulose 1.0%. The chemical composition of the diet was crude protein 31.71%, ether extract 4.68%, crude fiber 6.42% and gross energy 4170.7 Kcal/kg. Each one kg of vitamin mixture contained: Vitamin A 16060 IU, B1 6 mg, B3 1500 IU, B6 9 mg, B12 6 mg, C 60 mg, E 60 mg, pantothonic acid 60 mg, nicotinic acid 120 mg, folic acid 6 mg, biotin 0.3 mg and choline chlorids 30 mg. Fish were fed at the rate of 3% of wet body weight per day and it offered three times at 8.00, 12.00 and 17.00 hours. The fish in each aquarium were weighed biweekly, and the feed weight was adjusted after each fish weighing. About 25% of the water in the aquarium were daily replaced by aerated fresh water. Each aquarium was supplied with air pump to supply fish with oxygen.

Experimental Analyses

The proximate analyses of diet and fish samples were taken randomly at the beginning and at the end of the trial for whole body analyses including moisture, crude protein, crude fat, crude fiber and total ash content were determined according to Association of Official Analysis Chemists (AOAC, 2000) methods. These samples were kept frozen at -4^{o}C till the time of analysis (Eya and Lovell, 1997).

Measurement of Fish Growth and Feed Utilization

All fish were individually weighed to the nearest 0.1 g at the beginning of the experiment and at biweekly intervals throughout the experimental period. The mortality of fish was recorded biweekly at the time of weighing. Body weight gain (BWG) = final weight (g/fish) – initial weight (g),Specific growth rate(SGR%) = (L_n final weight– L_n initial weight / number of days) x, Condition factor (K)= Final body weight (g) / (Final body length (cm))^{3}x 100,Feed conversion ratio (FCR) = feed intake (g) / body weight gain (g), Protein efficiency ratio (PER)= body weight gain(g) / protein intake (g),Protein Productive Value (PPV%)=body protein gain(g) / protein intake (g).

Blood Parameters

At the end of the trial, fish were not fed for 24 hr., immediately prior to blood sampling. Fish per each aquarium were an aesthetized with buffered tricaine methane sulfonate (30 mg/l) Three fish were taken from each aquaria 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 stating position at room temperature for 30 minutes, then in a 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) and serum alanine aminotransfears ALT (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 of Bio-diagnostic Co. (Egypt).

Water Quality Parameters

Water temperature was measured in each aquarium daily using a mercury thermometer of 0 to 100^{o}C range. Dissolved oxygen was measured directly by using 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 – Nmg/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 –Nmg/l) was measured using Nitrite reagent Hi 93708-01. Hydrogen ion (pH) was measured using pH reagent Hi 937110-01.

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

RESULTS AND DISCUSSION

Growth Performance

Intensively raised fish high stocking density may be exposed to stressful situation which often result in a depressed immune results and growth performance. After 16 weeks of treatment applied, final body weight (FW), daily weight gain (DWG), condition factor (CF) and specific growth rate (SGR) were affected significantly (P<0.001) with stocking density, in low stocking density group FW, DWG, CF and SGR were higher with 21.80, 22.37, 20.00, 11.04 and 5.63%, respectively, when compared with these reared at high stocking density (Table 1). These results indicated that the decrease in growth performance due to the increase in stocking density is a direct result of crowding and the aggression of fish due to their high number in the given area.In several species of fish, crowding has been reported to be an aquaculture related chronic stress factor which reduces growth and affects the inflammatory and immune responses (Montero *et al.,* 1999). Stocking density is a major factor affecting fish growth under farming conditions (Jobling, 1995) and Irwin *et al*. (1999). Chang (1988) reported that fish density is an important factor used in aquaculture as it can affect natural food availability, the efficient utilization of food resource and total fish yield in ponds. These results are in agreement with the findings of Ronald *et al.* (2014) who reported that growth performance of Nile tilapia decreased significantly with each increase in the stocking density. Chang, (1988) reported that fish density is an important factor used in aquaculture as it can affect natural food availability, the efficient utilization of food resource and total fish yield in ponds. Also the same author added that when number of fish stocked in a pond increases the amount of feed available to each fish decreases. Mahmoud, (2007) found that live body weight of Nile tilapia fish decreased with increase stocking density. Reduction in growth with the increase population density has also been reported by Onumah *et al*. (2010) and Chakraborthy *et al*. (2010). Also, Ayyat *et al*. (2011) found that the final live body weight and daily body gain of Nile tilapia fish decreased with increasing stocking density.

There was significant effect of magnetic water (P<0.001) in growth performance. After 16 weeks of treatment applied, FW, DWG, CF and SGR were higher with 21.42, 21.89, 30.00, 8.97 and 5.63%, respectively, in fish group reared in magnetic water when compared with these reared at normal water (Table 1). These results are in agreement with Zhao *et al.* (2015) findings who evaluated the effect of magnetic treatment and found positive effect on growth in juvenile sea cucumbers. Also, Rosen (2010) who showed improved growth rates and mortality of juveniles. Despite the promise shown by magnetic treatment therapy, most studies of aquatic animals have focused on the effects in algae and fish (Li *et al.,* 2001; Wang *et al.,* 2005; Schultz *et al.,* 2010). The results concerning magnetic water are in agreement

Table 1. Effect of stocking density and magnetic water on growth performance of Nile tilapia

Item	IW	FW	BWG	DWG	CF	SGR
			Stocking density (SD)			
Low Density (LD)	0.3	14.36±0.64	14.06±0.46	0.12±0.005	1.71±0.018	1.50±0.01
High Density (HD)	0.3	11.79±0.50	11.49±0.50	0.10±0.004	1.54±0.050	1.42±0.02
Significant	NS	***	***	***	***	***
			Type of water (TW)			
Un magnetic water (UMW)	0.3	11.81±0.50	11.51±0.03	0.10±0.004	1.56±0.060	1.42±0.01
Magnetic water (MW)	0.3	14.34±0.66	14.04±0.66	0.13±0.005	1.70±0.020	1.50±0.02
Significant	NS	***	***	***	***	***
			Interaction between stocking density and type of water			
LD-UMW	0.3	12.95±0.10	12.65±0.10	0.11±0.001	1.68±0.010[ab]	1.46±0.003
LD-MW	0.3	15.77±0.23	15.48±0.23	0.14±0.002	1.75±0.020[a]	1.53±0.006
HD-UMW	0.3	10.66±0.14	10.36±0.14	0.09±0.001	1.43±0.003[c]	1.38±0.006
HD-MW	0.3	12.91±0.21	12.61±0.21	0.11±0.001	1.66±0.040[b]	1.46±0.005
Significant	NS	NS	NS	NS	**	NS

IW= Initial weight, FW = Final weight, BWG = Body weight gain, DWG = Daily weight gain, CF = Condition factor, SGR = Specific crowth rate, NS= Non-significant, ** = P<0.001 and *** = P<0.001.

with the findings of Zhang *et al.*, (1987) whose experiments showed that the fish in magnetic field grew faster than those in magnetized water and the fishes in magnetized water grew faster than those in ordinary water.

Growth performance parameters as affected with the interaction between the stocking density and the applied water treatments showed that there were non-significant differences in FW, BWG, DWG and SGR (%) in all groups. While CF recorded significant differences and its highest value was recorded in magnetic with low stocking density.

Feed Utilization

The statistical analysis for feed utilization parameters at the end of the experimental period are shown in Table 2, the results show that feed intake (FI), feed conversion ratio (FCR), protein efficiency ratio and protein productive value (PPV) affected significantly (P<0.001) with fish stocking density. Feed intake decreased in fish groups reared at low density with 40.25% when compared with these reared at high density, while feed conversion improved by 51.42%. Also PER and PPV increased by 105.41 and 101.12%, respectively, in fish reared at low density. Results of the present study are in agreement with the results obtained by Abdelhamid *et al.* (2007), Shubha and Reddy (2011), Mahmoud (2007) and Ayyat *et al.* (2011) who showed that feed efficiency of Nile tilapia decreased with increasing stocking density. Reduction in feed utilization with population density increase has also been reported for *O. niloticus* and hybrids of *O. niloticus* × *O. aureus* by Onumah *et al.* (2010) and Chakraborthy *et al.* (2010). Zaki *et al.* (2004) reported that feed utilization parameters were improved by decreased the density of marine shrimp. Ronald *et al.* (2014) showed a negative correlation between stocking density and feed utilization.

FI, FCR, PER and PPV (%) affected significantly (P < 0.05, 0.01 or 0.001) with magnetic water treatments. FI, PER and PPV(%)

Table 2. Effect of stocking density and magnetic water on feed utilization of Nile tilapia

Item	FI	FCR	PER	PPV (%)
		Stocking density (SD)		
Low Density (LD)	19.3±0.7	1.37±0.02	2.28±0.03	37.77±0.93
High Density (HD)	32.3±1.0	2.82±0.04	1.11±0.01	18.78±0.34
Significant	***	***	***	***
		Type of water (TW)		
Un magnetic water (UMW)	23.9±2.7	2.16±0.33	1.65±0.25	27.18±4.00
Magnetic water (MW)	27.6±3.1	2.04±0.30	1.74±0.27	29.37±4.46
Significant	***	**	*	*
		Interaction between stocking density and type of water		
LD-UMW	17.8±0.4	1.41±0.02	2.22±0.03	36.28±0.79
LD-MW	20.7±0.7	1.34±0.02	2.34±0.04	39.25±1.20
HD-UMW	30.1±0.2	2.90±0.02	1.08±0.01	18.07±0.19
HD-MW	34.5±0.1	2.74±0.04	1.14±0.02	19.49±0.25
Significant	NS	NS	NS	NS

FI= Feed intake, FCR = Feed conversion ratio, PPV = Protein productive value, PR = Protein retained, ER= Energy retained, EU= Energy utilization and EI= Energy intake.

increased with 15.48, 5.45 and 27.78, respectively in fish groups reared at magnetic water, when compared with those reared at normal water treatment, on the other hand feed conversion improved by 5.56% (Table 2). These results are in agreement with the findings of Zhao *et al.* (2015) who found that the effect of magnetic treatment had a positive effect on feed utilization in juvenile sea cucumbers. Despite the promise shown by magnetic treatment therapy, most studies of aquatic animals have focused on the effects in algae and fish (Li *et al.*, 2001; Wang *et al.*, 2005; Schultz *et al.*, 2010). In general applying magnetic water on aquaculture definitely on Nile tilapia farming improved feed utilization.

As presented in Table 2 results of feed efficiency as affected with the interaction between stocking density and the applied water treatments show that there were non-significant differences in feed utilization parameters. But there was non-significant improvement in LD-MW followed in order by LD-UMW, HD-MW and HD-UMW groups.

Water Quality

As presented in Table 3, averages of ammonia (NH_4), nitrate (NO_3), nitrite (NO_2), hydrogen ion (pH) and dissolved oxygen (DO) as affected with stocking density show that NH_4, NO_3 and NO_2 in low stocking density (LD) group were (0.023, 0.028 and 0.024, respectively), while their values in high stocking density (HD) group were (0.024, 0.048 and 0.050 ,respectively), They increased significantly ($P<0.001$) in HD group compared to LD group. While there were no significant differences between LD and HD in both pH and DO. These results are in agreement with the findings of Ibrahim (2000) who found that dissolved oxygen content of water decreased with increasing stocking density levels of Nile tilapia fish, while pH value was not affected. Also, Liti *et al.* (2005) reported that dissolved oxygen was significantly higher ($P<0.05$) at low density than high density. But there were no significant differences in mean total ammonia among density levels. Furthermore, Mahmoud (2007) found that NH_4, NO_3, pH and DO were significantly ($P<0.01$) increased in fish stocked at high density compared with low density.

Table 3. Effect of stocking density and magnetic water on water quality of Nile tilapia

Item	NH_4 mg/l	NO_3 mg/l	NO_2 mg/l	pH. ppm	DO. mg/l
		Stocking density (SD)			
Low Density (LD)	0.023±0.003	0.028±0.003	0.024±0.002	7.60±0.03	7.68±0.08
High Density (HD)	0.040±0.005	0.048±0.002	0.050±0.002	7.57±0.03	7.51±0.04
Significant	***	***	***	NS	NS
		Type of water (TW)			
Un magnetic water (UMW)	0.042±0.004	0.042±0.004	0.040±0.006	7.60±0.04	7.50±0.05
Magnetic water (MW)	0.022±0.003	0.033±0.005	0.035±0.007	7.57±0.02	7.70±0.07
Significant	***	*	NS	NS	*
		Interaction between stocking density and type of water			
LD-UMW	0.031±0.000	0.034±0.003	0.027±0.003	7.61±0.07	7.57±0.09
LD-MW	0.015±0.000	0.021±0.000	0.021±0.003	7.58±0.03	7.80±0.10
HD-UMW	0.052±0.002	0.050±0.005	0.052±0.006	7.58±0.07	7.43±0.03
HD-MW	0.028±0.004	0.045±0.003	0.049±0.006	7.56±0.04	7.60±0.06
Significant	NS	NS	NS	NS	NS

NH_4= Ammonia, NO_3= Nitrate, NO_2= Nitrite, pH =Hydrogen ion and DO =Dissolved oxygen
NS= Non-significant and MWT= Magnetic water treatment

Regardless of stocking density, averages of water quality parameters of NH_4, NO_3, NO_2, pH and DO as affected with the applied treatments for magnetic water were presented in Table 3. Results of this table reveal that the values of NH_4 decreased significantly (P<0.001) in MW group (0.022) compared to the UMW group (0.042). While NO_3 and DO in UMW group were 0.042 and 7.5, respectively, while in MW group, their values were 0.033 and 7.70, respectively. They recorded significant increase (P<0.01). As for NO_2 and pH, there were non-significant differences between them in the UMW and MW group.

These results are in agreement with the findings of Alkhazan and Sadddiq (2010) who stated that the pH value increased with magnetic field, while Shatalov (2009) observed a decrease in pH values with magnetic exposure. Dissolved oxygen is an essential parameter, required for all processes of aerobic metabolism in all living organisms and in particular the respiratory process of energy derivation from protein, lipid and carbohydrates (Hochachka and Lutz, 2001). Because oxygen is a central part of the respiratory process for energy derivation, it would reason that limitations to the supply of oxygen might also affect the utilization of energy or protein for growth by an animal (Miller, 2005). The increase in O_2 after the magnetic exposure in the study is in agreement with that of ANZECC (2000), Ayoola and Kuton (2009) and Sithik *et al*. (2009). Also Winnicki and Korozeleca-Orkis (2004) studied the influence of a constant magnetic field on physicochemical parameters of water and on rearing of larvae of the European sheat fish *Silurusglanis* L. larvae. No changes were observed in water ammonium. The effects of magnetism on water, however, is the subject of controversial debate. Many claim that magnetized water gives increased performance in regards to scale reduction (Alim *et al*., 2006; Lin and Yotvat, 1990) water tension reduction (Cho and Lee, 2005). Other scientific journals and research claim that magnetizing water has no effect and the current successes have not been able to be reproduced Krauter *et al.* (1996).

As presented in Table 3 results of water quality parameters as affected with the interaction between the stocking density and the applied magnetic water show that the LD-MW recorded non-significant improvement followed in order by LD-UMW, HD-MW and HD-UMW groups.

Blood Parameters

Total protein (TP), albumin (Alb), globulin (Glo), Triglyceride (Trig), cholesterol (Chol), glucose (Gluc), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) as affected with the stocking density showed non-significant differences between groups. The obtained results are in agreement with the findings of Ibrahim, (2000) who found that TP, ALT and AST of Nile tilapia were not significantly affected by increasing stocking density. Also, Mahmoud (2007 and 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, Mahmoud (2012) reported that ALT was significantly decreased with increasing stocking density. Ayyat *et al*. (2011) found that TP, Albu and ALT 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. Crowding on space may have direct effects on physiological as well as behavioral elevation combined with physiological changes.

Blood parameters TP, Albu, Glob, Trig, Chol, Gluc, ALT and AST as affected with the applied magnetic water treatment are presented in Table 4. The obtained results reveal non-significant differences as affected with magnetic water treatment.

Table 4. Effect of stocking density and magnetic water on Blood parameters of Nile tilapia

Items	T P (g/dl)	Albu (g/dl)	Glob (g/dl)	Trig (Mg/dl)	Chol (Mg/dl)	Gluc (Mg/dl)	ALT (U/l)	AST (U/l)
Stocking density (SD)								
Low Density (LD)	6.41±0.07	4.61±0.07	1.80±0.04	142.3± 25	148.8±2.8	109.3±2.4	39.0±1.6	36.7±1.2
High Density (HD)	6.38±0.09	4.57±0.09	1.82±0.04	167.8±2.3	149.0±3.0	107.7±1.5	42.0±1.9	42.5±6.0
Significant	NS	NS	NS	NS	NS	NS	NS	NS
Type of water (TW)								
Un magnetic water (UMW)	6.52±0.06	4.68±0.08	1.83±0.03	140.5±2.4	147.5±2.4	111.5±1.6	43.0±1.3	35.5±6.0
Magnetic water (MW)	6.28±0.07	4.50±0.07	1.78±0.04	169.7±2.3	150.3±3.0	105.5±1.5	38.0±1.7	37.7±1.5
Significant	NS	NS	NS	NS	NS	NS	NS	NS
Interaction between stocking density and type of water								
LD-UMW	6.53±0.09	4.70±0.10	1.83±0.03	114.0±4.8	147.7±3.8	113.3±2.8	41.3±2.0	38.70±1.5
LD-MW	6.30±0.05	4.53±0.08	1.77±0.07	170.7±2.3	150.0±4.7	105.3±2.3	36.7±1.7	34.70±1.2
HD-UMW	6.50±0.11	4.67±0.13	1.83±0.07	167.0±2,1	147.3±3.8	109.7±1.5	44.7±1.5	44.33±2.5
HD-MW	6.27±0.14	4.47±0.12	1.80±0.05	168.7±4.7	150.7±5.3	105.7±2.4	39.3±2.9	40.67±0.9
Significant	NS	NS	NS	NS	NS	NS	NS	NS

TP=Total protein, Albu.= Albumin, Glob.= Globulin, Trig = Triglyceride, Chol.= Cholesterol, Gluc. =Glucose, ALT=Alanine aminotransferase, AST = Aspartate aminotransferase, NS= non-significant.

The obtained results concerning magnetic water are in agreement with the findings of Zhao *et al.* (2015) who reported that the effect of magnetic treatment had an immune status in juvenile sea cucumbers. Sargolzehi *et al.* (2009) who indicated that conditioning the magnetic water did not affect blood metabolites (glucose and urea). 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. Formicki and Perkowski (1998) reported that an increased oxygen uptake was observed in embryos influenced by the magnetic field. Behari and Mathur (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.

As presented in Table 4, results of blood parameters as affected with the interaction between the stocking density and the magnetic water treatment show non-significant differences between all groups.

Conclusion

The results from the present study indicated that growth performance, feed utilization, water quality and blood 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 fish production.

REFERENCES

Abdelhamid, M.A., M.A. Ibrahim, N.A. Maghraby and A.A. Soliman (2007). Effect of ietary supplemented of betaine and/or stocking density on performance of Nile tilapia. J. Agric. Sci. Mansoura Univ., 32: 167- 179.

Alim, F., M. Tlili, M. Amor, C. Gabrielli and G. Maurin (2006). Influence of magnetic field on calcium carbonate precipitation, Desalination, 206 (2007): 163–168.

Alkhazan, M.M.K. and A.A.N. Sadddiq (2010). The effect of magnetic field on the physical, chemical and microbiological properties of the lake water in Saudi Arabia. J. Evol. Biol. Res., 2 (1): 7-14.

ANZECC (2000). Australian and New Zealand guidelines for fresh and 275 marine water quality.

AOAC (2000). Association of Official Analytical Chemists International. Official Methods of Analysis, 17th Ed. AOAC Int., Gaithersburg, MD, USA.

Ayoola, S.O. and M.P. Kuton (2009). Seasonal variation in fish abundance and physicochemical parameters of Lagos Lagoon, Nigeria. Afr. J. Environ. Sci. and Technol., 3 (5): 149-156.

Ayyat, M.S., H.I. El-Marakby and S.M. Sharaf (2011). Effect of dietary protein level, stocking density, and dietary pantothenic acid supplementation rate on performance and blood components of Nile tilapia *Oreochromis niloticus*. J. Appl. Aquac., 23: 122-135.

Balcavage, W.X., T. Alvager, J. Swez, C.W. Goff, M.T. Fox, S. Abdullyava and M.W. King (1996). A mechanism for action of extremely low frequency electromagnetic fields on biological systems. Biochem. Biophys. Res. Commun., 222: 374-378.

Behari, J. and R. Mathur (1997). Exposure effects of static magnetic field on some physiological parameters of developing rats. Indian J. Experim. Biol., 35: 894-897.

Brower, D. (2005). Magnetic Water Treatment, Pollution engineering" Life and Magnetic Fields. No. 7: 76. Nauka I Zhizn' (Science and Life).

Chakraborthy, S.B., D. Mazumdar and S. Banerjee (2010). Determination of ideal stocking density for cage culture of monosex Nile tilapia *O. niloticus* in India. Proc. Zool. Soc., 63 (1): 53-59.

Chang, W.Y. (1988). Fish production: Data synthesis and model development. In: Collaborative Research Support Program (CRSP), pond dynamic. Aquac. 6th Annual Administrative Report, Oregon State Univ., Oregon, USA, 41-49.

Cho, Y. and S. Lee (2005). Reduction in the surface tension of water due to physical water treatment for fouling control in heat exchangers, Int. Communications in Heat and Mass Transfer, 32 : 1–9

Duncan, D.B. (1995). Multible Range and Multible F- taste Biometrics, 11: 1 42.

Eya, J.C. and R.T. Lovell (1997). Available phosphorus requirements of food-size channel catfish *Ictalurus punctatus* fed practical diets in ponds. Aquac., 154: 283-291.

Fadil, O., S. Johan and Zularisham (2001). Application of magnetic field to enhance wastewater treatment process. The 8th Joint Int. Conf. Jan. 7-11. San Antonio, Texas: IEEE.

Flórez, M., M.V. Carbonell and E. Martínez (2007). Exposure of maize seeds to stationary magnetic fields: Effects on germination and early growth. Environ. and Exp. Bot., 59 (1): 68-75.

Formicki, K. and T. Perkowski (1998). The effect of a magnetic field on the gas exchange in rainbow trout *Oncorhynchusm ykiss*embryos Ital. J. Zool., 65 : 475-477.

Gordon, R.T. and D. Gordon (1981). Selective resolution of plaques and treatment of atherosclerosis by biophysical alteration of “cellular” and “intracellular” properties. Medical Hypotheses, 7 : 217-229.

Henery, R.J. (1974). Clinical Chemistry, Principles and Technique, 2nd Ed., Harper and Row.

Hochachka, P.W. and P.L. Lutz (2001). Mechanism, origin and evolution of anoxia tolerance in animals. Comparative Bioch. and Physiol., 130: 435-459.

Ibrahim, M.S.M. (2000). National studies on different levels of energy in fish nutrition. Ph. D. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Irwin, S., O.J. Halloran and R.D. FitzGerald (1999). Stocking density, growth and growth variation in juvenile turbot, *Scophthalm usmaximus*. Aquac., 178 : 77-88.

Jobling, M. (1995). The influence of environmental temperature on growth and conversion efficiency in fish. Causes of observed variations in fish growth. ICES, 1–25 C.M./ P:4.

Krauter, P., J. Harrar, K. Orloff and S. Bahowick (1996). Test of a Magnetic Device for the Amelioration of Scale Formation at Treatment Facility D, Livermore, California

Li, Z.Y., S.Y. Guo and L. Li (2001). Effects of magnetic field on the nutrition of Spirulina platensis and mechanisms analysis. Acta. Bio phys. Sin., 17 (3) : 187–191.

Lin, I. and J. Yotvat (1990). Exposure of irrigation and drinking water to a magnetic field with controlled power and direction, J. Magnetism and Mag. Materials, 83:525-526.

Liti, D., B. Fulanda, J. Munguti, M. Straif, H. Waidbacher and G. Winkler (2005). Effect of open- pond density and caged biomass of Nile tilapia on growth, feed utilization, economic returns and water quality in fertilized ponds. Aquac. Res., 36: 1535-1543.

Mahmoud, H.K.E. (2007). Some managerial nutritional factors affecting fish production. M. Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt

Mahmoud, H.K.E. (2012). Some managerial and environmental on fish performance. Ph. D. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Miller, A.T. (2005). The role of oxygen in metabolic regulation. Helgoland Marine Res., 14: 392-406.

Montero, D., M. Marrero, M.S. Izquierdo, L. Robaina, J.M. Vergara and L. Tort (1999). Effect of vitamin E and C dietary supplementation on some immune parameters of gilthead seabream (*Sparusaurata*) juveniles subjected to crowding stress. Aquac., 171: 269-278.

Moon, J.D. and H.S. Chung (2000). Acceleration of germination of tomato seed by applying an electric and magnetic field. J. Electro-Statistics, 48:103-114.

Nan, S., W. Yeong-Hwa, Chung and M. Yo (2000). Effect of magnetic water on the engineering properties of concrete containing granulated blast-furnace slag, Cement and Concrete Res., 30 (4): 599-605.

Onumah, E.E., S. Wessels, N. Wildenhayn, B. Brummer and G.H. Scgwark (2010). Stocking density and photpperiod manipulation in relation to Estradiol profile to enhance spawning activity in female Nile tilapia. Turk. J. fish. Aqua. Sci., 10: 463-470.

Parsons, S.A. (1997). Magnetic treatment of calcium carbonate scale-effect of pH control. Water Res., 31 (2): 339-342.

Reitman, F.S. (1957). A method for determination of plasma AST and ALT. Am. J. Clin. Path, 28:56.

Ronald, N., B. Gladys and E. Ga, (2014). The effects of stocking density on the growth and survival of nile tilapia (*Oreochromis niloticus*) Fry at Son Fish Farm, Uganda, J Aquac. Res. Develop., 5 : 2.

Rosen, A.D. (2010). Studies on the effect of static magnetic fields on biological systems. Piers Online 6 (2): 133–136.

Sallam, S.M. and A.M. Awad (2008). Effect of magnetic field on the electrical properties and enzyme function of rat liver, Romanian J. Biophys., 18 (4): 337–347.

Sargolzehi, M.M., M. Rezaee Rokn-Abadi and A.A. Naserian (2009). The effects of magnetic water on milk and blood components of lactating Saanen goats, Int. J. Nut. and Metabolism, 1 (2): 20-24.

SAS (2002). SAS Institute Inc., Cary, NC, USA. NOTE: SAS Proprietary Software Version 9.00 (TS M0).

Schultz, I.R., W.J. Pratt, D.L. Woodruf, G. Roesijadi and K.E. Marshall (2010). Effects of Electromagnetic Fields on Fish and Invertebrates. Pacific Northwest Nat. Lab., Washington.

Schwartz, P. and W. Klassen (1981). Estimate of losses caused by insects and mites to agricultural crops [in the US]. CRC Handbook of Pest Manag. in Agric.

Shatalov, V. (2009). Degassing as the mechanism of thermal electromagnetic fields effect on water and bioliquids. Donetsk, 1-18.

Shubha, M. and S. Reddy (2011). Effect of stocking density on growth, maturity, fecundity, reproductive behavior and fry production in the mouth brooding cichlid *O. mossambicus* (Peters). Afr. J. Biotechnol., 10 (48) : 9922-9930.

Sithik, A., G. Thirumaran, R. Arumugam, R. Kannan and P. Anantharaman (2009). Physico-chemical parameters of Holy Places Agnitheertham and Kothandaramar Temple; southeast coast of India. Am. Eurasian J. Scien. Res., 4(2): 108-116.

Sundeman, M.F.W. (1964). Studies of the serum proteins. Am. J. Clim. Path, 1-21.

Tai, C.Y., C.K. Wu and M.C. Chang (2008). Effects of magnetic field on the crystallization of CaCO3 using permanent magnets. Chem. Engin. Sci., 63: 5606-5612.

Wang, H.Y., X.B. Zeng and S.Y. Guo (2005). Effects of electro-magnetic field on the physiological characteristics of *Chlorella vulgaris* and mechanisms analysis. Fish. Sci., 24 (7) : 12–14.

Winniky, A., A. Korozelecka-Orkis, A. Sobocinska and A. Tanski (2004). Effects of the magnetic field on different forms of embryonic locomotor activity of Northern pike, *Esoxlucius* L. ActaIchthyol. Piscat., 34: 193–203.

Zaki, M.A., A.A. Nour, M.M. Abdel Rahim and T.M. Srour (2004). Effect of stocking density on survival, growth performance, feed utilization and production of marine shrimp *Penaeussemis ulcatus* in earthen ponds Egyptian J. Aquac. Res., 30: 429-442.

Zhang, Z.R., R.S. Xie, L.Y. Xiao and S. Wong (1987). Effects of magnetic field and the water heated by magnetic field on the growth of *Oreochromis nilotica*. Trop. Oceanol. 6 (1) : 91–93.

Zhao, W., J. Tang, J. Chi, G. Liu, X. Yu and L. LujunBian (2015). Effects of magnetic treatment on growth and immune and digestive enzyme activity in the juvenile sea cucumber *Apostichopus japonicus* (Selenka). Aquac., 435 : 437–441.

تأثير تقنية الماء الممغنط على أداء النمو والاستفادة الغذائية وجودة المياه وبعض مقاييس الدم في زريعة البلطي النيلي تحت كثافات تخزينية مختلفة

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أجريت هذه الدراسة لتوضيح تأثير تقنية الماء الممغنط على أداء النمو ومقاييس الاستفادة الغذائية وجودة المياه وبعض مقاييس الدم لزريعة البلطي النيلي المحولة جنسيا (وحيدة الجنس ذكور)، تم توزيع الزريعة عشوائيا على مجموعتين تجريبيتين في الأحواض الزجاجية، صممت التجربة علي مستويين من الكثافة (كثافة منخفضة بمعدل ٧ يرقات/ حوض زجاجي (٨٠ يرقة / م^{3}) وكثافة عالية بمعدل ١٤ يرقة / حوض زجاجي (١٦٠ يرقة / م^{3})، وتعرضت نفس الكثافات مع المياه الممغنطة لمجال مغناطيسي شدته ٠.٧ تسلا وقورنت بمجموعات مياه الكنترول (صفر تسلا مياه عادية) وتم عمل ثلاث مكررات لكل مجموعة، وكان متوسط وزن اليرقات في بداية التجربة ٠.٣ جرام/ يرقة، وغذيت الأسماك على عليقة تجارية ذات محتوي من البروتين ٣١.٧% بروتين خام وبمستوى طاقة كلية ٤٠١٧.٧ كيلو كالوري/ كيلو جرام عليقة، أوضحت النتائج في نهاية التجربة وجود تحسن معنوي ($P > 0.01$) في مقاييس النمو ومقاييس الاستفادة الغذائية في مجموعات المياه الممغنطة مقارنة بمجموعات الكنترول في كلا من الكثافة العالية والمنخفضة، وسجلت الدراسة تحسن معنوي ($P > 0.1$) في الأمونيا والنترات والنيتريت والأوكسجين الذائب في مجموعات المياه الممغنطة مع الكثافات العالية والمنخفضة مقارنة بمجموعات مياه الكنترول، بينما لا توجد فروق معنوية ($P > 0.05$) في الأس الهيدروجيني بين مجموعات مياه الكنترول ومجموعات المياه الممغنطة، أما بالنسبة لمقاييس الدم فقد لوحظ عدم وجود فروق معنوية ($P > 0.05$) في مقاييس الدم بين مجموعات الكثافة العالية والمنخفضة، عموما فإن تطبيق المياه الممغنطة في الاستزراع السمكي و بخاصة في استزراع البلطي النيلي يحسن من أداء النمو و الاستفادة الغذائية.

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