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Effect of Magnetized Water on Improving the Growth Performance, Composition Factors and Microbiota of Deteriorated Sea Bass Larvae *(Dicentrarchus labrax)*

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ABSTRACT

A 45- day study investigated the effect of magnetized water on improving the larval aquaculture of the European sea bass in the deteriorated conditions. The present study addressed the impact of magnetized water on growth performance, body proximate composition, oxidative stress indicators, water properties, and microbiota at the early larval stages. The larvae were stocked into fiberglass tanks. Four magnetic devices with different intensities in Tesla [T1 (0.015 T), T2 (0.035 T) and T3 (0. 050 T)] were manually prepared and applied in triplicates in addition to a control tank (no magnet). The results proved the suitability of using the strength of 0.035T for attaining better survival, and growth performance parameters that were significantly (P>0.01) surging the other investigated factors compared to the control. Meanwhile, this magnet dose (0.035 T) showed significantly higher crude protein content (CP%) as well as higher antioxidative activity in superoxide dismutase and catalases levels. Otherwise, microbial analysis of the different magnetized waters and the larval body showed varied counts. Thus, it was concluded that the exposure and intensity of 0.035T gave different bio-responses on the level of improving larval aquaculture and have varied physico-chemical-response withrespect to water quality.

INTRODUCTION

The paramagnetic water compound has positive and small susceptibility to magnetic fields (MF) which is slightly attracted to MF. Technological processes for water treatment are affected by the theory of magnetic field using a simple and efficient approach during water flows through a magnet and consequently acquire different physico-chemical characteristics (**Parsons, 1997**). For instance, the magnets in water have been used as a new possible way to ameliorate aspects of water quality, like softening water then reducing mineral solubility, which gives significant importance in

aquaculture and industrial horizons (**Hassan *et al.*, 2018a**). Moreover, magnets form larger water clusters *via* hydrogen bonding enhancement with other water molecules that decreases water surface tension and increases viscosity **(Cai *et al.*, 2009)**.

Magnets have been considered as water quality parameters improvement in fish culture as mentioned previously in the study of **Krzemieniewski *et al.* (2003)** who proved that the magnetic field caused a change in the conductivity (CD), pH and reduced chloride level and water hardness by decreasing the total dissolved solid (TDS) in water. Another laboratory study of **Lo *et al.* (2007)** has confirmed that the magnetic field can accelerate the degradation of organic waste in the intensities that ranged from (0.005-0.14 T), but the effectiveness of the process depends on the type of magnet used, the chemical content of treated water and the exposure time. **Hassan *et al.* (2018b)** reported that increased Tesla (T) promoted fish growth. The possible use of magnetized water has expanded to many fish species with different Tesla levels (**Hassan & Abdul Rahman, 2016**). Farmed *Dicentrarchus labrax* L. (the European sea bass) is of economic importance for the Mediterranean fishery and aquaculture industry; the fish reproduced in commercial facilities, but farmers still face some problems at the end of the season.

Properly, most of the hatcheries encounter failure in producing high quality of fish seeds. **El-Sayed *et al*. (2021)** stated that marine sea bass fry suffer from increasing high level of mortality and poor growth performance mainly during the late rearing period in hatcheries compared with reviews at the beginning of the season (once temperature turned higher to 20^{o}C) as reported by **El-Sayed and Barakat (2016)** whose studies on the European sea bass revealed high survival percentage in controls that reached 30-40% in very early stages (30dph), and 68.5% in the weaning stages (60dph) in such studies, respectively. **Cominassi *et al*. (2019)** reported that the optimal physiological thermal limit is stage-specific and appear narrower, with the colder conditions, in larvae compared to juveniles. **Billerbeck *et al.* (2001)** declared that at such stages the rapid growth organizes more aerobic capacity leaving less energy vanishing capacity or lower dissolved oxygen for mobility. Early developmental stages have a nearly low aerobic capacity **(Killen *et al.*, 2007)**.

It was demonstrated that magnetic field treatments through restoring the activity of enzymes and proteins can affect free radicals and overall biochemical processes in fish **(Florez *et al.*, 2007).** Also, it has a positive effect on immune status, growth, proteins metabolism, blood parameters and digestive enzymes levels in most fish species**. Zhao *et al.* (2015)** reported that magnetic biological technology offers a number of superiorities over traditional chemical treatments which improves growth rates and reduces the mortality rate in aquacultures. In fact, different magnetic field types, intensities and action times cause different biological effects, which may promote or inhibit microbial growth **(Geng *et al.*, 2020)**. The magnetic field has adverse effects on the cell wall transport mechanism of Gram-negative and Gram-positive bacteria **(Konopacki &**

Rakoczy, 2019). However, the effect of magnetic fields on microbial cells has been poorly studied. Currently, the long-term effects of continuous magnetic exposure to *D. labrax* larvae are not investigated.

Therefore, this study aimed to study the changes in the physicochemical properties of the magnetized water by rising the levels of magnetic intensity that attained optimum growth performance and survival as well as better body proximate composition, improved oxidative stress ability and microbial analysis for European sea bass larvae (*Dicentrarchus labrax*) in the first 45 days post hatch during larval culture especially in the deteriorated fish spawned at the end of the season considering higher temperature and other limiting factors .

MATERIALS AND METHODS

Magnetized water, growth performance and condition factors of sea bass larvae

The practical work; kept at the marine hatchery of National Institute of Oceanography and Fisheries (NIOF) Alexandria, Egypt. Sea water salinity was 39 ppt, temperature 17.3- 18.2^{o}C, the pH 7.80- 8.30 (pH/Temperature Branch Meter, Italy). The dissolved oxygen 4.4 - 5.5 mg/L, total ammonium (NH_4) 0.01 mg/L and no NH_3 detected (YSI ECO Sense® 9300 photometer, England).

Algal Species

Nannochloropsis salina was cultured indoor in flasks and fiberglass cylinders using f/2-Guillard medium **(Guillard, 1975)**. Density of *N. salina* was 20 x 10^6 cells /mL. (**FAO, 1999)**.

Rotifer Culture

Rotifers *Brachionus plicatilis* (live prey) were enriched with a mixture of *Nannochloropsis sp* and a natural culture diet (Selco®).

Brine Shrimp Culture (Great Salt Lake Artemia Cysts)

Artemia cysts (brine shrimp) were incubated to hatch as described by **Lavens and Sorgeloos (2000)**. The produced nauplii were harvested after 24 h. washed with filtered sea water, and after 36 h Artemia metanauplii was enriched with *Nannochlorosis salina* alga for 24 h then Artemia was harvest by plankton net (100 µm).

Artificial feeding

The larvae were fed 4 times daily on diets purchased from ALLER Egypt Company contained 65% protein with sizes ranged from 200 µ to 400 µ with increasing the fish size **(Table 1)**. The feeding protocol was performed based on the manual of FAO.

Table 1. Chemical composition % Aller Futura EX Size 0.2 -0.4mm

Chemical composition	Size 0.2-0.04 mm
Crude protein %	**65**
Crude fat %	**14.5**
NFE %	**2.7**
Ash %	**13**
Fiber %	**0.8**
P (%)	**1.8**
Gross energy (MJ)	**21.2**
Digestible energy (MJ)	**19.8**

Experimental design

The experiment was conducted to evaluate the effect of the different magnetized water on the growth performance and condition factors on early and post larval stage after 45 days post hatch (dph) using the *N. salina* as green techniques in the rearing water in larval tanks. Larvae of sea bass with an initial weight 2.99 to 3.00 mg were collected from artificial spawns of brood stock maintained under controlled conditions. Larvae were stocked at the rate of 2000 larvae/tank (20 larvae/l) into fifteen 100-liter round fiberglass tanks. Four treatments, triplicate per each were carried out: control without any magnetic effect and the other treatments with different magnetic intensities T1 (0.015 T), T2 (0.035 T), T3 (0.050 T) **as (Fig.1)**. Total length of each post larvae was measured by ocular micrometer with nearest minimum accuracy of 0.5 mm. Larval weight was recorded by using the mono-pan balance with accuracy of 0.01mg. Growth parameters such as: length gain (LG), weight gain (WG) and Specific Growth Rate (SGR) were determined according to the following equations:

Weight gain (WG) (mg/larva) = FW- IW

Where: IW initial mean weight of fish in mg; FW: final body weight of fish in mg

Length gain (LG) (mm larva^{-1})

Final mean length of larvae (FL) in mm - Initial mean length of larvae (IL)in mm

Specific growth rate (SGR) (%/ day) = $100 \times (\ln W_t - \ln W_0)/$ day

Where: ln: natural logarithm

Average daily weight gain (ADWG) (mg larva^{-1} day^{-1})

Final weight (FW) (mg) - Initial weight (IW) (mg) / experimental period (days)

Survival percentage (S %) = {(No. of fish at end / No, of fish at the start)} ×100

Condition factor: (k-value) = (body weight. g)/ (body length, L^3) ×100

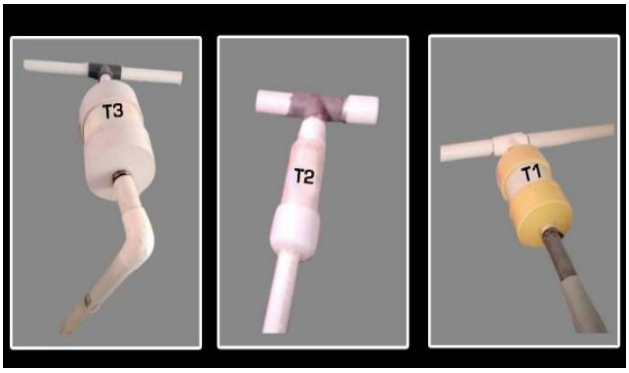

FIG. 2 Photograph of magnetic water devices with different intensities (T1, T2 and T3) water was magnetized by running it through the magnetic devices.

Determination of Oxidative Stress activity

Catalase (CAT) activity was assayed by the method **Claiborne (1985)**, Superoxide dismutase (SOD) activity was assayed according to **Paya *et al.* (1992)** with minor modified cations **(Peixoto *et al.*, 2006)** and Lipid peroxidase (Malondialdehyde assays): Peroxidative damage of lipids was determined according to the method of **Utley *et al.* (1967)**.

Proximate composition analysis

The biochemical composition of the examined post-larvae in the different magnetic strengths after 45 days was determined following the standard methods **(AOAC, 2000)** regarding crude protein CP, crude lipid EE, ash and nitrogen free extract levels (NFE)

Microbial analysis

The experimental fish samples from ten fish/aquaria were aseptically collected alive in sterile bags besides water samples obtained from the same collected area. The isolated mid-gut from fish samples was treated with saline diluents to prepare a set of dilutions. One ml of the diluted fish samples and water samples were inoculated on the selective media where the viable aerobic bacterial counts were determined using pour plate method and enumerated in standard plate count agar after incubation at 37°C for 24-48 h **(APHA, 2005).** Selective media were used for microbial detection: Thiosulfate-citrate-bile salts-sucrose agar (TCBS) for *Vibrio* species isolation and *Salmonella-Shigella* (SS) agar to differentiate *Salmonella* spp. and some strains of *Shigella* spp. (**Aryal, 2019**). De Man, Rogosa & Sharpe (MRS) agar is a medium for the cultivation and enumeration of *Lactobacillus* spp. (**Vanderzant & Splittstoesser, 2015**). *Aeromonas* isolation medium base agar with ampicillin is used for *Aeromonas hydrophila* (**Baird *et al.*, 2015**). Mannitol Salt Base agar (MSA) is used as a selective and differential medium for the isolation of *Staphylococcus aureus* (**Aryal, 2019**).

Statistical analysis

Data were statistically analyzed by using SAS ANOVA procedure (SPSS Statistics17.0). The assay data were submitted to Bartlett test to verify homoscedasticity. The data showed no variances in homogeneity. Subsequently, the data were submitted to one ways classification variance analysis. Duncan‟s multiple range test was used to compare differences between treatment means when significant F values were observed (Duncan, 1955), at ($P \leq 0.05$) level.

RESULTS

Using different magnetized water to study its impact on the growth performance, health condition and survival % of rearing European sea bass larvae was determined as found in **Table 2**.

Table 2: Effect of the magnetized water on the growth performance of sea bass larvae

Treatment	(control)	T1(0.015T)	T2 (0.035T)	T3 (0.050T)
IW, mg/larvae	3.00±0.00	2.99±0.01	3.00±0.00	2.99±0.01
FW, mg/larvae	10.63±0.23^{d}	14.31±0.05^{b}	15.90±0.02^{a}	12.37±0.09^{c}
WG, mg/larvae	7.63±0.23^{d}	11.32±0.05^{b}	12.90±0.02^{a}	9.38±0.09^{c}
ADWG mg/larvae/day	0.17±0.01^{d}	0.25±0.00^{b}	0.29±0.00^{a}	0.21±0.00^{c}
SGR (%/day)	2.81±0.05^{d}	3.48±0.01^{b}	3.71±0.00^{a}	3.15±0.02^{c}
I L, mm/larvae	2.66±0.01	2.65±0.00	2.64±0.01	2.64±0.01
FL, mm/larvae	12.67±0.10^{c}	14.33±0.08^{b}	15.89±0.06^{a}	12.60±0.08^{d}
LG, mm/larvae	10.01±0.09^{c}	11.69±0.09^{b}	13.25±0.05^{a}	9.96±0.07^{d}
k value	0.84±0.01^{d}	0.99±0.30^{b}	1.00±0.00^{a}	0.98±0.01^{c}
Survival %	10.87±0.12^{e}	14.63±0.07^{d}	30.30±0.35^{a}	11.57±0.07^{d}

*All treatments mean±SD in the same row with different superscript (a, b, c) are significantly different ($P < 0.05$)

Growth performance

Using different magnetized water systems were carried out to detect their effect on the growth performance on the early sea bass larvae. The data obtained for sea bass larvae exposed to a magnetic field 0.035 T showed the highest growth performance parameters FW, WG, LG, ADG and SGR by values of 15.90±0.02 mg/larvae, 13.25±0.05 mm/larvae, 12.90±0.02 mg/larvae, 0.29±0.00 mg/larvae/day and 3.71±0.00% /day, respectively.

Health condition of Sea bass larvae

The best values for sea bass larvae health condition were recorded when exposed to a magnetic field 0.035 T showed the highest condition factor (1.00±0.24), and SGR value 3.71±0.00% /day compared by sea bass larvae with no magnetic field (Control).

Survival %

The effect of magnetic fields on sea bass larvae of different magnetic intensities on the survival % was represented in **Table (2).** The obtained data showed significant (P<0.01) differences among all treatments. The highest survival rate was observed in larvae exposed to a magnetic field 0.035 T (30.30±0.35%), and the lowest value was noticed in control 10.87±0.12%.

Proximate body composition

Table 3 illustrated the body composition analysis of sea bass larval extract. Crude protein analysis (CP %) recorded significantly (P<0.01) highest values (18.62±0.21 %) for larvae exposed to 0.035 T compared to the lowest values observed in the normal water (control) (16.15±0.05%). Contrary, the highest EE% value was recorded for larvae in normal water (control) (3.68±0.08 %) compared with the lowest value using 0.035 T (1.82±0.18). No significant (P>0.01) difference was recorded for carbohydrate % and ash %.

Oxidative stress indicators in larval extract of sea bass (Dicentrarchus labrax)

Table 3: Body proximate compositions of sea bass (*Dicentrarchus labrax*) larval extract

Treatment (%)	(control)	T1(0.015 T)	T2 (0.035 T)	T3 (0.050 T)
Crude protein	16.15±0.05^{d}	18.20±0.02^{b}	18.62±0.21^{a}	17.27±0.08^{c}
ether extract	3.68±0.08^{a}	1.84±0.07^{c}	1.82±0.18^{d}	2.30±0.12^{b}
Carbohydrate	2.36±0.05^{b}	2.30±0.03^{c}	2.15±0.02^{d}	2.56±0.23^{a}
Crude ash	2.56±0.04^{a}	2.32±0.03^{c}	2.23±0.01^{d}	2.52±0.03^{b}
Moisture	75.24±0.07^{c}	75.35±0.09^{a}	75.19±0.06^{d}	75.34±0.10^{b}

*All treatments mean±SD in the same row with different superscript (a, b, c) are significantly different (P < 0.05)

Table 4 illustrats the body oxidative stress indicators in larval extract of sea bass, where superoxide dismutase activity, catalase activity and lipid peroxidation were significantly (P<0.01) recorded. The highestsuperoxide dismutase activity value was recorded for larvae exposed to 0.035 T (78.61±0.33 U/g) whichsignificantly differed from T1, T2 and control. The highest catalase activity values were also recorded for larvae exposed to 0.035T (81.43±0.56 µM/min/g) compared to the control and other treatments. However, the highe stlipid peroxidation values were recorded for larvae in normal water (control) (42.17±0.34 nmol) and the lowest value for 0.035T (27.47±0.49 nmol).

Table 4: Oxidative stress indicators in larval extract of sea bass (*Dicentrarchus labrax*)

Treatment	(control)	T1(0.015T)	T2 (0.035T)	T3 (0.050T)
Superoxide dismutase activity (U/g/50% inhibition wet weight tissue)	68.71±0.52[d]	74.42±0.16[b]	78.61±0.33[a]	70.94±0.20[c]
Catalase activity (μM/min/g/wet weight tissue)	54.20±1.44[d]	67.23±0.78[b]	81.43±0.56[a]	57.83±0.45[c]
Lipid peroxidation (nmol TBARS g tissue^{-1})	42.17±0.34[a]	35.10±0.36[c]	27.47±0.49[d]	39.40±0.59[b]

*All treatments mean±SD in the same row with different superscript (a, b, c) are significantly different (P < 0.05)

Magnetized water properties

The result in **Table 5**showed that all the water property parameters had significant effect except for the conductivity parameter have no significant effect on the trend with magnetization intensities .It was clear that the pH decreased slightly with the intensity of the magnets. The adequate pH value was 7.98±0.00 for the larvae exposed to a magnetic field 0.035T, compared with the other treatments. The dissolved oxygen also increased significantly with increasing water magnetization. An increase of dissolved oxygen ~ 8.6 ppm for the larvae exposed to 0.050 and 0.035 was observed. The temperature was lowered from 20 to 18.11 C^{o} in magnetized water at strength 0.035 T with corresponding to highest survival and better larval performance among treatments.

Table 5 Effect of exposure of magnetic field on properties of water magnetized

Treatment	(control)	T1(0.015 T)	T2 (0.035 T)	T3 (0.050 T)
Salinity, ppt	35.49±0.01[a]	35.43±0.00 [b]	35.34±0.00 [d]	35.39±0.00[c]
TDS mgL^{-1}	157.3±2.60[a]	155.3±0.38[b]	155±0.00 [c]	150±0.00[d]
Coductivity CD	247.85±0.71[a]	246.55±0.5[a]	246.35±0.62[a]	246.38±0.40[a]
SPC uscm^{-1}	242.7±4.60[a]	240.6±0.21[b]	240.4±0.17[c]	240.3±0.26[d]
Ammonia NH_3	0.02±0.00 [a]	0.01±0.00 [a]	0.001±0.00 [b]	0.001±0.00[b]
NH_4- N mgL^{-1}	0.20±0.03 [a]	0.18±0.01[b]	0.17±0.01[b]	0.16±0.01[b]
Water Temp. ^{o}C	20.01±0.02[a]	18.85±0.00 [b]	18.11±0.00 [c]	18.00±0.00 [c]
pH	8.13±0.03[c]	7.9 ±0.02[b]	7.75±0.01[a]	7.66±0.01[a]
DO, ppm	7.15±0.07[d]	7.82±0.07[c]	8.15±0.08[a]	8.33± 0.04[b]

*All treatments mean±SD in the same row with different superscript (a, b, c) are significantly different (P < 0.05)

Microbiological analysis

Using different Magnetic intensities**,** microbiological analysis for sea bass larvae's body and magnetized water was illustrated in **Fig. 2**. Results showed that higher *Vibrio* sp. count was in control (7603.33±3.33 cfu/mL) than the count observed at 0.035 T exposure (2070.67±90.34 cfu/mL). The highest *Aeromonas* sp. count was detected in control (6603.33±3.33 cfu/mL) while the lowest count at 0.035 T (382.00±3.61 cfu/mL). The highest *Staphylococcus* sp. and total bacterial count were ranging between 6000 and 10000 cfu/mL, where, the lowest count for the tanks exposed to 0.035 T. Larval body (L.B) showed that the highest *Vibrio* sp. count in water recorded at control (2276.33±1.86 cfu/mL) where the lowest value observed in 0.035 T (382.00±3.61 cfu/mL). Also, the highest *Aeromonas* sp. values were detected in control and no count for any remained treatments. The total bacterial count increased greatly in sea bass larvae in all treatments including the control (>1000 - >4000 cfu/mL) except the tank exposed to 0.035 T (621.00±1.00 cfu/mL). *Staphylococcus* sp. recorded its highest values from >3000 - >4000 cfu/mL. *Shigella* sp. and *Salmonella* sp. showed no detectable count for both larvae's body and magnetized water treatments.

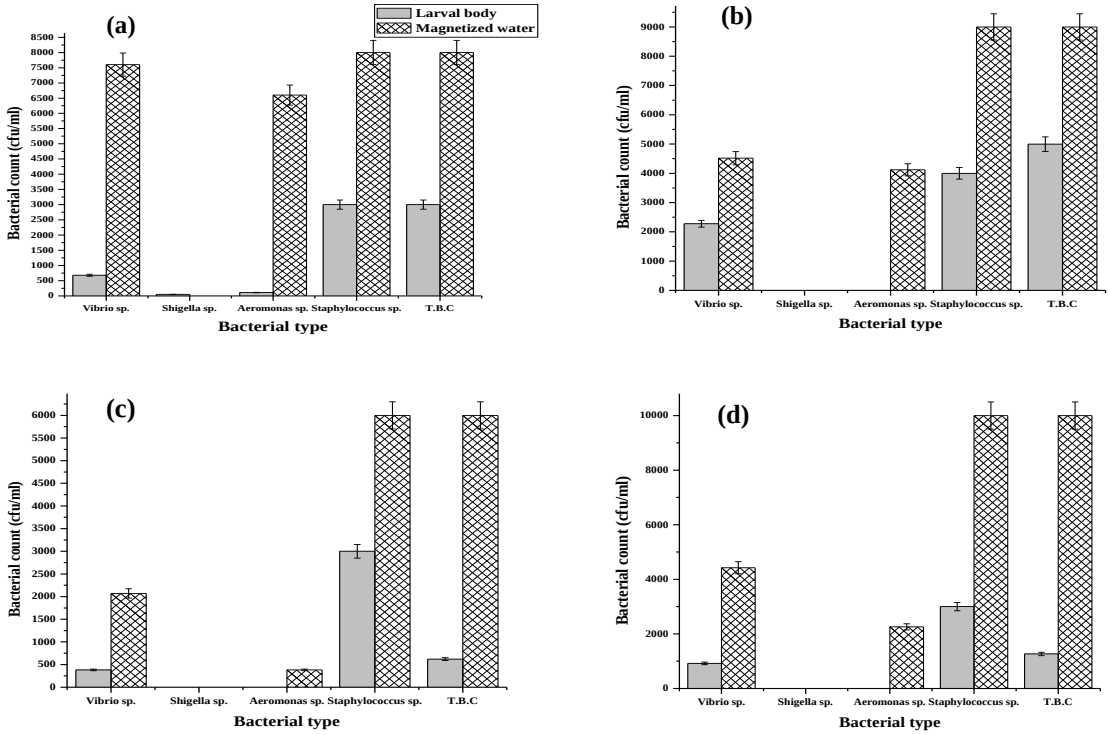

FIG. 2 Microbiological analysis for Sea bass larvae's body rearing and magnetized water in tanks containing control (a), T1(0.01 T) (b), T2 (0.03 T) (c), T3 (0.050 T) (d).

DISCUSSION

The application of the magnetic treatment in aquaculture sector is still a new approach for several studies that have been conducted to test the effect of magnetic field on aquaculture (**Hassan *et al.*, 2019; Ahmed & Abd El-Hamed, 2020)**.

The highest values for sea bass larvae growth performance parameters (FW,WG,LG,ADG and SGR) as well as condition (K value) were recorded for magnetic field 0.035 T. Recently, **Hassan *et al.* (2019)**and **Ahmed and Abd El-Hamed (2020)** evaluated the continuous exposure of magnetized water using different Tesla intensities on Jade Perch (*Scortum barcoo*) and on juveniles of Nile tilapia (*Oreochromis niloticus*) respectively, recording growth performance in terms of FW, FL ,WG ,LG ,SGR and K value had significantly improved at 0.2 T. **Mabrouk *et al.* (2016)** showed that the male type of Nile tilapia (*Oreochromis niloticus*) fry growth performance have been recorded the highest values of the (DWG) and WG using higher magnetic intensity at 0.7 T. Authors explained that the different magnetic effect may attributed to the difference in fish species and water quality .

In the present study the highest survival percentage of sea bass exposed to magnetized water at different magnetic intensities was obtained at 0.035 T (30.30±0.35%), compared with control (11.57±0.07). At 0.035 T intensity, the temperature was decreased from 20 to 18C^{o} considering as this is the optimum degree for juveniles survival rather than larval stage survival. As **Zanuy *et al.* (1995)** who reported that establishing optimal survival in sea bass is a problematic under suboptimal environmental conditions, specially at high winter elevated temperatures that may be shifted to the photoperiods at the ending of spawning season. Also, **Cominassi *et al.* (2019)** mentioned that in harsh condition (temperature at 20°C), sea bass larvae are already exposed to a sub-lethal warm temperature led to decreased mitochondrial efficiency that provide energy demanding during swimming, hence this is resulting to mortality and poor growth larval performance. Contrary, **Howald *et al.* (2019)**, reported higher thermal optima in sea bass juveniles than larvae, due to better mitochondrial capacities for aerobic ATP production of permeable heart fibers reared at high temperature which would generally indicate a rearrangement of biochemical pathways during evolution thermal optima (colder for larvae than for juveniles). However, **Leis *et al.* (2012)** suggested that temperature below 20°C support the survival% of juveniles' stage once the larvae reached one month of rearing.

Our results in the current work indicated that the body composition analysis of sea bass larval extracts showed the highest crude protein (CP %) significantly of 18.62±0.21 % whereas carbohydrate and ash % showed no significant difference for treatments for larvae exposed to 0.035 T compared to the normal water conditions (control). However, higher EE% value was recorded for larvae in normal water (control) (3.68±0.08 %).

These results are in accordance with the study of **Hassan *et al.* (2019)** who reported that highest values of the whole body proximate composition of Jade Perch of crud protein is significantly affected by exposure to 0.15 T (17.24 ± 1.20%) while crude ash (3.96±0.08%) at 0.2T.This was incongruence with **Ahmed and Abd El-Hamed (2020)** that found a decrease in crude protein and ash level, but a slight increase in ether extract in the Nile tilapia exposed to 0.2 T magnetic reared water compared to control. This also may attribute to the different fish species and water quality.

Regarding body oxidative stress indicators in larval extract of sea bass, superoxide dismutase activity, catalase activity and lipid peroxidation were significantly recorded showed their highest values: for larvae exposed to 0.035 T. It was reported that elevation of some oxidative stress by magnetized water may play constructive role in increasing thegrowth and the use of protein to build somatic cells **(Yacout *et al.*, 2015).** Also, the change of this stressindicators and magnetic field could be interacted directly with electrons in DNA to affect protein biosynthesis (**Al-Hilali, 2018)**. The effect of magnetic water on some fish biochemical parameters may be different accordingto the species and intensity of magnetic field **(Sedigh *et al.*, 2019)**.

The results showed that the pH was slightly decreases for the larvae exposed to a magnetic field 0.035 and 0.050 T well as the temperature significantly did. In parallel, dissolved oxygen was increases by ~ 8.6 ppm for the larvae exposed to. Otherwise, **Ahmed and Abd El-Hamed (2020)** observed that no significant difference in temperature between the magnetic water and control with the Nile tilapia exposed to 0.2 Tesla in reared water, but the dissolved oxygen (8.73±0.20 ppm) were also significantly increased. On the other hand, many reports showed no significant difference in temperature, dissolved oxygen, pH, and salinity for fish treated with different magnetic fields (**Mabrouk *et al.*, 2016; Hassan *et al.*, 2018b; 2019).** This incongruity between results could be attributed to the differences in magnetic intensities, water qualities and the type of fish **(Irhayyim *et al.*, 2019**). In the present study the data showed gradual decrease in the water conductivity as well as salinity and temperature records after the exposure to magnetic field and reached maximum decrease at magnetic intensity (0.035 T), supporting the finding of **Maus (2007)** who indicated that the conductivity of seawater depends on the number of dissolved ions per volume (i.e., salinity) and the mobility of the ions (i.e., temperature and pressure). Previous study by **Alkhazan and Sadddiq (2010)** found that CD level was decreased after the exposure to low-magnetic level of 18 G. but without any change in values of water temperature or in salinity. In our study, the data indicate that the pH values were still declining up to 0.035 T and start to increase again in the higher ones that were disagreed regarding the results of **Alkhazan and Sadddiq (2010)** and **Hassan *et al.* (2018a)** who observed slight increase in the pH value with the higher magnetic field strength. However, **Khater and Ibraheim (2016)** indicated a decrease in pH values with magnetic exposure even in the lower magnetic

intensities which was 0.0018 T. **Pandeyand Tiwari (2009)** confirmed that when water magnetization exceeds 0.050 T, the pH value may increase upward and that explain our results. Also, within the limit of magnetization 0.015- 0.050 T, authors observed a significant increase in the dissolved oxygen (mg/L) levels at ($P \leq 0.05$) which was supported by **Hassan *et al.* (2018a)** who used more higher strengths 0.10-0.20 T. Moreover, **Sunitha and Padmavathi (2013)** reported that the dissolved oxygen is the crucial parameter of water quality because of its effect on metabolism of the aquatic organisms. Interestingly, the results revealed also that the total dissolved solids (TDS) of the magnetized water showed a significant decrease which was accompanied by a decrease in SPC and CD in the same trend with increasing magnetic strength revealing increasing the ability of magnetic field to decrease consolidation degree between water molecules which could cause an increase in the solubility of the salts and size of molecules which may explain the lowering salinity with increasing magnetic strength and exposure time to 48 h. On the contrary, **Shatalov (2009)** and **Khater & Ibraheim (2016)** reported a decrease in O_2 level after the magnetic exposure in very low strength that indicating the correlation between increasing DO and increasing magnetic intensity in the water is directly proportional and also related to water type and quality **(AL-Ibady, 2015)**.

Concerning the fact that high ammonia level is a limiting factor to the fish health, hence a low level of NH_3- N in rearing larvae is desirable for fish growth. Our present study recorded the lowest and the best levels of NH_3- N as well as Ammonium (NH_4-N) with highest larval growth at magnetic intensity 0.035 T. That was in harmony with **Hassan *et al.* (2018a)** who reported a significant decrease in NH_3 and ammonium levels with increasing magnetization to 0.20 T but with slight difference increase in survival of the larvae may related to the different experimental fish species. **Chang and Weng (2008)** found that the raise of mobility of the ions under a magnetic field causes significant damage to the hydrogen bond network in the high Na concentration (as in case of sea water). Contrarly, in the low concentration, the structural behavior is governed by the properties of the water molecules and hence the hydrogen bonding ability is built up, as the magnetic field is increased. That was obviously observed in our study because the growth performance and survival of sea bass larvae (in very early stages) were negatively affected by increasing magnetic strengths in the treatments as even though the benefits were achieved with this elevating DO level as well as decreasing pH, temperature, salinity, TDS, SPC, CD in addition to minimizing ammonia and ammonium levels.. Recently, **Khater and Ibraheim (2016)** reported that, although the benefits of the magnetic field in treating the water, it has harmful effects on kidney tissue cells of the studied rats drinking this magnetized water. So, using the magnetic field with an intensity even at very low levels are not a safe method for treating water and they added that many studies are needed to reveal the safety of magnetic field usage before it is applied.

Microbiological analysis for rearing waters and the larval body using different intensity of magnets showed varied counts, where lower microbial values were detected at 0.035 T exposure compared with the higher control values. It was reported that magnetic fields with different intensities for water treatment decreased or inhibited bacterial content **(Al-khazan and Saddiq, 2010)**. The magnet affected the metals in treated water, especially organic substances, nitrogen and phosphorus which are important for bacterial metabolism. Moreover, the amount of water in bacterial cells was 80%, so water physical and chemical properties may be changed by magnetic force affecting bacterial growth as their composition changed **(Strasak *et al.*, 2002)**. The magnetic field may be considered as bactericidal effect that decreases the oxidoreductive activity and formation of colonies. Many authors studied the exposure of different magnetic fields in water bacteria 330 communities **(Piatti *et al.*, 2002; He *et al.*, 2009).** These indicate the possibilities of using a magnetic force to stop bacterial growth in water.

CONCLUSION

It may be concluded that the intensity 0.035 T at exposure duration 48 hr was the appropriate condition of water magnetization for better growth and survival of sea bass larvae in the hazard conditions in the late spawning season and could be a potential to dispense the losses in seed production being occurred in this period.

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