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Full Length Article

Performance of Nile Tilapia (*Oreochromis niloticus*) Fingerlings. I. Effect of pH

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ABSTRACT

Nile tilapia (*Oreochromis niloticus*) fingerlings averaging 19.0±1.0 g in weight were stocked for 60 days, at different levels of pH (6, 7, 8 & 9) using 12 glass aquaria (40×70×60 cm). Tilapia were fed with diet containing 26.58% crude protein. Water was changed twice daily with 100% of water size. Growth measurement of tilapia was recorded at 15 days intervals. Blood parameters were recorded at stocking and at the end of the experiment. Results showed that growth performance was significantly (P≤0.05) decreased at pH 6 and 9, while the differences between pH 7 and 8 were not significant (P≥0.05). No mortality occurred during the whole experiment. Feed conversion ratio (FCR) increased at pH 6 and 9, since its value at the pH 6 was significantly (P≤0.05) higher than pH 9. Decreasing pH resulted in decreased hematocrit and hemoglobin values, while differences were not significant (P≥0.05) from control in pH 7, 8 and 9. It was concluded that water pH 7-8 could be more suitable to tilapia culture for optimum growth performance and survival rate.

Key Words: Nile tilapia; pH; Performance; Survival rate; Hematology

INTRODUCTION

More than half of world's population depends on fish as a principal source of animal protein (Corpei, 2001). Tilapia is an important food fish in many tropical areas of Africa, America and Asia. Many species of tilapia have been cultured in developing countries, where animal protein is lacking. Tilapias are considered suitable for culture, because of their high tolerance to adverse environmental conditions, their relatively fast growth and the ease with which they can breed, good utilization of artificial diets, resistance to disease, excellent quality of its firmly textured flesh and finely appetizing fish to consumers (Corpei, 2001). De Croux *et al.* (2004) showed the acute lethal effects of elevated pH on *C. macropomum* juveniles. They found no mortality at pH 6 (control) and 7 but it was 10-20% at pH 8 and 100% at pH 9. The lethal effects of elevated pH are recognized as a potential factor contributing to the variable success of tambaqui production. Therefore, the present study was planned to investigate the effect of different levels of pH on growth performance and some blood parameters of Nile tilapia (*Oreochromis niloticus*) fingerlings.

MATERIALS AND METHODS

This study was carried out at the indoor wet lab of Animal Production and Fish Resources Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt, in order to evaluate the effect of different pH levels on growth performance, survival rate and some physiological parameters of Nile tilapia (*O. niloticus*).

Experimental fish. Nile tilapia (*O. niloticus*) fingerlings with mean average weight of 19.0±1.0 g and 10.0±0.30 cm of length were obtained from Fish Research Center, Suez Canal University, Ismailia, Egypt. Fish were homogenous in size, body weights and apparently healthy. They were fed on the same diet used in this study for 1 week, prior to adapt them for the experimental conditions.

Experimental aquaria. Twelve glass aquaria (40×70×60 cm) with capacity of 60 l water were used for rearing the *O. niloticus* fingerlings. De-chlorinated water in aquaria were aerated by a constant supply of compressed air pump and were exchanged twice daily (Randall, 1976) with 100% of the water volume from each aquaria and replaced with fresh water, before morning feeding.

Experimental design. This experiment was devoted to study the effect of pH on blood parameters and growth performance of *O. niloticus*. The fish (*O. niloticus*) were stocked at four different levels of pH i.e., 6, 7, 8 and 9, three replicates for each treatment. Sodium hydroxide solution was added gradually into the water to increase the pH values to 8 and 9 (Xu *et al.*, 2005) and HCL was used to obtain pH 6 and 7 (Randall, 1976). Tilapia were stocked for 60 days at a rate of 14 fish per aquarium.

Experimental diet. Commercial diet was purchased from (El Bardeny Company, Egypt) in pellets size 2 mm, containing 26.58% crude protein according to Jauncey and

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Ross (1982). The diet was stored in a refrigerator (4°C) during the experimental duration to avoid the nutrients deterioration.

Feeding regime. The daily feeding rate was 3% of the total stocking biomass. The Feed quantity was readjusted at the beginning of each next two weeks, according to the actual body weight of the fish in each aquarium. Tilapia fish were fed the experimental diet three times daily. Feeding rates were assigned to a particular range of wet weight according to NRC (1993).

Blood measurements. To determine the effect on hematocrit value and hemoglobin concentration, blood was obtained from the fish after they were immobilized by a sharp blow to the head. The caudal peduncle was severed immediately posterior to the adipose fin, and blood was collected from the caudal vessels in a heparinized capillary tube (Tomasso *et al.,* 1980). Hematocrit was measured by a microhematocrit centrifuge at 1500 rpm for 15 min and hemoglobin was determined using a spectrophotometer by method described by Vankamlen (1961).

Growth parameters. The following parameters were used to evaluate tilapia growth performance (De-Silva & Anderson, 1995): Body weight gain (BWG)=W_1–W_0, average daily body weight gain (ADG), expressed as weight gained per fish per day=(W_1–W_0)/t. Specific growth rate (%/day): SGR=(Ln W_1–Ln W_0)×100/t. feed conversion ratio: FCR=Df/(W_1–W_0). Survival rate (%): SR=Ni×100/N0 (Harrell *et al.*, 1990).

Where: W_1 = Final wet weight (g); W_o = Initial wet weight (g). t=Time interval in days. N_i=Number of fishes at the end. N_0=Number of fishes initial stocked. Df=Dry feed intake (g).

Statistical analysis. The data obtained in this study were analyzed by one-way ANOVA Procedure of Statistical Analysis System (SAS, 1988). Means were compared by Duncan's new multiple range test (Zar, 1996).

RESULTS AND DISCUSSION

Mean individual body weights. It was observed that the initial average weight of fingerlings at the beginning of the experiment was 19±1.0 g for all levels of pH (Table I). The final average body weight at the end of the experimental period (after 60 days of stocking) showed great differences among different pH levels with a decrease at low pH. No mortality occurred in any of the experimental groups throughout the experimental period. The level of pH 7 showed the highest body weight (36.1 g) followed by pH 8 (35.1 g), then pH 9 (30.8 g) and finally pH 6 (23.3 g). It could be concluded that the average individual body weights of tilapia observed in the experimental groups pH 7 and 8 were found to be the best. This is in agreement with the findings of Saber *et al.* (2004), Atle *et al.* (2004) and Xu *et al.* (2005). Also, Saha *et al.* (2002) and Scott *et al.* (2005) found that ammonia excretion increased with increasing pH (alkalinity), while growth decreased. It was attributed to a decrease in feed consumption. This was in agreement with the present results. Moreover, Mabaye (1971) found growth reduction at low pH levels, which attributed to a decrease in feed consumption. The differences among the mean weight of Nile tilapia obtained from pH levels 6, 8 and 9 were significant (P≤0.05), but it was not significant (P≥0.05) between pH 7 and 8.

Mean body weight gain. The averages of body weight gains were 0.5, 3.0, 2.8 and 2.0 g $fish^{-1}$ in the first 15 days (Table II) and then gradually reaching 1.8, 5.8, 5.4 and 4.1 g $fish^{-1}$ at the end of the experimental period for pH levels of 6, 7, 8 and 9, respectively. The data also indicated that the mean weight gain decreased with increasing pH; whereas, it decreased at pH 6. These results supported Saber *et al.* (2004), Willingham *et al.* (2004) and Scott *et al*. (2005). The decrease in growth at pH 6 was attributed to a decrease in feed consumption. There were significant differences (P≤0.05) among pH levels (6, 8 & 9) but no significant difference (P≥0.05) was found between pH 7 and 8.

Average daily body weight gain (ADG). The averages of body weight gain per tilapia per day were 0.03, 0.2, 0.19 and 0.13 g for groups exposed to pH levels 6, 7, 8 and 9, respectively during the first 15 days (first period) (Table III). The average daily weight gain of tilapia gradually reached its maximum of 0.12, 0.39, 0.36 and 0.27 g at the end of the experimental period at pH 6, 7, 8 and 9, respectively. It can be concluded that there were differences in the average daily body weight gain of tilapia at different pH levels. The gain per fish per day decreased as the pH value increased and the best body weight gains were achieved at pH 7 and 8, respectively. Similar results were obtained by Scott *et al.* (2005) and Xu *et al.* (2005). On the other hand, Robert and William (1986) found that in channel catfish, excretion of ammonia at pH 6 increased; whereas, it decreased with increased pH. There were significant differences (P≤0.05) among the average daily body weight gains of tilapia at the different pH values; while, the difference was not significant (P≥0.05) between pH 7 and 8.

Average feed consumption. Average feed consumption at pH 6, 7, 8 and 9 were 8.7, 9.9, 9.8 and 9.4 g, respectively during the first 15 days of the rearing (Table IV). Thereafter, average feed consumption gradually reached 10.4, 16.2, 15.7 and 13.8 g for the exposed groups to pH 6, 7, 8 and 9, respectively. It can be stated that the average feed consumption reached its maximum value at pH 7 and 8. Similar results were obtained by Saber *et al.* (2004) and Willingham *et al.* (2004) who obtained best feed consumption at pH 7.2–7.9. It could be concluded that the average feed consumption of Nile tilapia varied by varying pH levels. Data also indicated that the average feed consumption decreased as the level of pH increased. Moreover, low feed consumption at pH 6 may be attributed to the decrease of fish ability to feed consumption. The differences among pH levels 6, 8 and 9 were significant (P≤0.05). But the difference between pH 7 and 8 was not significant (P≥0.05). This was in full agreement with that found by Saber *et al.* (2004).

Table I. Effect of different levels of pH on mean individual body weight of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
0	19.0 ± 1.0 [a]	19.0 ± 1.0 [a]	19.0 ± 1.0 [a]	19.0 ± 1.0 [a]
15	19.5 ± 0. 95 [c]	22.0 ± 0.68 [a]	21.8 ± 0.41 [a]	21.0 ± 1.12 [b]
30	20.3 ± 0. 95 [c]	25.7 ± 0.68 [a]	25.3 ± 0.43 [a]	23.5 ± 1.07 [b]
45	21.5 ± 0. 94 [c]	30.3 ± 0.68 [a]	29.7 ± 0.46 [a]	26.7 ± 1.02 [b]
60	23.3 ± 0. 94 [c]	36.1 ± 0.69 [a]	35.1 ± 0.49 [a]	30.8 ± 1.01 [b]

Means with the same letter in each row are not significantly different (P≤0.05)

Table II. Effect of different levels of pH on average body weight gain (g /individual fish) of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
15	0.5 ±0.008 [c]	3.0 ± 0.02 [a]	2.8 ± 0.03 [a]	2.0 ± 0.09 [b]
30	0.8 ± 0.005 [c]	3.7 ± 0.06 [a]	3.5 ± 0.03 [a]	2.5 ± 0.06 [b]
45	1.2 ± 0.003 [c]	4.6 ± 0.06 [a]	4.4 ± 0.03 [a]	3.2 ± 0.06 [b]
60	1.8 ± 0.003 [c]	5.8 ± 0.06 [a]	5.4 ± 0.03 [a]	4.1 ± 0.01 [b]

Means with the same letter in each row are not significantly different (P≤0.05)

Table III. Effect of different levels of pH on average daily body weight gain (g/individual fish) of Nile tilapia fingerlings reared in aquaria for 60 days (mean±SE)

Rearing period (day)	pH of medium 6	7	8	9
15	0.03 ± 0 [c]	0.2 ± 0.003 [a]	0.19 ± 0 [a]	0.13 ± 0.006 [b]
30	0.05 ± 0 [c]	0.25 ± 0.006 [a]	0.23 ± 0.003 [a]	0.16 ± 0.003 [b]
45	0.08 ± 0 [c]	0.31 ± 0.003 [a]	0.29 ± 0 [a]	0.21 ± 0 [b]
60	0.12 ± 0 [c]	0.39 ± 0.003 [a]	0.36 ± 0 [a]	0.27 ± 0 [b]

Means with the same letter in each row are not significantly different (P≤0.05)

Table IV. Effect of different levels of pH on average feed consumption (g/individual fish) of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
15	8.7 ± 0.43 [c]	9.9 ± 0.31 [a]	9.8 ± 0.18 [a]	9.4 ± 0.50 [b]
30	9.1 ± 0.42 [c]	11.6 ± 0.31 [a]	11.4 ± 0.20 [a]	10.5 ± 0.48 [b]
45	9.6 ± 0.43 [c]	13.6 ± 0.31 [a]	13.4 ± 0.21 [a]	12.0 ± 0.46 [b]
60	10.4 ± 0.42 [c]	16.2 ± 0.31 [a]	15.7 ± 0. 22 [a]	13.8 ± 0.45 [b]

Means with the same letter in each row are not significantly different (P≤0.05)

Specific growth rate (SGR). The SGR values of tilapia in all treatments were initially low and then gradually increased throughout the experimental period of 60 days (Table V). In the same time, the SGR of tilapia was influenced by varying treatments and the size of fish. The results showed that the SGR values of tilapia at the end of the experimental period were increased by 0.53, 1.16, 1.11 and 0.95% for the groups under pH 6, 7, 8, and 9, respectively. The differences among pH levels (6, 7, 8 & 9) for the SGR of tilapia were significant (P≤0.05); whereas, it was non significant (P≥0.05) between pH 7 and 8. These results supported Atle *et al.* (2003, 2004)

Table V. Effect of different levels of pH on average specific growth rate (%/day) of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
15	0.17 ± 0.024 [c]	0.97 ± 0.026 [a]	0.91 ± 0.012 [a]	0.66 ± 0.068 [b]
30	0.26 ± 0.021 [c]	1.04 ± 0.030 [a]	0.99 ± 0.009 [a]	0.74 ± 0.049 [b]
45	0.38 ± 0.019 [c]	1.09 ± 0.026 [a]	1.06 ± 0.007 [a]	0.85 ± 0.046 [b]
60	0.53 ± 0.015 [c]	1.16 ± 0.020 [a]	1.11 ± 0.007 [a]	0.95 ± 0.028 [b]

Means with the same letter in each row are not significantly different (P ≤0.05)

Table VI. Effect of different levels of pH on average feed conversion ratio (g food/g weight gain) of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
15	17.4 ± 0.55 [a]	3.3 ± 0.18 [c]	3.5 ± 0.042 [c]	4.7 ± 0.55 [b]
30	11.3 ± 0.44 [a]	3.1 ± 0.19 [c]	3.2 ± 0.039 [c]	4.2 ± 0.39 [b]
45	8.0 ± 0.42 [a]	2.9 ± 0.17 [c]	3.0 ± 0.037 [c]	3.7 ± 0.35 [b]
60	5.7 ± 0.42 [a]	2.7 ± 0.15 [c]	2.9 ± 0.037 [c]	3.3 ± 0.23 [b]

Means with the same letter in each row are not significantly different (P≤0.05)

Table VII. Effect of different levels of pH on average PCV(%) values of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
0	25.0 ±1.67 [a]	25.1 ± 1 [a]	24.5± 0.12 [a]	24.5 ± 1.67 [a]
60	22.3 ± 2.60 [c]	25.5 ± 1.03 [a]	24.2 ± 0.23 [b]	24.1± 2.54 [b]

Means with the same letter in each row are not significantly different (P≤0.05)

Table VIII. Effect of different pH levels on average concentration of Hb (g 100 mL^{-1}) of Nile tilapia fingerlings reared in aquaria for 60 days (mean ± SE)

Rearing period (day)	pH of medium 6	7	8	9
0	7.5 ± 0.06 [a]	7.5 ± 0.06 [a]	8.0 ± 1.1 [a]	7.6 ± 0.07 [a]
60	5.8 ± 0.03 [b]	7.4 ± 0.75 [a]	7.8 ± 0.94 [a]	7.1 ± 0.36 [a]

Means with the same letter in each row are not significantly different (P≤0.05)

and Saber *et al.* (2004) who reported that the best SGR were at pH 7 and 8 and there was no significant difference (P≥0.05) between them.

Feed conversion ratio (FCR). The feed conversion ratios recorded as 5.7, 2.7, 2.9 and 3.3 at pH levels 6, 7, 8 and 9, respectively (Table VI). The mean feed conversion ratio of tilapia increased as pH levels differ than the pH 7. This may be due to a decrease in feed consumption at low pH, since the FCR achieved at pH 9 was significantly higher (P≤0.05) than that achieved in pH 7 and 8 being 3.3, 2.7 and 2.9, respectively as reported by Scott *et al*. (2005).

Hematocrit value (PCV%). Hematocrit value at the end of the experimental period was 22.3, 25.5, 24.2 and 24.1% for the groups of pH 6, 7, 8 and 9, respectively (Table VII). The

average hematocrit value in the experimental groups was not different from the control. Similar results were obtained by Milda and Nijole (2004). Also, it decreases at pH 6 as feed consumption decreased with appearance of anemia. It can be reported that, at pH 7 and 8, there were no significant ($P \geq 0.05$) differences from control. It was in agreement with Robert *et al.* (1984). Significant differences ($P \leq 0.05$) were obtained among the pH 6, 7, 8 and 9, but the difference was not significant ($P \geq 0.05$) between pH 8 and 9.

Hemoglobin concentration (Hb). The Hb concentration at the end of the experimental period was 5.8, 7.4, 7.8 and 7.1 (g 100 mL^{-1}) for the treated fish at pH 6, 7, 8 and 9, respectively (Table VIII). The average Hb concentration in the experimental groups at pH 7, 8 and 9 was not different from control (Pratap *et al.,* 2004). Also the average Hb concentration decreased at pH 6. It could be attributed to decrease in feed consumption. It can be concluded that there were no significant differences ($P \geq 0.05$) among average Hb in pH 7, 8 and 9, while there were significant differences ($P \leq 0.05$) at pH 6, 7, 8 and 9.

CONCLUSION

It could be concluded that Nile tilapia fingerlings with average initial weight of 19.0±1.0 g, were more suitable to culture at water pH level 7-8 for optimum growth performance and survival rate than other water conditions. Therefore, it can be recommended to be carried out under similar experimental conditions.

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