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# EFFECT OF PH ON SURVIVAL, GROWTH, FEED UTILIZATION, HEMATOLOGICAL AND HISTOLOGICAL RESPONSE IN RED TILAPIA (*OREOCHROMES NILLOTICUS* X *OREOCHROMES AUREUS)* FINGERLINGS

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## ABSTRACT

One hundred fish of red tilapia (*O. niloticus X O. aureus*) fingerlings averaging 7.33 ± 0.57g in weight, 10 fish / aquarium (40 x 70 x 60 cm). The pH levels tested were 2, 3, 5, 9 and the control (7.53) for a period of 30 days. When red tilapia subjected to water pH 2 treatment the fish were die out after 24 hours, but when red tilapia subjected to water pH 3 the fish were die out after 36 hours from the beginning of the experiment. The survival of fish subjected to water pH 9 was 95% and to water pH 5 (85%). The growth rate of fish at pH 5 (1.2±0.3) g/fish compared to the control group 2.0±0.40 g/fish, it was noted that the feed conversion ratio was less in water pH 5 and 9 treatments as compared to the control group. Analysis of the blood samples shows that significant differences ($p \leq 0.05$) for red blood cells count and the hemoglobin values in fish subjected to water pH 9 treatments was very close to the control group. But the highest value in the analysis of serum urea was recorded at pH 5 however this treatment recorded minimum values in the analysis of serum uric acid, serum total protein and serum creatinine compared to the control group. The analysis of blood sugar shows significantly decrease in treatments pH 5 and 9 compared to the control group. Microscopic examination of histological sections in each of kidney and liver for fish was found that there had been light damage in these organs compared to the control group. This damage was reflected in the growth and productivity of these fish. We are recommend that red tilapia fingerlings cannot be cultured at pH levels of 2 or 3, where lead to deaths of these fish. Could farming of red tilapia fingerlings under the levels of acidity and alkalinity ranged between 5 to 9 without a significant effect on the productivity and physiological parameters of these fish.

**Key Word:** Growth, Feed Utilization, Histological, Red Tilapia (*Oreochromes Nilloticus* X *Oreochromes Aureus).*

## INTRODUCTION

The pH of waters is important to aquatic life because the pH of water affects the normal physiological functions of aquatic organisms, including the exchange of ions with the water and respiration. Such important physiological processes operate normally in most aquatic biota under a relatively wide pH range (6-9 pH units) **(Ghazy *et al.*, 2011). Alabaster and Lloyd (1980)** identified the pH range that is not directly lethal to fresh water fish as 5-9. With few exceptions, pH values between 6.5 and 9 are satisfactory, on a long-term basis, for fish and other freshwater aquatic life. The pH of most inland fresh waters containing fish ranges from about 6 to 9, with most waters, particularly those with healthy, diverse, and productive fish and macro-invertebrates communities having a pH between approximately 6.5 and 8.5 units **(NAS, 1972).**

The sensitivity of aquatic organisms to pH changes can vary significantly among

aquatic ecosystems. The change of pH in water bodies may be due to acidic rain or anthropogenic NaOH spills.

NaOH is a very high production volume compound (estimated world-wide demand about 44 million tons), used for several industrial and domestic purposes.

Due to emission patterns, chemical properties (high solubility, low vapor pressure), environmental fate properties (rapid neutralization and wash-out in the atmosphere, neutralization in soil) it is expected to be present in significant amounts only in water, where it is ionized in Na+ and OH- **(Ghazy et al., 2011).**

On the other hand, acid rain occurs when pollution in the atmosphere (sulfur dioxide and nitrogen oxide) is chemically changed and absorbed by water droplets in clouds. When there is precipitation, the droplets fall to earth as rain, snow or sleet. The polluting chemicals in the water droplets form an acid by combining with the hydrogen and oxygen in the water. These acidic droplets (pH < 5) can increase the acidity of the soil and affect the chemical balance of lakes and streams. It also contributes to acidification of rivers and streams **(Ghazy et al., 2011).**

The acute toxicity of pH on decapod crustaceans has been studied in several species of crayfish **(Morgan and McMahon 1982; France 1984; Distefano *et al.* 1991)** and tiger shrimp Penaeus monodon (**Allan and Maguire, 1992).** Low pH water has been reported to cause retarded growth in **P. monodon (Allan and Maguire, 1992),** disturbed ion regulation in crayfish and tiger shrimp (**Morgan and McMahon, 1982; Allan and Maguire, 1992)** and acid–base imbalance in crayfish and freshwater prawn (**Chen and Chen, 2003).**

In rainbow trout, exposure to highly alkaline conditions (pH > 9.5) causes severe physiological disturbances, including blood alkalosis, inhibition of Na+ influx, impairment of branchial ammonia excretion and a decrease in swimming speed **(Wright and Wood, 1985; Ye, 1986)**.

It is unusual, therefore, that a species of teleost fish, Oreochromis alcalicus grahami, is able to thrive in water of pH 10. **(Wright *et al.,* 1990)** reported that O. a. grahami produces urea by the ornithine-urea cycle and excretes all nitrogenous wastes as urea **(Randall et al., 1989; Wood et al., 1989),** presumably enabling the fish to survive in alkaline water.

Exposure to water of pH 7 will present a number of physiological problems to O. a. grahami. By reducing the pH of water, the total $CO_2$ concentration will also be reduced as $HCO_3$- is titrated to form $CO_2$, which is then removed from solution by aeration.

In neutral water, therefore, the tilapia will be exposed to a reversal of both the $H^+$ and $HCO_3^-$ gradients**. Reite *et al.*(1974)** reported the pH tolerance of O. a. grahami to be between 5 and 11. The aim of this study was to determine the effects of pH levels of water on survival, growth, feed utilization, hematological and histological response in red tilapia fingerlings.

## MATERIALS AND METHODS

Red tilapia were obtained from the Mariculture research center (MRC), El-Arish, North Sinai, Egypt; and acclimatized in the laboratory for 2 weeks before the experiment.

Artesian well water was used and considered as control (pH = 7.53). It was adjusted twice daily (09:00 and 13:00 hrs.) to pH levels of 2.0, 3.0, 5.0, and 9.0 with 0.1 M $H_2SO_4$ and 0.1 N NaOH.

SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol.: (2) Is.: (2), Aug. 2013

The control was not adjusted and varied by 7.53 ± 0.04 throughout the experiments.

Hundred red tilapia fingerlings had an average length 7.19 ± 0.29 cm and mean body weight 7.33 ± 0.57g were held in duplicates glass aquaria (40 x 70 x 60 cm) with capacity of 50 L. and faeces sediments removed by siphon and one-fifth of the water were changing every day with clean water. The water was changed completely every 7 days and aeration was adopted.

Fish were fed diet in pelleted form 35% protein at a rate of 3% of total biomass every day in two equal portions at 10:00 and 16:00 hrs. The fish were weighed every 7 days for ration adjustment.

Upon exposure to selected pH levels, survivors and dead fish were counted after 1, 2, 3, 12 and 24 hrs, and after 2 and 3 days and recount every 3 days thereafter for a total of 30 days. Dead fish were identified by lack of any reaction when touched with a glass rod removed from the water tanks. Hematological parameters

Red blood corpuscles (RBCs) were counted visually according to the method of **Dacie and Lewis (1991).**

Hemoglobin concentration was determined according to method of **Drabkin and Austin (1932).** Hematocrit value was determined according to the method of **Rodak (1995)** using heparinized capillary tubes.

**Biochemical parameters:**

Serum total protein was determined according to method of **Doumas (1975)**. Blood glucose was determined according to the enzymatic colorimetric method **Tietz (1986).** Serum urea enzymatic was determined as described by **Patton and Crouch (1977).**

Serum uric acid was determined according to method of **Young (1995).** Serum creatinine was determined as mentioned method of **Henry (1974).**

**Histological examinations by light microscopy:**

At the end of each experiment, the livers, kidneys and muscles were removed from the fish in isotonic saline solution, after which, they were fixed in Bouin's solution for about 24 hr.

The specimens were then preserved in 70% ethyl alcohol, dehydrated in graded series of alcohol, cleared in xylene and embedded in paraffin wax as usual. Sometimes, tyrpinol was used for clearing and showed best results. Sections of 4-6 µ thickness were mounted on chemically clean glass slides.

The specimens were then preserved in 70% ethyl alcohol, dehydrated in graded series of alcohol, cleared in xylene and embedded in paraffin wax as usual. Sometimes, tyrpinol was used for clearing and showed best results. Sections of 4-6 µ thickness were mounted on chemically clean glass slides.

The sections were prepared then stained with Harri's Haematoxylin and Eosin (Hx and E) according to **Pearse (1972).**

**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 ranges test **(Duncan, 1955).**

## RESULTS

**1. Water quality parameters:**

Results of water temperature (°C), water salinity (ppt), dissolved $O_2$ (mg/l)

and total ammonia nitrogen (TAN) (mg/l) of red tilapia (O. niloticus X O. aureus) fingerlings at different pH water values Table (1) indicated that significantly deference ($P \leq 0.05$) was observed between treatments with the minimum value recorded for water (pH 5) treatment and the maximum value for water (pH 9) treatment.

**2. Survival (%):**

Survival (%) of red tilapia fingerlings kept in water of different pH: 2.0, 3.0, 5.0, control (7.53) and 9.0 are shown in Table (2) throughout first three days. There was gradually mortality in pH 2.0 treatment in 1 hr, to 12 hrs, where total mortality was occurred in first day.

**Table (1): Means ± SD of water quality parameters during the experimental periods (30 days) of rearing for red tilapia (*O. niloticus* X *O. aureus*) fingerlings at different pH water levels.**

| Items | pH levels * | | |
|---|---|---|---|
| | Control (7.53) | 5 | 9 |
| Temperature(°C) | 25.80 [a] ±0.36 | 25.43 [a] ±0.85 | 25.65 [a] ±0.91 |
| Salinity (ppt) | 21.60 [a] ±0.08 | 21.35 [a] ±0.15 | 21.55 [a] ±0.06 |
| pH | 7.53[b] ±0.04 | 5.09[c] ±0.05 | 9.04[a] ±0.05 |
| Dissolved $O_2$ (mg/l) | 6.74[a] ±0.63 | 6.93[a] ± 0.58 | 6.94[a] ±0.56 |
| TAN (mg/l) | 2.41[a] ± 0.31 | 2.48[a] ± 0.15 | 2.45[a] ± 0.41 |

*Values in rows having the same superscript letters are not significantly different ($P \geq 0.05$).

While in pH 3.0 group mortality increased from 2 hrs, to 12 hrs, where total mortality was achieved after 12 hrs. Survival (%) of 100% in pH 5.0, 9.0 and control (7.53) were observed respectively Table (2). Survival (%) of red tilapia fingerlings kept in water of different 2.0, 3.0, 5.0, control (7.53) and 9.0 are shown in Table (2) throughout rearing period (30 days). Results indicated that the highest survival was recorded with control (100%). While the lowest was recorded with pH 5.0 treatment (85%).

**3. Growth performance:**

The effects of pH levels on Red Tilapia, initial weight (g), final weight (g) and average gain in weight (g) after 30 days of rearing are presented in Table 4. It is evident that there were no significant differences in initial weight for the pH levels tested ($P < 0.05$), at the beginning of the experiment.

At the end of the experiment average weight affected significantly ($P < 0.05$) by pH levels. The highest average final weight of weight of fish was recorded with the control group (pH = 7.53) and the lowest recorded with the pH 9. While at pH 5 fish were moderate comparison with control treatment Table (3).

An average gain in weight was pH affected significantly ($P < 0.05$) by pH levels. The control group (pH = 7.53) and the fish reared at pH 5 were grows faster than fish reared at pH 9.

The effects of pH levels on relative gain in weight (%), specific growth rate (%/day) and condition factor (K) after 30 days are presented in Table (3).

Analysis of variance were obtained revealed that no affected significantly ($P \geq 0.05$) between control group and pH 5 for relative gain in weight (%) and specific growth rate (%/day) by pH levels. While these were affected significantly for condition factor (K) between groups.

SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol. (2) Is.: (2), August 2013.

## 4. Feed utilization:

The effects of pH levels on feed conversion ratio (FCR), feed efficiency ratio (FER), protein efficiency ratio (PER) and feed intake (g/fish) after 30 days are presented in Table (4).

The best results of feed intake, FCR, FER and protein intake were obtained at the pH level of control (7.53). The lowest feed intake, FCR, FER and protein intake were obtained at pH 9.

There was no significant between pH 5 and pH 9 in terms of feed utilization (FCR and FER).

## 5. Hematological parameters:

Data in Table (6) shows means of red blood corpuscles (RBCs) (cell/mm$^3$), hemoglobin value (g/dl) and hematocrit (Hct) values (%) for red tilapia (*O. niloticus* X *O. aureus*) fingerlings after 30 days of rearing at different water pH levels with significantly deference ($P \leq 0.05$) between treatments, the minimum values was recorded for the pH5 treatment And the maximum values for the control treatment.

## 6. Biochemical parameters:

Results of means of serum urea (mg/dl) of red tilapia fingerlings (*O. niloticus* X *O. aureus*) at different pH levels indicate significantly deference ($P < 0.05$) between treatments with the minimum value was recorded for control and the maximum value for (pH water 5) treatment (Table 7).

Means of serum uric acid (mg/dl), serum creatinine and total protein (g/dl) shows significantly deference ($P < 0.05$) between treatments was observed with the minimum value was recorded for (pH water 5) treatment and the maximum value for control Table (7).

**Table (2): Means of survival and dead for red tilapia (*O. niloticus* X *O. aureus*) fingerlings at 1, 2, 3, 12 and 24 hrs. throughout first 3 days.**

| Day | Hours | pH level | | | | |
|---|---|---|---|---|---|---|
| | | Control (7.53) | 2 | 3 | 5 | 9 |
| 1st | 1 | --- | 3 | --- | --- | --- |
| | 2 | --- | 5 | --- | --- | --- |
| | 3 | --- | 7 | --- | --- | --- |
| | 12 | --- | 5 | --- | --- | --- |
| | 24 | --- | --- | --- | --- | --- |
| 2nd | 1 | --- | --- | 2 | --- | --- |
| | 2 | --- | --- | 5 | --- | --- |
| | 3 | --- | --- | 10 | --- | --- |
| | 12 | --- | --- | 3 | --- | --- |
| | 24 | --- | --- | --- | --- | --- |
| 3rd | 1 | --- | --- | --- | --- | --- |
| | 2 | --- | --- | --- | --- | --- |
| | 3 | --- | --- | --- | --- | --- |
| | 12 | --- | --- | --- | --- | --- |
| | 24 | --- | --- | --- | --- | --- |
| Total fish | | 20 | 20 | 20 | 20 | 20 |
| Mortality | | 0 | 20 | 20 | 0 | 0 |
| Survival | | 20 | 0 | 0 | 20 | 20 |
| Survival% | | 100 | 0 | 0 | 100 | 100 |

**Table (3): Means of survival and dead for red tilapia (*O. niloticus* X *O. aureus*) fingerlings within rearing period (30 days) every 3 days.**

| | pH level | | |
|---|---|---|---|
| **Day** | **Control (7.53)** | **5** | **9** |
| 3 | --- | 1 | --- |
| 6 | --- | 1 | --- |
| 9 | --- | --- | --- |
| 12 | --- | --- | 1 |
| 15 | --- | --- | --- |
| 18 | --- | 1 | --- |
| 21 | --- | --- | --- |
| 24 | --- | --- | --- |
| 27 | --- | --- | --- |
| 30 | --- | --- | --- |
| Total fish | 20 | 20 | 20 |
| Mortality | 0 | 3 | 1 |
| Survival | 20 | 17 | 19 |
| Survival% | 100 | 85 | 95 |

**Table (4): Means ± SD of growth performance of red tilapia (*O. niloticus* X *O. aureus*) fingerlings at different pH water levels (after 30 days).**

| * pH levels / Items | Control (7.53) | 5 | 9 |
|---|---|---|---|
| Initial body weight (g/fish) | $7.80^{a}$± 0.20 | $7.15^{a}$± 0.15 | $7.05^{a}$± 0.65 |
| Final body weight (g/fish) | $9.80^{a}$± 0.20 | $8.35^{b}$± 0.15 | $7.07^{c}$± 0.37 |
| Body gain in weight (g/fish) | $2.00^{a}$± 0.40 | $1.20^{b}$± 0.30 | $0.02^{c}$± 0.28 |
| Relative gain in weight **%** | $25.64^{a}$± 0.79 | $16.78^{a}$± 0.55 | $0.28^{b}$± 0.032 |
| Average daily gain in weight (g/fish) | $0.07^{a}$± 0.013 | $0.040^{b}$± 0.010 | $0.0007^{c}$± 0.009 |
| Specific growth rate (**%**/day) | $0.76^{a}$± 0.002 | $0.52^{a}$± 0.06 | $0.009^{b}$± 0.064 |
| Initial length (cm/fish) | $7.27^{a}$± 0.50 | $7.20^{a}$± 0.40 | $6.90^{a}$± 0.19 |
| Final length (cm/fish) | $7.95^{a}$± 0.06 | $8.01^{a}$± 0.31 | $7.26^{b}$± 0.06 |
| Gain in length (cm/fish) | $0.68^{a}$± 0.01 | $0.81^{a}$± 0.09 | $0.36^{b}$± 0.13 |
| Condition factor (K) | $1.95^{a}$± 0.84 | $1.63^{b}$ ± 0.16 | $1.85^{ab}$± 0.055 |

* Values in rows having the same superscript letters are not significant different ($P \geq 0.05$).

**Table (5): Means ± SD of feed utilization parameters of red tilapia (*O. niloticus* X *O. aureus*) fingerlings at different pH water values.**

| * pH levels / Items | Control (7.53) | 5 | 9 |
|---|---|---|---|
| Feed intake (g/fish) | $2.18^{a}$± 0.07 | $3.30^{a}$±0.92 | $0.06^{b}$±0.38 |
| FCR | $1.09^{b}$± 0.85 | $2.75^{a}$±0.95 | $2.78^{a}$±0.41 |
| FER | $91.74^{a}$± 0.34 | $36.30^{b}$±0.63 | $33.33^{b}$±0.05 |
| Protein intake (g/fish) | $2.63^{a}$± 0. 25 | $1.03^{a}$±0.32 | $0.18^{b}$±0.13 |
| PER | $0.76^{b}$± 0.15 | $1.16^{a}$±0.19 | $0.11^{b}$±0.02 |

* Values in columns having the same superscript letters are not significant different ($P \geq 0.05$)

SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol.: (2) Is.: (2), Aug. 2013

**Table (6): Means ± SD of hematological parameters during the experimental periods (30 days) of rearing for red tilapia (*O. niloticus* X *O. aureus*) fingerlings at different pH water levels.**

| Items | pH levels * | | |
|---|---|---|---|
| | Control (7.53) | 5 | 9 |
| RBCs x $10^3$ (cell/$mm^3$) | $1440^{a}$±110.50 | $800^{c}$±100 | $1358^{b}$±713.25 |
| Hb (g/dl) | $2.00^{a}$±0.011s | $1.41^{c}$±0.105 | $1.82^{b}$±0.009 |
| Hct (%) | $32.09^{b}$±0.031 | $31.14^{c}$±0.11 | $33.22^{a}$±0.11 |

* Values in rows having the same superscript letters are not significant different ($P \geq 0.05$)

**Table (7): Means ± SD of biochemical parameters during the experimental periods (30 days) of rearing for red tilapia (*O. niloticus* X *O. aureus*) fingerlings at different pH water levels**

| Items | pH levels * | | |
|---|---|---|---|
| | Control (7.53) | 5 | 9 |
| Urea (mg/dl) | $18.95^{c}$±1.05 | $31.11^{a}$±0.95 | $23.80^{b}$±0.82 |
| Uric acid (mg/dl) | $60.00^{a}$±1.00 | $30.00^{c}$±1.00 | $54.00^{b}$±1.00 |
| Creatinine (mg/dl) | $4.32^{a}$±0.32 | $1.58^{c}$±0.60 | $2.07^{b}$±0.16 |
| Total protein (g/dl) | $6.02^{a}$±0.02 | $4.14^{b}$±0.15 | $5.50^{ab}$±0.50 |
| Glucose (mg/dl) | $236.82^{a}$±1.00 | $228.80^{b}$±1.10 | $72.26^{c}$±0.36 |

*Values in rows having the same superscript letters are not significantly different ($P \geq 0.05$)

Results of means of serum glucose (mg/dl) of red tilapia (*O. niloticus* X *O. aureus*) indicates significantly deference ($P < 0.05$) between treatments with the minimum value was recorded for (pH water 9) treatment and the maximum value for control (Table 7).

**7. Renal Histology:**

Figure (1) shows the normal histological structures of fingerlings red tilapia *O. niloticus* X *O. aureus* kidney respectively.

Red tilapia kidney is located between the vertebral column and swim bladder extending longitudinally from cranium to anus.

The organ is divided into two portions, an anterior head kidney which composed of hematopoietic, lymphoid and endocrine tissue, and a posterior trunk kidney which composed of numerous nephrons surrounded by interstitial lymphoid issue.

Posterior to this saddle the trunk kidney thins as it conforms to the curve of the swim bladder.

When examining kidney tissues from fingerlings red tilapia after 30 days of exposure to water pH 9, the results showed large numbers of destroyed glomeruli and large numbers of destroyed renal tubules (Figs. 2 and 3).

By examining kidney tissues from fingerlings red tilapia after 30 days of exposure to water pH 5, the results showed hemorrhage, large spaces between renal tubules and large numbers of destroyed renal tubules (Figs. 4 and 5).

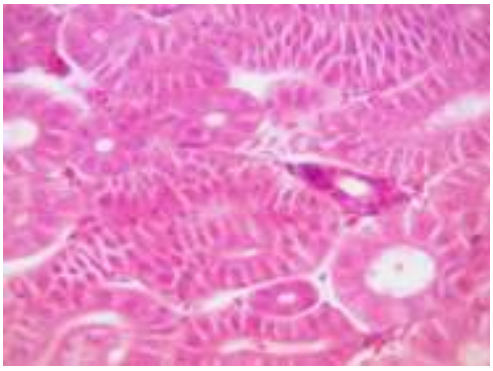
**8. Liver Histology:**

Red tilapia *O. niloticus* X *O. aureus* liver is a largest of the extramural organs.

It is roughly U-shaped, situated ventral to the esophagus and conforming to the peritoneal cavity and surrounding viscera.

The color varies from dark brown to cream or even yellow. Functions of the liver include assimilation of nutrients, production of bile, detoxification, hematopoiesis and effete red cells destruction.

Figure (6) shows the normal histological structures of red tilapia fingerlings liver When examining hepatic tissues from fingerlings red tilapia after 30 days of exposure to water pH 9, the results showed an increase of hepatic degeneration in different areas and some hepatic necrosis (Fig. 7). And by examining hepatic tissues from fingerlings red tilapia after 30 days of exposure to water pH 5, the results showed degenerating blood vessel and some vacuolations Fig. (8).



**'ig.(1):** Photomicrograph of normal red tilapia fingerlings kidney stained by Hx and E stain 400 X; shows. renal tubules.

## DISCUSSION

The pH of water exerts major effects on water quality and aquatic life **(Odum, 1959)**. Most natural water bodies have a pH close to neutrality, but some lakes and reservoirs acid pHs as low 2.9 **(Beamish, 1976)**.

The behavior of fish placed in pH 2.0 or 3.0 were appearance of dead fish suggest that the major cause of death may be respiratory failure. **Schofeild (1976)** found that acid water destroyed gill tissue, caused redness and swelling of the gills and increased mucus secretion. Red tilapia fingerlings here showed only 15% mortality in pH 5.0 even after 30 days.

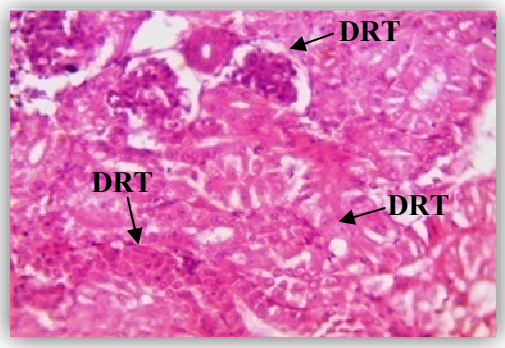
However, environmental factors, also influence the tolerance of fish to low pH, for example, poor water quality, temperature **(Dunson *et al.*, 1977)** and iron **(Balarin and Hatton, 1979)**, therefore tank experiments such as were performed here are not representative of field conditions and performance.

However, this study suggests that the recommendation the suitable pH of water for fish culture in general should be 5.0 or higher, applicable to the culture of red tilapia. These results are in agreement with **Beamish (1976)**.

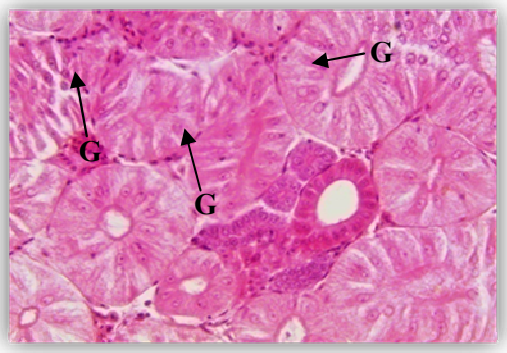
Results indicate that fingerlings of red tilapia can't tolerate pH 2.0 or 3.0.

SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol.: (2) Is.: (2), Aug. 2013

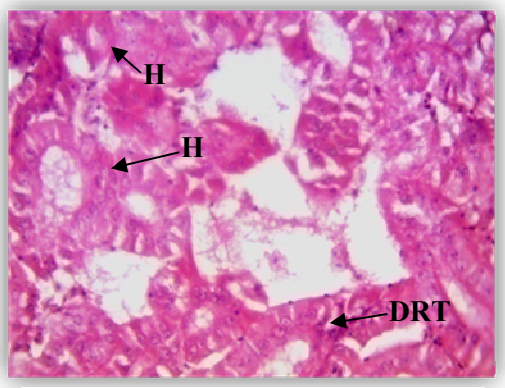
Their 30 days survival was greater than 80% in pH 5.0 and 90% in pH 9.0 and there were no different in growth between these pH levels. The ability of red tilapia to adapt to very low pH seems to be limited with a threshold at pH 4.0.




**ig.(2):** Photomicrograph of red tilapia fingerlings kidney (after 30 day exposure to water pH 9) stained by Hx and E stain 400 X; shows large numbers of destroyed renal tubules (DRT).




**ig.(3):** Photomicrograph of red tilapia fingerlings kidney (after 30 day exposure to water pH 9) stained by Hx and E stain 400 X; shows large numbers of destroyed glomeruli (G).




**ig.(4):** Photomicrograph of red tilapia fingerlings kidney (after 30 day exposure to water pH 5) stained by Hx and E stain 400 X; shows large amount of hemorrhage (H) and destroyed renal tubules (DRT).

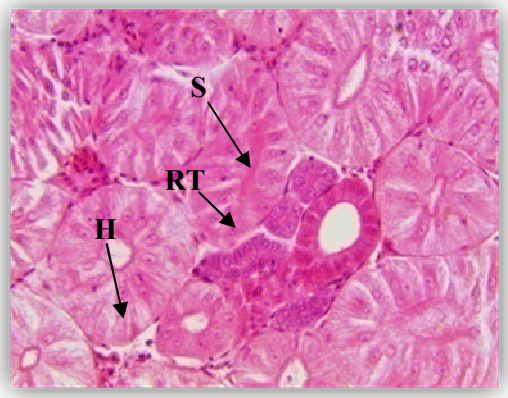



**Fig. (5):** Photomicrograph of red tilapia fingerlings kidney (after 30 day exposure to water pH 5) stained by Hx and E stain 400 X; shows large space (S) between renal tubules, hemorrhage (H) beginning of destroyed renal tubules (RT).

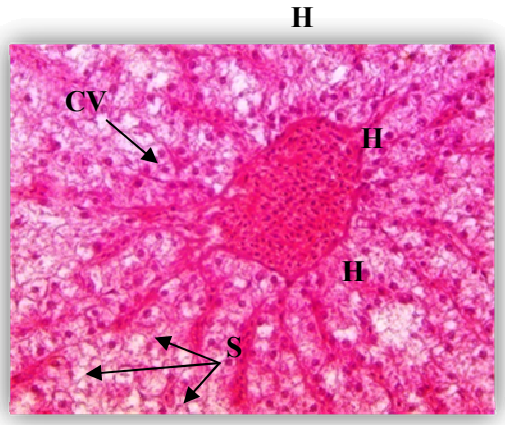



**Fig. (6):** Photomicrograph of normal red tilapia fingerlings liver stained by Hx and E stain 400 X; shows central vein (CV), hepatocytes (H) and hepatic sinusoids (S).

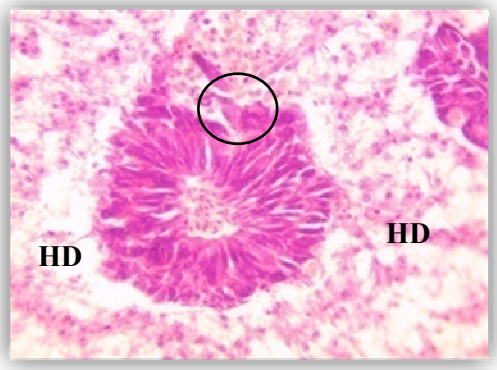



**Fig. (7):** Photomicrograph of red tilapia fingerlings liver (after 30 day exposure to water pH 9) stained by Hx and E stain 400 X; shows an increase of hepatic degeneration (HD) in different areas and some necrosis (circle).

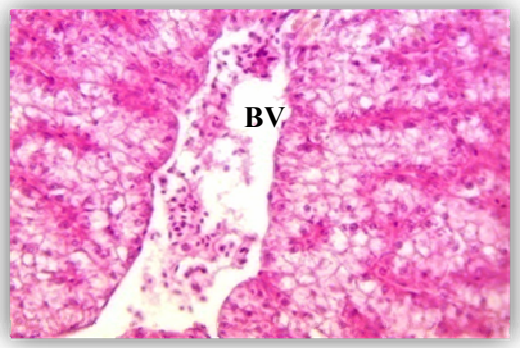



**Fig. (8):** Photomicrograph of red tilapia fingerlings liver (after 30 day exposure to water pH 5) stained by Hx and E stain 400 X; shows degenerating blood vessel (BV).

This is comparable with data presented by **Balarin and Hatton (1979)** that *O. niloticus* survive in the range of pH 4.0 to 11.0 but die within 2-6 hrs, in pH outside this range.

In the present study, although there is no ready explanation for the poor performance of the pH level 9 of rearing water with diet introduced (53 % protein) comparable to that produced by pH 5 with the same diet level this is in agreement with the finding reported by **El-Gamal and Hassanen (1994)**, where they recommended that under high salinity condition with high pH there is the "Masking Factor" of salinity.

This is indirectly manifested through retarded growth or reduced conversion efficiency.

**Carvalho and Fernandes (2006)** reported that in the case of *Prochilodus scrofa* at 20°C, regardless of the water pH in which the fish were kept, the increase of hematocrit and mean corpuscular volume, with concomitant decreases in red blood corpuscles, hemoglobin

concentrations and mean corpuscular hemoglobin concentration compared to the controls water pH 7.0, may indicate cell swelling.

However, copper exposure in both water pHs at the same temperature suggested a possible discharge of stored red blood corpuscles from the spleen, since the red blood corpuscles and hemoglobin concentration returned to the levels found in water pH 7.

As hematology has been used to assess the health status of most animals, several studies have shown hematological changes in fish exposed to numerous stress agents, including copper and pH stress are known to induce changes in the blood parameters of fish **(Cerqueira and Fernandes, 2002).**

The effects of pH on blood have been more intensively studied in acid water than in alkaline water **(Wood, 1989).**

Most changes in blood cells at low water pH reflect disturbances in the ionic status and fluid volume **(Milligan and Wood, 1982; Wood, 2001).**

**Das *et al.* (2006)** indicated that the higher serum protein reduction in fingerlings of mrigal and catla in all the acidic and alkaline pH exposures may be attributed to the protein catabolism, the process converting blood and structural protein to energy, to meet the higher energy demand during the prevailing stress.

Hemolysis and shrinkage of the erythrocytes, already been implicated in these species in the present study, also might have caused dilution of the plasma volume contributing to some extent in such reduction of serum protein content **(Das *et al.*, 2004).**

However, fingerlings of rohu did not show any significant change in serum protein content at any of the pH exposure, since the species is less prone to altered water pH.

**Balm and Pottinger (1993)** reported that when rainbow trout were exposed to acidic conditions (pH 4.0) for 14 days, they displayed decreases in food consumption, hematocrit values and plasma proteins.

In *O. mossambicus*, there were no significant differences in plasma sodium, chloride, cortisol and glucose between the control and the groups at pH 4.0 for 3, 17 and 37 days. These results suggest that adaptation to low pH is accompanied by few physiological changes. Therefore, it is concluded that red tilapia can acclimate to acidic water at pH 4.0, when the acidification rate is lowered gradually and additional stressors are avoided.

## CONCLUSION

The red tilapia fingerlings can culture under pH levels from 5 and not more than 9 without a significant effect on the productivity of these fish.

The red tilapia fingerlings cannot be cultured at pH levels 2 or 3, where it leads to death of these fish.

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## الملخص العربي

# تأثيرات درجة الأس الهيدروجيني للمياه على بقاء ونمو واستخدام الغذاء وتغيرات الدم والتركيب النسيجي لأصبعيات أسماك البلطي الأحمر

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استخدم في هذه التجربة عدد ١٠٠ سمكة من إصبعيات البلطي الأحمر بمتوسط وزن ٠,٢٩±٧,١٩ جرام ومعدل تخرين ١٠ سمكة/حوض (٤٠ × ٧٠ × ٦٠ سم) وكانت مستويات الأس الهيدروجيني المختبرة هي ٢ و٣ و٥ و٩ بجانب المجموعة الضابطة لمدة ٣٠ يوماً.

حدث موت لأسماك المعاملة ذات الأس الهيدروجيني ٢ بعد ٢٤ ساعة من بداية التجربة، وموت للمعاملة ذات الأس الهيدروجيني ٣ بعد ٣٦ ساعة من بداية التجربة، معدل بقاء أسماك المعاملة ذات الأس الهيدروجيني ٥ كان ٩٥% وأسماك المعاملة ذات الأس الهيدروجيني ٩ كانت ٨٥ %. معدل الزيادة فى متوسط الوزن لأسماك المعاملة ذات الأس الهيدروجيني ٥ كان ٠,٣±١,٢ جرام /سمكة مقارنة بالمجموعة الضابطة ٠,٤٠±٢ جرام/السمكة، ولوحظ أن معامل تحويل الغذاء كان مختفاً معنويا عن معاملة الكنترول مقارنة بالمعاملة ذات الأس الهيدروجيني ٥ و٩.

من تحليل عينات الدم اتضح أن هناك اختلافات معنوية ($p\leq0.05$) فى عدد كرات الدم الحمراء وقيمة الهيموجلوبين في الدم لأسماك المعاملة ذات الأس الهيدروجيني ٩ والمعاملة الكنترول. وسجلت أسماك المعاملة ذات الأس الهيدروجيني ٥ أعلى قيمة في تحليل اليوريا في سيرم الدم بينما سجلت أسماك هذه المعاملة أقل قيمة فى تحليل حمض البوليك والبروتين الكلى والكرياتينين في سيرم الدم مقارنة بالمجموعة الضابطة، وسجل تحليل سكر الدم نقصاً معنوياً للمعاملات ذات الأس الهيدروجيني ٥ و٩ مقارنة بالمجموعة الضابطة.

بعد الفحص الميكروسكوبي للقطاعات الهستولوجية في كلٍ من الكلية والكبد للأصبعيات تبين أنه حدث ضرراً خفيفاً في كل من هذه الأعضاء مقارنة بالمجموعة الضابطة وأن هذا الضرر أنعكس على نمو وإنتاجية هذه الأسماك.

وعليه نوصي بأنه لا يمكن استزراع إصبعيات البلطي الأحمر عند مستويات تركيز للأس الهيدروجيني ٢ أو ٣ حيث يؤدي ذلك إلى نفوق هذه الأسماك مع أنه يمكن استزراع إصبعيات البلطي الأحمر تحت مستويات حموضة وقلوية تتراوح من ٥ إلى ٩ دون حدوث تأثير معنوي على انتاجية وفسيولوجية هذه الأسماك.

**الكلمات الإسترشادية**: أصبعيات البلطي الاحمر، الأس الهيدروجينينى، معدل بقاء، معدل التخزين.

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