DUCKWEED AS A BIOLOGICAL FILTER IN TILAPIA FISH HATCHERIES AND ITS IMPACT ON TILAPIA REPRODUCTION

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ABSTRACT

Due to the decrease of freshwater in the current period, tilapia hatcheries depend on the agricultural drainage water. So this study was conducted on using duckweed as a biological filter in tilapia broodstock ponds. Nine concrete ponds were randomly assigned for 3 treatments; the 1st treatment as a control (without duckweed; 0 DW), the 2nd treatment received 200 g fresh weight of duckweed (200 DW)/pond stocked in a wooden frame, of 1m^2 area (1 frame/pond), and the 3rd treatment received 400 g fresh weight of duckweed (400 DW)/pond stocked in two wooden frames, each of 1m^2 area (2 frames/pond). All ponds were stocked with 68 Nile tilapia broodstock fish with an average weight of 225g/fish at a sexual rate of 3 females: 1 male. The experiment lasted for 15 days and replicated four reproduction cycles. Total ammonia, nitrite, nitrate, total nitrogen, particulate nitrogen, dissolved organic nitrogen and all fractions of phosphorus were measured in water ponds. Growth performance parameters of duckweed and fry production were also determined. The results showed that the 2nd (200 DW) and the 3rd (400 DW) treatments effectively improved the studied water quality parameters, increased fry production as access to by-product “duckweed” that may contribute in fish feeding and reduce the water consumption in tilapia hatcheries. Pearson correlation coefficients between the treatments and fry production proved significant positive relation. Interestingly, duckweed yielded an increase in fry production more than 13.5% compared to the control, as it doubled in biomass by 2.81% and 3.2% times, for 200 DW and 400 D, respectively, every 15 days.

Key words: Oreochmois niloticus, duckweed, wastewater treatment, phytoremediation, Nile tilapia reproduction.

INTRODUCTION

The family of *lemnacae* known as duckweed contains the world's smallest species of floating plants (macrophytes). It includes five genera, namely *Lemna, Spirodela, Wolffia, Wolffiella,* and *Landoltia* (Bergmann *et al*., 2000) and can grow at temperatures ranging from 5°C to 35°C (Les and Crawford, 1999). The most striking qualities of duckweed are a capacity for nutrients uptake; explosive reproduction and an almost complete lack of fibrous material. Consequently, they are widely used for treating the household and agricultural wastewater as well as for animal and fish feeding (Wang *et al*., 2002). Moreover, duckweed biomass is distinguished with high nutritional value, with crude protein levels ranging from 15% to 45% and starch up to 70% on dry basis (Gupta and Prakash, 2014), which nominates duckweed as feed for fish such as carp and tilapia (Fasakin *et al*., 1999; Leng, 1999 and Landesman *et al*., 2002). Duckweed has a high capacity for removing dissolved nutrients from water, especially nitrogen and phosphorous compounds, as well as for reducing organic matter and suspended solids (Wang *et al*., 2002; Goulet *et al*., 2005 and Stout and Nusslein, 2005). In aquaculture, it is reported that approximately 75% of nitrogenous and phosphorous compounds in applied feeds are accumulated in water as waste products (Piedrahita, 2003; Gutierrez-Wing and Malone 2006) that can exert toxic effects and impairment of physiological parameters, such as growth rate, oxygen consumption and disease resistance in fish species (Chan, 2003; Aiyuk *et al*., 2004).

In general, because of duckweed's rapid proliferation, tolerance to high nutrient levels, and excellent uptake ability of nutrients (mainly nitrogen and phosphorus), they have been used widely in phyto-remediation applications (Cheng *et al*., 2002 and Frederic *et al*., 2006). The phyto-remediation is a less expensive alternative that utilizes natural processes (Litchfield, 2005) than other approaches. Meanwhile, duckweed can be collected by simple and low-cost harvesting technologies (Hassan and Edwards, 1992 and Haustein *et al*., 1994). So it is employed in aquaculture effluent treatment as bio-filter for removing nutrients for their own growth and as a turbidity reducing agent by a setting of physical, chemical and microbial processes (Sirakov *et al*., 2015). The study of ammonium uptake kinetics showed that duckweed is tolerant to the high NH^{+4} levels (up to 240 mg/l, Cheng *et al*. 2002). Therefore, duckweed is recommended as a primary candidate for use in constructed wetland systems for the various types of wastewaters treatment (Zhang *et al.*, 2014). However, previous researches emerged questions connected to the impact of duckweed within tilapia broodstock pond on the fish reproduction performance, particularly since scarce researches are conducted with duckweed as a biological filter in fish ponds (Ferdoushi *et al*., 2008).

So, the aim of the conducted study was to determine the possible advantages of using duckweed as biological filter within the Nile tilapia broodstock concrete ponds and their impact on the reproduction performance of Nile tilapia as well as determine the biomass productivity of duckweed.

MATERIALS AND METHODS

Experimental design:

The present study was conducted in Nile tilapia (*Oreochromis niloticus*) concrete ponds at the hatchery of the Central Laboratory for Aquaculture Research (CLAR) to investigate the effect of duckweed on some water quality characteristics and reproductive performance of Nile tilapia fish as well as duckweed production within the fish ponds during summer of 2018. One year old Nile tilapia (*O. niloticus*) with an average weight of 225g/fish were stocked for spawning in nine concrete ponds (each 2.8 x 8.1 m and water depth of 0.8 m) at a density of 68 fish/pond (51 females and 17 males). These ponds were assigned for three treatments (with three replicates per each). Nine wooden frames were made (with an area of 1 m^2 and 3 cm height and covered with a net to prevent the duckweed from escaping inside the broodstock concrete pond). Artificial feed (30% protein) was applied daily at a rate of 0.6% of the total fish biomass. The 1st treatment (0DW) used as a control (without duckweed). The 2nd treatment (200DW) received three wooden frames (1 frame/pond), and the

3rd one (400DW) received 6 wooden frames (2 frames/pond). The duckweed (*Lemnaceae* sp.) were collected randomly from the drainage water canals at the Central Laboratory for Aquaculture Research (CLAR) and introduced into the frames at a density of 200 g/frame. This experiment was conducted for four hatching cycles, each of 15 days.

Water analysis:

Inlet water samples were analyzed at the beginning of each hatching cycle, while at every fry harvest; water final samples from the ponds were collected for chemical analysis. Total ammonia (NH_3 +NH_4^+), nitrite (NO_2-N), nitrate (NO_3-N), total nitrogen, dissolved organic nitrogen, particulate nitrogen, orthophosphate, dissolved organic phosphorus, particulate phosphorus, total phosphorus and chlorophyll "*a*" were determined. Total ammonia, nitrite, nitrate were measured spectrophotometrically by using an instrument (model WPA Linton Cambridge, UK) according to (APHA, 2000). Total N, before and after samples filtration was measured by Kjeldahl method (APHA, 1985). Samples for total phosphorus (TP) measurement, before and after samples filtration were digested using the dry ash method (Tavares and Boyd, 2003) then phosphorus estimated using the vanadomolybdate method (APHA, 1985). While, chlorophyll "*a*" was measured according to (Vollenweider, 1969) using the spectrophotometer instrument (model WPA Linton Cambridge, UK). Also, duckweed biomass in ponds were harvested and weighed freshly at the end of every hatching cycle in the 2nd and 3rd treatments using an electronic balance. Duckweed samples were analyzed to evaluate the moisture%, ash content, organic matter%, total N and total P according to (APHA, 1985) and (Tavares and Boyd, 2003).

Reproduction performance:

The number of Nile tilapia fry was estimated in each pond at the end of each hatching cycle. At the termination of the study, relative Fecundity estimated as the following equation:

Relative fecundity = (Fry count/Female) / weight of female (g) (Bagenal, 1978). The relative fecundity is usually calculated using the total number of ripe eggs per gram of female body weight.

Duckweed growth:

The relative growth rate, net gain, daily net gain, doubling rate for each g of duckweed were calculated using the following equations:

- Relative growth rate (%) = $(W_2/W_1)*100$
- Net (g/period) = W_2-W_1
- Daily duckweed gain (g/day) = $(W_2-W_1)/t$ (days)
- Doubling rate for g duckweed = $(W_2-W_1)/W_1$.

Where: W_1 and W_2 are the initial and final fresh weights of duckweed (g), respectively, and t is the period culture time in days.

Statistical analysis:

All data were computed and statistically evaluated to estimate Means ± SE and Duncan's Multiple Range Test (Alpha=0.05) using (SAS for Windows 9.4).

RESULTS

As it can be noticed in Table (1), the presence of duckweed at 400g/pond significantly decreased the total ammonia concentration more than 52% of that in the control treatment, while the presence of duckweed at 200g/pond insignificantly lower the total ammonia concentration than that in the control. An insignificant increase in nitrite and nitrate concentrations were measured in both duckweed treatments compared to those in control. However, overall decrease in dissolved inorganic nitrogen (DIN) by a percentage of 33.7% was determined as a result of duckweed presence at a density of 400g/ pond, compared to the control ponds. However the high variations among replicates hindered the significance among treatments.

Table 1. Water quality parameters in concrete ponds stocked with Nile tilapia (*O. niloticus*) broodstock and provided with different densities of duckweed during hatching season.

Parameters	Treatment			
	Inlet	Control	200DW	400DW
Total ammonium (NH_4) mg/l	0.49 ± 0.044[a]	0.69 ± 0.134[a]	0.66 ± 0.073[a]	0.33 ± 0.053[b]
Nitrite (NO_2-N) mg/l	0.03 ± 0.005[a]	0.03 ± 0.004[a]	0.06 ± 0.014[a]	0.04 ± 0.007[a]
Nitrate (NO_3-N) mg/l	0.18 ± 0.024[a]	0.17 ± 0.020[a]	0.21 ± 0.023[a]	0.22 ± 0.046[a]
DIN mg/l	0.70 ± 0.070[a]	0.89 ± 0.143[a]	0.93 ± 0.084[a]	0.59 ± 0.084
Total N (before filtration, mg/l)	5.08 ± 0.070[a]	3.75 ± 0.167[b]	3.34 ± 0.176[bc]	2.86 ± 0.138[c]
Total dissolved N (after filtration, mg/l)	2.89 ± 0.298[a]	2.53 ± 0.048[a]	2.67 ± 0.146[a]	2.55 ± 0.126[a]
Dissolved organic N (mg/l)	2.19 ± 0.228[a]	1.65 ± 0.102[a]	1.74 ± 0.197[a]	1.96 ± 0.110[a]
Particulate N (suspended matter, mg/l)	2.19 ± 0.316[a]	1.21 ± 0.212[b]	0.67 ± 0.145[c]	0.31 ± 0.048[c]
Total P (before filtration, mg/l)	0.21 ± 0.032[b]	0.34 ± 0.023[a]	0.24 ± 0.024[b]	0.25 ± 0.021[b]
Total dissolved P (after filtration, mg/l)	0.14 ± 0.013[a]	0.16 ± 0.014[a]	0.16 ± 0.019[a]	0.18 ± 0.019[a]
Particulate P (suspended matter, mg/l)	0.07 ± 0.019[b]	0.18 ± 0.134[a]	0.08 ± 0.009[b]	0.07 ± 0.017[b]
Inorganic dissolved P (PO_4) mg/l	0.11 ± 0.014[a]	0.11 ± 0.026[a]	0.12 ± 0.014[a]	0.13 ± 0.020[a]
Dissolved organic P (mg/l)	0.02 ± 0.007[a]	0.05 ± 0.014[a]	0.04 ± 0.01[a]	0.05 ± 0.007[a]
Chlorophyll "a" (µg/l)	25.65 ± 0.00[b]	138.15±21.86[a]	115.89±15.292[a]	112.63±14.13[a]

Means with the same letter are not significantly different. Alpha= 0.05

Moreover, a decrease by 23.7 and 10.9% was determined in the total nitrogen (TN) as the effect of the duckweed presence at a density of 400 and 200g g/pond, respectively, in comparison with the control treatment. Nevertheless, the duckweed treatments 400DW and 200DW resulted in an increase in the dissolved organic nitrogen concentration by 18.79 & 5.5%, respectively, compared to the control treatment. Also, an increase in the total dissolved nitrogen was determined in the 400DW and 200DW by 0.79 and 5.5% of that in the control treatment. Interestingly, the presence of duckweed at the 400DW and 200DW treatments led to a significant decrease in the concentration of total particulate N by 72.7and 44.6 %, respectively, of that in the control.

The treatments of 400DW and 200DW resulted in a significant decrease in total phosphorous (TP) concentration by 26.5 and 29.4%, respectively of the TP in the control ponds, while total dissolved phosphorus (TDP) increased as a result of the duckweed presence at a density of 400g/pond by 12.5% in comparison with that of the control. However, the duckweed treatments (400DW and 200DW) significantly decreased the total particulate phosphorus by 61 and 55.6% of that in the control, respectively. The orthophosphate increased by 18.2 and 9%in the duckweed treatments (400DW and 200DW), respectively of that in the control. No particular trend can be noticed for dissolved organic phosphorus.

As it is expected, a decrease in the Chlorophyll "a" (µg/l) concentration was noticed in the presence of duckweed at both 400DW& 200DW treatments by 18.5 & 16.1 % of that in the control, respectively.

From Table (2) it can be noticed that the average biomass of harvested duckweed increased 3.2 and 2.81 times than that of the starting amount for 400DW and 200DW treatments, respectively, every 15 days. The 400DW had significant higher ($P \leq 0.05$) final weight (1279.33 g); net gain (879.33 g/period); daily gain (80.41 g/day) and dry matter (6.45 %) than those of 200DW. However, no significant differences were detected between the relative growth rate (%), doubling rate for each g, daily gain, organic matter content (%), nitrogen content (%) and phosphorus content (%) in both treatments (Table, 2). Duckweed in the 200DW treatment had higher N concentration (1.41%) than that of 400DW (1.35). On contrary, P content at 400DW was insignificantly higher (0.47%) than in the 200DW (0.39%).

Table 2. Performance and chemical composition of duckweed stocked at different densities in Nile tilapia (*O. Niloticus*) broodstock concrete ponds during the hatching season.

Item	Treatment		
	0.0 DW	200 DW (1 frame)	400 DW (2 frames)
Duckweed growth performance			
Final duckweed weight (g)	0.00	562.40 ± 39.33[b]	1279.33 ± 117.72[a]
Increasing %/ the starting amount	0.00	2.81	3.2
Relative growth rate (%)	0.00	281.20 ± 19.67[a]	319.83 ± 29.43[a]
Net duckweed gain (g/period)	0.00	362.40 ± 39.33[b]	879.33 ± 117.72[a]
Daily duckweed gain (g/day)	0.00	35.17 ± 4.48[b] B	80.41 ± 8.73[a]
Periodically production rate for 1 g duckweed	0.00	1.81 ± 0.20[a]	2.20 ± 0.29[a]
Daily duckweed gain for every g/day	0.00	0.18 ± 0.02[a]	0.20 ± 0.02[a]
Duckweed chemical composition			
Duckweed miosture content (%)	0.00	94.45 ± 0.29[a]	93.55 ± 0.29[b]
Duckweed dry matter (%)	0.00	5.55 ± 0.29[b]	6.45 ± 0.29[a]
Duckweed organic matter content (%)	0.00	68.16 ± 2.41[a]	66.66 ± 3.02[a]
Duckweed Nitrogen content (%)	0.00	1.41 ± 0.13[a]	1.35 ± 0.90[a]
Duckweed Phosphorus content (%)	0.000	0.39 ± 0.11[a]	0.47 ± 0.12[a]

Means with the same letter are not significantly different. Alpha= 0.05

Table (3) showed that the 400DW treatment yielded the significantly highest fry production/pond and fry production/♀. The fry production/g ♀ was highest in the 400DW treatment, significantly in the first and fourth reproduction cycles and insignificantly in the second and third reproduction cycles. Similarly, the presence of duckweed at a density of 200 g/ pond resulted in higher reproduction performance than the control. Pearson correlation coefficients and significant (P) were +0.38 & P = 0.021, for both treatments and fry production/pond and fry production/ ♀, while it was +0.34 & 0.04 for fry production/g ♀.

Table 3. Reproduction performance of Nile tilapia (*O. niloticus*) broodstock in concrete ponds provided with different densities of duckweed during hatching season.

Item	Tre.	Total fry count/pond (Mean ± SE)	Fry count/♀ (Mean ± SE)	Fry count/g of ♀ (Mean ± SE)
Harvest (1)	0 DW	21000 ± 577.35[c]	412 ± 11.26[c] C	2 ± 0[b] B
	200 DW	27667 ± 333.33[b]	542 ± 6.67[b]	2 ± 0[b]
	400 DW	31667 ± 881.92[a]	621 ± 17.32[a]	3 ± 0[a]
Harvest (2)	0 DW	20167 ± 440.96[b]	395.33 ± 8.82[b]	2 ± 0[a]
	200 DW	21000 ± 577.35[ab]	412 ± 11.26[ab]	2 ± 0[a]
	400 DW	23000 ± 1154.70[a]	451 ± 22.52[a]	2 ± 0[a]
Harvest (3)	0 DW	11000 ± 577.35[b]	216 ± 11.26[b]	1 ± 0[a]
	200 DW	14000 ± 577.35[a]	275 ± 11.26[a]	1 ± 0[a]
	400 DW	15333 ± 333.33[a]	301 ± 6.67[a]	1 ± 0[a]
Harvest (4)	0 DW	13967 ± 290.59[c]	274 ± 5.51[c]	1 ± 0[b]
	200 DW	17333 ± 440.96[b]	340 ± 8.50[b]	1.67 ± 0.33[a]
	400 DW	19000 ± 577.35[a]	373 ± 11.26[a]	2 ± 0[a]
Overall Ave.	0 DW	16825 ± 1376.87[b]	330 ± 26.99[b]	1.5 ± 0.15[a]
	200 DW	20000 ± 1543.56[ab]	392 ± 30.33[ab]	1.67 ± 0.14[a]
	400 DW	22250 ± 1863.22[a]	436.25 ± 36.5[a]	2 ± 0.21[a]

Means with the same letter are not significantly different. Alpha= 0.05

DISCUSSIONS

Duckweed filtration performance:

An increased concentration of nutrients (mainly nitrogen and phosphorus) promoting the multiplication of primary producers (Zhang *et al*., 2014). This condition can lead to a rapid deterioration of water quality (Smith *et al*., 1999) and in the worst-case scenario, frequent outbreaks of blue-green algal blooms. So, ammonium concentration in the water bodies must be controlled to avoid the occurrence of eutrophication.

In the present study, the duckweed in 400DW treatment significantly decreased the total ammonium concentration by 52.2 % compared to the 0DW treatment. Similarly, Velichkova and Sirakov (2013) reported that when the two macrophytes (*Lemna and Wolffia*) used as biofilter, they can significantly decrease the total ammonia concentration in RAS water by 19.6% compared to its concentration in the control. Zhang *et al*. (2014) reported that duckweed prefer ammonia and the maximum uptake rate for ammonium was estimated at 0.082 mg / g fresh weight.h^{-1}. They also mentioned that more decrease can be obtained at higher stocking density, i.e. 700 g duckweed/ m^2. The stocking density of duckweed at the present study is lower than that recommended density, which suggesting higher decrease in the total ammonia can be reached at higher duckweed densities. Caicedo *et al*. (2000) have shown that the optimum ammonium removal rate was obtained under the ammonium concentration of 8 mg/L. Moreover, the maximum uptake rate is reported to be achieved at the range of 10–14 mg N/l (Zhang *et al*., 2014). These differences are caused primarily by the different culture conditions of duckweed as well as the difference in the operational settings of the experiments (Oron *et al*., 1988).

On contrary, the duckweed led to an increase in nitrite (NO_2-N) and nitrate (NO_3-N) mg/l concentrations. This can be attributed to, firstly, duckweed preferentially absorbs ammonia rather than nitrate (El-Shafai *et al*., 2007), secondly, duckweed improves the levels of DO in the water ponds that could stimulate nitrifying bacteria growth and subsequently the nitrification process. Ferdoushi *et al*. (2008) and Velichkova and Sirakov (2013) investigated the impact of aquatic plants (*Lemna*, *Wolffia*) as bio-filters in RAS fish ponds, and found that the quantity of dissolved oxygen was higher in the pond treated with duckweed plants. Ondok *et al*. (1984) and Zhang *et al*. (2014) also reported that duckweed oxygenate the water very effectively and finally, results in nitrate formation. Velichkova and Sirakov (2013) concluded that the higher DO in the duckweed treated RAS stimulates the growth of nitrobacter bacteria, which in turn increase the nitrification process. However, overall decrease in dissolved inorganic nitrogen (DIN) at 400DW treatment, because the decrease in ammonia was higher than the increase of both nitrite and nitrate, indicating that the duckweed harnesses and directly consumes the total ammonium in its growth.

Nevertheless, duckweed treatments (400 DW & 200 DW) increased the dissolved organic nitrogen concentration and this may be as a result of higher fry production in comparison with control. Velichkova and Sirakov (2013) found that *Lemna* and *Wolffia* as biofilter in RAS significantly increase the growth of the cultivated carp's fingerlings.

The duckweed (400 DW) treatment reduced particulate N, this can be attributed to a decrease in chlorophyll "a" and total suspended solids (TSS) mg/l in comparison with control. This is in consistence with Abou-El-Kheir *et al*. (2007) who reported that aquatic plants when acts as biological filters are very effective in the eliminating suspended solids and algal abundance. Moreover, Azeez and Sabbar (2012) and Velichkova and Sirakov (2013) reported that phytoremediation using duckweed significantly decrease the quantity of total dissolved solids.

The same tendency was found, even much better expressed, for total N total phosphorus and particulate phosphorus, where 400DW treatment efficiently reduced their levels in comparison with control. Similar results were reported by Velichkova and Sirakov (2013). Our results are also in agreement with those of Boyd and Queiroz (1997) who stated that aquatic plants in biofilter systems are able to remove 97% of the phosphorus compound in the water.

The duckweed led to a decrease in the chlorophyll "*a*" (µg/l) concentration. Our results are in confirmation with Abou El-kheir *et al*. (2007) who reported that duckweed treatment system caused a continuous gradual decrease in chlorophyll-*a* concentration with prolonged treatment periods. Also, Steen *et al*. (2000) stated that, the algal concentration in the algal ponds was reduced by the intermediary duckweed ponds in the integrated system. This may be due to duckweed fiercely competed for nutrients as the duckweed mat effectively reduced sunlight transmission, thereby reducing photosynthesis by algae (Hammouda *et al*. 1995).

In general, our results are compatible with that of different researches investigated the possibility of aquatic plant to be used for phytoremediation (Wang *et al*., 2002; Goulet *et al*., 2005 and Stout and Nusslein, 2005). As the decrease of chlorophyll "a" is an indication of the efficiency of duckweed to sequester nutrients from water that in its turn reduce the growth of algae.

Duckweed growth performance:

Xu and Shen (2011) mentioned that the total biomass harvested was 5.30 times folds of the starting amount, while in the present study the total biomass harvested was 3.2 times folds of the starting amount at 400DW treatment. This may be due to the lower nutrient concentrations than that adequate for duckweed growth as well as to the lower initial stocking of duckweed at the present study. Zhang *et al*. (2014) reported that the nitrogen concentrations between 1 and 5 mg/l had no significant influence on the growth rate of duckweed; hence it is adequate to support duckweed growth. In the present study the total dissolved N concentration was less than 1 mg/l, so, duckweed growth rate was lower than that reported in the other studies. Also, Landolt and Kandeler (1987) reported that *Lemna* sp. requires high phosphorus concentrations to grow in water. Under favorable conditions duckweed have been reported to double their biomass every 16 to 48 hours (Leng, 1999).

Stocking duckweed with a rate of about ~20 (18.18 g duckweed fresh weight /m^2; 400 DW/pond treatment), not only, effectively improved the environment of the *O. niloticus* concrete hatching ponds, but also positively affected fry production, where each g of duckweed enhance and contribute to produce 16.43 fry/pond/harvest cycle or increase the fry production by 62-106 fry/female every 15 days in comparison with the 0DW control treatment. Moreover, Pearson correlation coefficients proved a well positive relationship between the presence of duckweed and Nile tilapia fry production. Velichkova and Sirakov (2013) recorded that the utilization of two macrophytes (*Lemna* and *Wolffia*) as a biofilter in RAS significantly increased the growth of the cultivated carp’s fingerlings. Sirakov *et al*. (2015) also stated that the better water quality in experimental system, including a filter of zeolites and macrophytic plants, influenced positively the growth of rainbow trout and feed utilization.

In the present study, duckweed produced economic by-product biomass, where each g of duckweed doubled to 3.2 times fold at the end each harvest every 15 days. This biomass can be used in fish feeding. Abou El-kheir *et al*. (2007) and Pandey (2001) reported that duckweed had high nutrient value as a dried biomass; 20 - 31% protein, 0.5 - 2.2% fat, 0.008 - 0.01% vitamin C and 0.003 - 0.007% iron that recommends its use as a food supplement for fish, poultry and cattle. It was also noticed that fish growth was better in a pond in which duckweed was given as a feed (Fasakin *et al*., 1999; Leng, 1999 and Landesman *et al*., 2002).

CONCLUSION

According to the present study, duckweed can be efficiently employed as biofilter within the Nile tilapia (*O. niloticus*) broodstock ponds for reducing nutrients concentrations (N and P). Thus reduces the water contamination and subsequently water consumption in the tilapia hatcheries. Moreover, duckweed stimulates nitrification process through increasing the level of DO, so it helps in avoiding the harmful effect of ammonia. Also duckweed can reduce the level of total suspended solids as well as microalgae within the fish ponds, through competing on nutrients. Furthermore, duckweed increases the *O.niloticus* fry production, which enhances the economic efficiency of tilapia hatcheries. Finally, duckweed itself can be used as feed supplement for fish since it has a high nutritional value. Higher nutrient removal rates can be achieved at higher stocking density than that applied in the present study.

Accordingly, the present study suggesting that this technique can be applied to a wider scale in fish farms and hatcheries specially those use agricultural drainage water to improve water quality as increase sustainbility and subsequently improve the fish production and economic efficiency of farms and hatcheries.

This study also implies that further studies should be done to investigate which duckweed species is more efficient as biofilter and its optimal stocking rate for the highest effective for improving the water quality within the concrete ponds of *O. niloticus* broodstocks and how much is the economic impact of the duckweed production as secondary production.

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عدس الماء كمرشح بيولوجى لمياه مفرخات اسماك البلطى واثره على الإنتاجية

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الملخـــــص العربـــــي

نظرا لندرة المياه المتاحة حاليا للمفرخات والمزارع السمكية تلجأ المفرخات والمزارع السمكية إلى استخدام مياه الصرف الزراعى العالية فى محتواها من المغذيات لذا اجريت هذه الدراسة لإستخدام عدس الماء كمرشح بيولوجى للمياه. أُجريت هذه الدراسة بمفرخ البلطي بالمعمل المركزي لبحوث الثروة السمكية بالعباسة– شرقية، لدراسة تأثير نبات عدس الماء على جودة المياه وآداء الأمهات وإنتاج الزريعة بالإضافة لمحصول عدس الماء. صُنعت ٩ إطارات من الخشب (كل إطار خشبى بمساحة ١ م٢) وبطُنت بشباك لمنع تسرب العدس الى داخل الحوض. أُختيرتسعة أحواض أسمنتية قسمت الأحواض إلى ثلاث مجموعات: أُعتبرت المجموعة الأولى كمعاملة ضابطة (0 DW) بدون عدس ماء، أما المجموعة الثانية وضع بكل حوض منها إطار خشبي واحد فقط (1 frame = 200 g duck weed) (200DW). وبالمقابل وضع بكل حوض من المجموعة الثالثة إطارين خشبيين (2 frames = 400 g duck weed) مع وضع ٢٠٠ جم عدس الماء/ إطار (400DW). زرعت الأحواض بالأمهات (بإجمالى ٦٨ أم/ حوض بنسبة جنسية ١♂ : ٣♀)، بمتوسط وزن ٢٢٥ جم/أم. غُذيت الأسماك بأعلاف صناعية (٣٠ % بروتين) بمعدل ٠.٦% من وزن الأمهات الحى لمدة ١٥ يوم (دورة تفريخ). كُررت هذه المعاملات أربع مرات متتالية مع تسكين أُمهات جاهزة للتفريخ بنفس الأوزان ونفس المعدلات تقريباً فى كل مرة. أُخذت عينات مياه من مصدر الري ومن كل حوض لتقدير مقاييس جودة المياه فى بداية ونهاية كل دورة تفريخ للوقوف على حالة المياه، كما تم تجميع وعد الزريعة مع حصاد عدس الماء ووزنه فى نهاية كل دورة تفريخ. وخلصت النتائج إلى أن: تحميل عدس الماء فى أحواض التفريخ عمل على، ليس فقط، تحسين جودة المياه، بل أيضا، زيادة إنتاج الزريعة زيادة معنوية عن المعاملة الضابطة (0 DW) بالأضافة الى انتاج منتج ثانوي من عدس الماء بمعدل تضاعف ٢.٨١ و ٣.٢ مرات كل ١٥ يوم فى معاملة 200DW ومعاملة 400DW على الترتيب، وساهم كل جم من عدس الماء في زيادة إنتاج الزريعة أكثر من (13.5%) بالمقارنة بالكنترول. بالاضافة الي معامل ارتباط موجب بقيمة (+0.38) بين وجود عدس الماء في الأحواض وإنتاج الزريعة.

وتنصح الدراسة بإستخدام عدس الماء كمرشح بيولوجى للمياه فى مفرخات اسماك البلطى التى تستخدم مياه الصرف الزراعى فى التفريخ لأن ذلك يحسن من انتاجية المفرخات.