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The Effect of Acidic pH on Ammonia Removal from Aquaculture and its Impact on Survival and Growth Performance of the Nile tilapia (*Oreochromis niloticus*) Fingerlings

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ABSTRACT

An attempt was conducted to save the water in fish aquaculture by replacing water exchange cycle in aquaculture with water acidification. Thus a study was organized to reduce the toxic effect of harmful substances, especially ammonia on *Oreochromis niloticus* fingerlings in farming water and maintain the water quality. In addition, this work aimed to assess the effectiveness of different acids in removing ammonia and detect the tolerance of the Nile tilapia to different low pH and acidified water by evaluating its survival and growth performance. The survival rate of the Nile tilapia fingerlings was 0 %, 0 %, 30 % and 80 % at pH of 3, 4, 5 and 6 in water acidified using hydrochloric acid (HCL); while, in water acidified with acetic acid (Ch_3COOH) it was 0 %, 0 %, 80 % and 90 % at pH 3, 4, 5 and 6. The control aquarium water and the aquaria treated with Ch_3COOH at different pH levels had significantly similar concentrations of ammonia (NH_3), nitrite (NO_2) and nitrate (NO_3). Initial body weight (IBW), final body weight (FBW), weight gain (WG), specific growth rate (SGR) and the survival (%) of Nile tilapia in the control group and groups exposed to different concentrations of ammonium chlorides (NH_4CL) and treated with CH_3COOH at different pH levels showed a significant difference increase compared to the fingerlings exposed only to different concentrations of NH_4CL. The data clearly demonstrate that the water acidification with Ch_3COOH was the best and cheapest for fish survival and growth, as well as improving water quality.

INTRODUCTION

Fish aquaculture is one of the world's fastest-growing industries for providing food which is expanding daily **(Habib *et al.*, 2020)**. Egypt is the seventh-largest aquaculture country in the world and the major in Africa. Fish aquaculture field is the primary source of Egypt's fish production which represents approximately 77.9% **(MALR, 2018)**. The tilapia aquaculture has sky rocketed from 0.54 million tons in 2005 to 1.23 million tons in 2015 due to accelerated growth in the use of innovative technologies such as using expanded feed, water circulation systems and enhanced farm management techniques **(Soliman, 2017)**. Egypt's aquaculture industry has experienced a great success. Besides the presence of several lakes of different properties and the presence of the Nile River, Egypt has large areas of water fisheries. However, these sources are not fully utilized because the fish production does not keep up with consumers' growing demands **(Ali *et al.*, 2020)**.

Oreochromis niloticus frequently referred to as the Nile tilapia is the third most well-known cultivated species for supplying high-quality fish protein to cover the world's population's diet. **(FAO, 2017)**. The highly cultured fish in Egypt is the Nile tilapia that contributes about 65.15% of the total fish production **(Elsheshtawy *et al.*, 2019)**. Due to its ability to resist a variety of environmental variables, tilapia production has more recently contributed up to 75% of the global aquaculture production **(Syed *et al.*, 2022)**. Tilapia is known as ‘‘aquatic chicken” due to its quick development, outstanding capacity to adapt to changing environmental circumstances, increased resistance to a certain disease and its protein- rich meat **(Abdel-Aziz *et al.*, 2021)**.

On the other hand, Egypt’s fish farmers are facing a number of obstacles, such as conflicts hindering resource usage (water and land), synthesis of fish seed, cost and the availability of good feed, marketing and trade as well as creating a positive atmosphere (policies and framework) amongst others **(Soliman, 2017)**. Given that water is the main part of aquaculture, and a huge amount of water is consumed in the process of water exchange to eliminate the toxic products from water farm, the availability of water resources is considered the biggest problem facing the aquaculture industry.

The main source of water in Egypt is the Nile River, and as a result of population growth procedures, climate change, diet and lifestyle changes and urbanization are raising the load on the water resources that are accessible. Water shortage is a major issue due to the constraints placed on expanding water supplies by economic and environmental factors **(Christoforidou *et al.*, 2022)**. Egypt has reached a point of extreme freshwater per capita that does not exceed $550m^3$ $year^{-1}$, which is below the poverty line of $1000m^3$ $year^{-1}$ **(Omran & Negm, 2020)**. In addition, since the quality of water ultimately decides the success or failure of an aqua operation, water source and its adaptability must be taken into account. Poor water quality has an impact on the production, growth and quality of fish products via contaminating fish flavor or causing bioaccumulation of high concentrations of some elements or hazardous compounds **(Aniebone *et al.*, 2018)**. Typically, the most significant water quality factors in aquaculture are dissolved oxygen (DO), unionized ammonia (NH3), nitrite, nitrate, total alkalinity, total hardness and pH **(Kaleem & Bio Singou Sabi, 2021)**. In fish aquaculture, high stock density of tilapia has a great effect on water quality due to the significant increase in the amount of ammonia in pond water. For this reason, fish become under stress, raising the possibility of sickness **(Yilmaz, 2019)**.

The most nitrogenous waste that tilapia excrete is ammonia **(Miramontes *et al.*, 2020)**, which is produced from the protein catabolism and immediately and gradually produced into water from the blood through fish gills. Ammonia can cause chronic and acute hazardous effects even at relatively low doses **(Mercante *et al.*, 2018)**. Deficiency in the immune system and growth of tilapia may result from high ambient ammonia concentrations leading to fish death, leading to massive financial losses in aquaculture **(Zhang *et al.*, 2021)**. The variety in the type and severity of ammonia poisoning depends on a number of variables, including the chemical formula of ammonium, the water pH and temperature, time spent exposed, and the stage of life of the exposed fish **(Ortiz *et al.*, 2022)**. The result of NH_3 (non-ionized) and NH_4^+ (ionized) is called total ammonia nitrogen (TAN). The NH_3 is considered the TAN's most harmful form as it is simply secreted through the fish gills **(Shalaby *et al.*, 2019)**. The most popular method for removing nitrogen compounds and other elements that impair water quality in aquaculture ponds is changing water. This technique is risky since it opens the path for viruses entering the ponds in addition to water loss **(Robles-Porcas *et al*., 2020)**. Thus, introducing new methods is highly required to eliminate the toxic substances as ammonia from water of tilapia aquaculture. According to the Egyptian strategy, a continuous effort has been exerted to develop wastewater management plans for aquaculture to protect the environment and natural water resources. This would have an additional value for the aquaculture industry **(El-Sherbiny *et al.*, 2019)**.

Therefore, this study aimed to conserve the national water resources by replacing the water exchange cycle in aquaculture with water acidification to eliminate ammonia and reduce its harmful and toxic effect on the Nile tilapia *Oreochromis niloticus* collected from farming water. Thus, the present study was designed under controlled laboratory condition to analyze the effectiveness of different acids in removing ammonia effect and detect the tolerance of the Nile tilapia to different low pH values and acidified water by evaluating the survival and growth performance of the species under study.

MATERIALS AND METHODS

The experiment was performed on 240 Nile tilapia fingerlings for the first experiment and 270 fish for the second experiment, with weights of 6.2 ± 0.42g. The Nile tilapia fingerlings were obtained from the fish hatching pond in Fowa City (Kafer El-Sheikh Governorate) and transported gently in oxygenated cellophane bags in mid-August to the laboratory for the acclimation. Fish of nearly equal sizes were distributed in twenty-four 33L glass aquaria (10 for each) for the first experiment and twenty-seven aquaria for the second experiment. The fish samples were acclimated for 10 days before the experimental work and the rearing density of approximately 1.1g L^{-1}. The upper rearing density limit of the fish for toxicity testing was 2.5g L^{-1} **(Hegazi *et al.*, 2010)**. Each aquarium was supplied with continuous aeration via a sponge biological filter. The filter was washed and cleaned thoroughly every day. The water in each aquarium was daily changed with fresh dechlorinated city tap water. The level of dissolved oxygen was maintained at about 80-85% air saturation, and the fish samples were exposed to normal photoperiod from 10h light to 14h of darkness in laboratory. The fish were fed once every day at 9:00 a.m. with the commercially available pellets diet (25.2% protein, 5% lipids and 5.7% fibers, with a total energy of 2505 kcal Kg^{-1}).

Fish were carefully observed every day, and the body weights were precisely registered every week. Water pH values were daily checked twice using 0.01 digital pH meter tester to determine water quality food aquarium (Shenzhen Ruiqi Electronics Co., Ltd). The experiment was conducted for three months at the Department of Zoology, Faculty of Science, University of Tanta, Egypt.

In the 1st experiment, the Nile tilapia fingerlings were divided into two sets (4 groups for each), the first one was acclimated to HCL at different pH levels (3, 4, 5 and 6), while the second set was acclimated to CH_3COOH at different pH levels (3, 4, 5 and 6). The Nile tilapia fingerlings' survival rate was 0 %, 0 %, 30 % and 80 % in pH 3, 4, 5 and 6, respectively, in water acidified using hydrochloric acid (HCL). Whereas, the survival rate for the fingerlings in water acidified with acetic acid (Ch_3COOH) was 0 %, 0 %, 80 % and 90 % at pH 3, 4, 5 and 6, respectively.

In experiment two, the Nile tilapia fingerlings were divided into 9 groups (30 fish per each). Group 1 was (control) fed normal diet and acclimated at normal pH of 7.4; in group 2, the fish were exposed to 7 (high) mg TAN L^{-1} concentration and the water of the aquaria was daily exchanged; while, in group 3, the fish specimens were exposed to 2.5 (low) mg TAN L^{-1} concentration, and the water of the aquaria was daily exchanged. For group 4, the fish samples received acetic acid to maintain the pH value at 6. No water exchange was performed during the entire the experiment. The fish samples in group 5 were exposed to 7 (high) mg TAN L^{-1} concentration, and the PH was maintained at 6. The water of the aquaria was daily exchanged, while those of group 6 were exposed to 2.5 (low) mg TAN L^{-1} concentration, and the pH was maintained at 6. The water of the aquaria was exchanged. In group 7, the fish received acetic acid to maintain pH at 5. No water exchange was performed during the whole experiment; whereas, group 8 fish samples were exposed to 7 (high) mg TAN L^{-1} concentration, and the pH was maintained at 5. The water of the aquaria was daily exchanged. For group 9, the fish were exposed to 2.5 (low) mg TAN L^{-1} concentration, and the pH was maintained at 5. The water of the aquaria was daily exchanged.

The pH readings were daily performed in the morning and afternoon. The daily water pH values were calculated to determine the average of those two records. A stock solution of high purity NH_4Cl (50 g L−1) was used as a source of TAN, and the experiment was continued over a period of 50 days.

Water quality measurements

Water samples were collected every week at a depth of 30cm from the aquarium with no water exchange. The water pH value was measured using 0.01 digital pH meter tester for water quality food aquarium (Shenzhen Ruiqi Electronics Co., Ltd). The analysis of water was done in the water analysis unit in the central laboratory, Tanta University, using standard methods. Un-ionized ammonia (NH3), nitrite (NO_2) and nitrate (NO_3) were detected by using UV-Vis double beam Pc scanning spectrophotometer UVD 2950, following the standard method of the American public health association **(APHA, 2000)**.

Fish growth

Growth indices were calculated as follows:

- weight gain (WG) = 100 × ((W2) final average weight (g) – (W1) initial average weight (g)/ (W1) initial average weight (g))
- specific growth rate (SGR) = 100 × (lnW2 − lnW1)/ (T) the number of days of the experimental period

Statistical analysis

The data were statistically analyzed using one-way analysis of variance (ANOVA), followed by Tukey test using a computer program (GraphPad InState3 Software, Inc.). For all comparisons, *P*-values less than 95% ($P< 0.05$) were considered to be statistically significant.

RESULTS

Experiment 1

Survival of Oreochromis niloticus fingerlings after using Hydrochloric acid (HCL) with different pH levels

The pH 6 of HCL showed significantly ($P\leq0.001$) higher survival rate, compared to other pH levels (3, 4 and 5). Fingerlings in pH 3 died within the first day of the experiment with a survival rate of 0.00± 0.00. While, the fingerlings of pH 4 died between days 1 & 3. The survival rates were recorded (0.50± 0.09) at the 1st (0.27± 0.08), 2nd day and (0.00± 0.00) 3rd days. At pH 5, the fingerlings died between 1 & 8 days. The survival rates were recorded (0.80± 0.07, 0.57± 0.09, 0.47± 0.09, 0.37± 0.08, 0.23± 0.07, 0.13± 0.06, 0.03± 0.03 and 0.00± 0.00) respectively. On the other hand, at PH 6, the death of fingerlings was only recorded in the first three days with recorded survival rates (0.86± 0.06, 0.77± 0.07 and 0.67± 0.08, respectively), then the death event censored till the end of the experiment (Fig. 1).

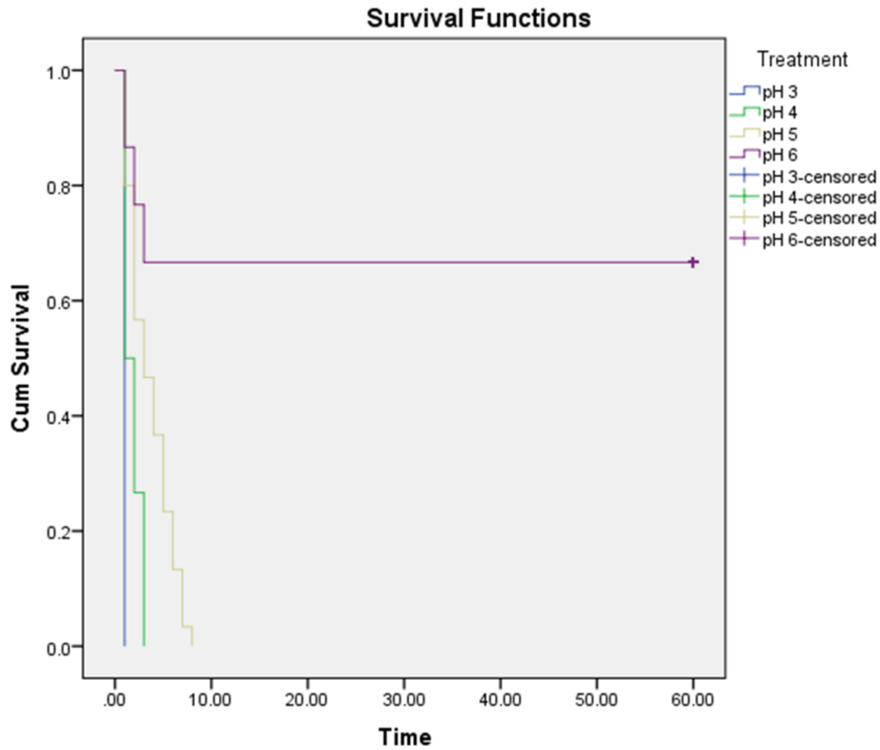

Fig. 1. Kaplan-Meier survival curves. Effects of different pH levels of HCL on the cumulative survival of *Oreochromis niloticus* fingerlings during 30 days

Survival of Oreochromis niloticus fingerlings after using acetic acid (CH_3COOH) with different pH levels

The pH 6 and 5 of CH_3COOH showed significantly ($P \leq 0.001$) higher survival rate than pH 3 and 4. All the fingerlings in pH 3 died within the first day of the experiment with survival rate of 0.00± 0.00. While, the fingerlings of pH 4 died within four days of the experiment. The survival rates were recorded at the 1^{st} (0.67± 0.08), 2nd (0.43± 0.09), third (0.17± 0.06) and the 4^{th} days (0.00± 0.00) of the experiment. At pH 5, the death of fingerlings recorded only within 1 to 3 days, then the event censored till the end of the experiment. The survival rates in the first three days were recorded (0.83± 0.06, 0.73± 0.08 and 0.63± 0.08) respectively. At pH 6, the death event censored from day 2 till the last day of the experiment, while the survival rate values at the first two days was as follows: 0.80± 0.07 for the first day and 0.90± 0.05 for the second day (Fig. 2).

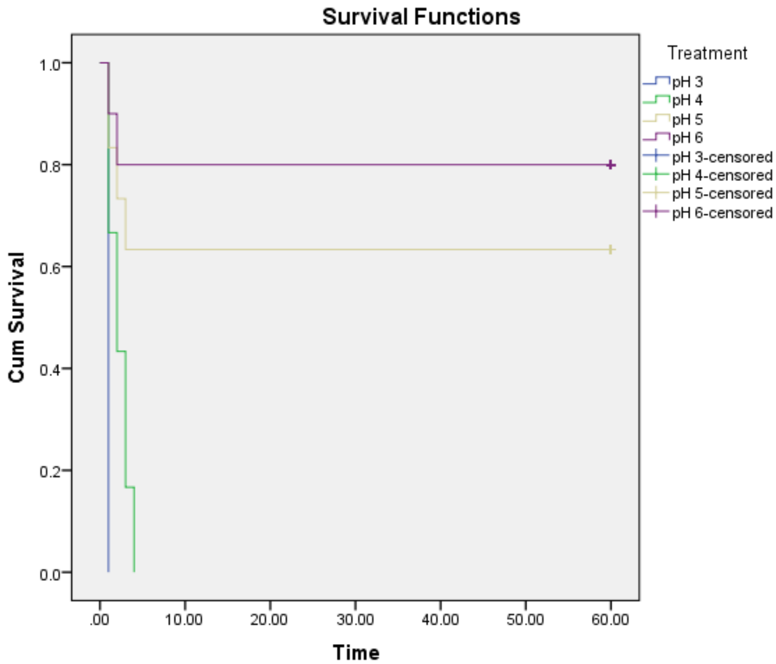

Fig. 2. Kaplan-Meier survival curves. Effects of different pH levels of CH_3COOH on the cumulative survival of *Oreochromis niloticus* fingerlings within 30 days

Experiment 2

Water quality

The NH_3 levels in water treated with CH_3COOH at pH 6 and 5 was not significantly different in comparison with their respective control water. NO_2 levels in water treated with CH_3COOH at pH 6 and pH was not significantly different, compared to their respective control water. While, NO_3 levels in water treated with CH_3COOH at pH 6 and 5, respectively, was not significantly different, compared to their respective control water (Table 1).

Table 1. Ammonia, nitrite and nitrate levels in water treated with CH_3COOH at different pH levels

Parameter	Control	pH 6	pH 5
Ammonia NH_3 (mg/l)	0.07± 0.01	0.04± 0.01	0.06± 0.02
Nitrite NO_2 (mg/l)	0.02± 0.003	0.046± 0.01	0.04± 0.01
Nitrate NO_3 (ppm)	8.87± 0.45	8.3± 0.8	8.50± 0.8

Each reading represents Mean±SD (n= 5)
The data were subjected to one-way analysis of variance (ANOVA) and Dunnett test (compare all vs. control) using a computer program (GraphPad InState Software, Inc)
The effect of different pH levels of CH_3COOH checked by ANOVA was significant at $P \leq 0.05$.

Growth performances and survival of Oreochromis niloticus fingerlings

It was observed that, the mean initial weight of fingerlings at the beginning of the experiment showed no significant difference in all groups, compared to the control. However, the FBW values of the groups 4, 5, 6, 7, 8 & 9, treated with CH_3COOH at different pH levels were significantly increased, compared to group 2 (7 TAN^{-1}) and group 3 (2.5 TAN^{-1}). Whereas, no significant differences were detected in those groups, compared to the control. Remarkably, the increase in FBW in all groups treated with CH_3COOH wasn't significant compared to the control; however, a significant decrease was recorded in FBW of groups 2 and 3, compared to the control. The calculated data of WG of the groups 4, 5, 6, 7, 8 & 9 were significantly increased than group 2 and 3; while, the increase was not significant control. The data of WG in groups 2 and 3 were significantly decreased compared to the control group. The calculated data of SGR of the all groups, except group 5, were significantly decreased than the control group. While, the data of SGR in all groups were significantly increased, compared to groups 2 and 3. The survival rate of the Nile tilapia in all groups (4, 5, 6, 7, 8 and 9) was significantly decreased, compared to that recorded for the control group. However, the survival rates of all other groups were significantly increased compared to those recorded for groups 2 and 3 (Table 2).

Table 2. Growth performances and survival of *Oreochromis niloticus* fingerlings

Groups	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
No of fingerlings	30	30	30	30	30	30	30	30	30
IBW (g)	5.20± 0.93	6.32± 0.6	5.89±0.4	6.24± 0.42	6.16± 0.86	5.94± 0.99	5.86± 0.57	5.60± 0.72	6.14± 0.69
FBW (g)	26.36± 1.08	17.25± 0.72□	18.23± 1.02□	25.78± 1.08 □□	29.48± 1.077□□	25.46±2.03 □□	23.70± 1.04 □□	22.48± 0.96 □□	25.64± 0.7□□
WG (%)	415±0.97	172.94±1.45□	209± 0.85□	313.6±1.02□, □□	378.4± 2.31□, □□	328.5± 1.45□, □□	304.4± 1.26□, □□	301.4± 1.26□, □□	317.5± 2.12□, □□
SGR (%)	5.4±0.54	3.34±0.66 □	3.73± 0.55□	4.7±0.8□, □□	5.2± 0.25 □□	4.9± 0.25□, □□	4.1± 0.14□, □□	4.6± 0.58□, □□	4.7± 0.25□, □□
Survival (%)	98.03± 0.85	93.26±0.8 □	94.14± 1.25□	95.39± 1.24□, □□	96.78± 1.47□, □□	97.45± 0.78□, □□	94.12± .67□, □□	96.35± 1.27□, □□	95.42± 1.07□, □□

G1 (control), G2 (7 TAN^{-1}), G3 (2.5 TAN^{-1}), G4 (PH 6), G5 (PH 6/ 7 TAN^{-1}), G6 (pH 6/ 2.5 TAN^{-1}), G7 (PH 5), G8 (PH 5/ 7 TAN^{-1}) and G9 (PH 5/ 2.5 TAN^{-1}).

Each reading represents Mean± SD.

The data were subjected to one-way analysis of variance (ANOVA), Dunnett test (compare all vs. control) and Tukey test (compare each group vs. all groups) using a computer program (GraphPad InState Software, Inc).

The symbol * in the same row means that the difference checked by Dunnett test is significant at $P< 0.05$ in comparison with the controls.

The symbol ** in the same row means that the difference checked by Tukey test is significant at $P< 0.05$, compared to groups 2 and 3.

DISCUSSION

Egypt is facing a crisis in water resources sustainability and management. The water shortage dilemma is not only related to the increasing demands but rather to poor management practices. Thus, it is necessary and imperative to maintain water resources by all means, viz. rationalizing the consumption, reducing the waste and strict laws governing the process of industrial wastewater pumping into water resources. Most of the water loss in Egypt occurs in aquaculture due to water exchange cycle used for maintaining farming water quality. As a result, this study was conducted in an attempt to save water in aquaculture by reducing the harmful effect of toxic substances on aquaculture and maintaining the water quality via water acidification. In this study, some trials were adopted to throw a light on fish survival and growth in acidified water with different pH levels.

Animal physiology functions in a set of species-specific environmental circumstances. The gradients in water pH that depart from the species' optimal range may have an impact on fish growth and survival **(White *et al.*, 2014)**. When fish are exposed to challenging pH circumstances, they attempt to modify their behavior and physiology. Some fish species grow more quickly in waters with pH levels outside neutrality. Fish evolved to survive in acidic environments **(Duarte *et al.*, 2013)** and alkaline **(Rebouças *et al.*, 2015)** waters are called acidophilic and basophilic, respectively. Most laboratory investigations on the effects of acid water on fish focus on acute acidification and short-term exposure. However, when progressive water acidification is used as opposed to acute acidification, the negative effects of acid water on fish are significantly reduced **(van der Salm *et al.*, 2005)**.

This study revealed that the Nile tilapia fingerlings did not survive in water acidified by both HCL and CH_3COOH of pH 3. This could be due to toxic action of hydrogen ions which affected oxygen uptake leading to acid stress, precipitation of proteins within the epithelial cells and/or acidosis of the blood **(Furukawa *et al.*, 2011)**. It could also be probably attributed to the erosion of the epidermal layer of the integument and gills, sodium ion influx inhibition **(Duarte *et al.*, 2013)**. In addition, it could be related to brain, kidney and spleen injuries or the lysis of erythrocytes **(Hill *et al.*, 1988; Mustapha & Atolagbe, 2018)**. This study showed that the fingerlings didn't survive in pH 4. The mortality could be attributed to the above reasons and could also be due to the production of mucus on the gill epithelium, which interferes with the exchange of respiratory gasses and ions across the gills. Hence, respiratory distress and osmotic imbalance were culpable as the primary physiological symptoms, leading to acid stress for the fish. The low pH stress in the aquatic environment induces an increase in the influx of H^+ ions into the fish blood across gills, and the inhibition of the excretion of metabolically generated H^+ ions and CO2 cause acidemia, thereby decreasing the ability of hemoglobin to transfer oxygen **(Kim *et al.*, 2021)**.

On other hand, the current study remarked a significant increase in the survival rate of fish in pH 5 and 6 of water acidified with HCL and CH3COOH. The increase in the survival rate may be attributed to their increasing adaptation to the acidified water or due to efficient ion transportation systems, which allowed them to maintain a more effective salt **(Mustapha & Atolagbe, 2018)**. According to **Mustapha and Atolagbe (2018)**, the acceptable range of pH to fish depends on prior pH acclimatization. It is worth noting that, the Nile tilapia fish are able to adapt to a low pH as long as the water pH is gradually lowered **(Van der salem *et al.*, 2005)**. This result also proved that the survival of the Nile tilapia fingerlings at PH 5 and 6 was the best using Ch_3COOH acidification than HCL acidification. This may be due to the nature of the CH_3COOH being an organic acid. Organic acids are organic carboxylic compounds of general structural formula (R-COOH), whose acidity is associated with their carboxyl group (-$COOH^-$). They are weak acids because they partially and slowly dissociate in water to form a hydrogen ion (H^+) and carboxylate ion (-COO^-). These results are similar to those of **Nobre *et al.* (2014)** and **Mustapha and Atolagbe (2018)** who postulated that, the optimal pH range for rising the Nile tilapia juveniles in fresh water is 5 to 8. Nevertheless, the present finding conflicts with that of **El-Sherif and El-Feky (2009)** who revealed that the pH range of water that is best for raising the Nile tilapia, *Oreochromis niloticus*, is between 7 and 8. The toxic and harmful effect from elevating ammonia results in elevating water PH for tilapia juveniles.

Poor water quality stresses and adversely affects the fish growth with subsequent low production, profit and product quality **(Yeganeh *et al.*, 2020)**. Production is reduced when the water contains contaminants, impairing development, growth, reproduction or even cause mortality to the cultured species. As a result, fish farmers are obliged to manage the water quality so as to provide a relatively stress-free environment that meets the physical, chemical and biological standards for the fishes' normal health and growth performance **(Shoko *et al.*, 2014)**.

Water quality is regulated by complex interactions including dissolved oxygen and nitrogen waste such as ammonia, nitrite and nitrate is linked to the input of organic matter and ammonium excretion by fish **(Sriyasak et al. 2015).** In water, nitrogen can be found in the forms of ammonia, nitrite, and nitrate (**Emerenciano *et al.*,2017)**. Ammonia (NH_3) is produced from the breakdown of proteins from unconsumed feed, feces, and urine of fish. This compound will turn into nitrite (NO_2) when oxygen levels are poor, which is toxic for fish. By contrast, ammonia is changed into nitrate when the dissolved oxygen level is sufficient **(Jiménez-Ojeda *et al.*,2018)**. Fish produces ammonia (inorganic) through the osmoregulation process; feces and urine contribute about 10%–20% of total nitrogen **(Putra *et al.*,2020).** Principally, in healthy fish ponds the levels of ammonia should always be zero. Otherwise, any presence of ammonia in fish ponds is a sign that the system may be running out of control **(Francis-Floyd et al. 2009).**

The study revealed that the concentrations of ammonia, nitrite, and nitrate were significantly low at PH 5 and 6 in non-changed water acidified by CH_3COOH. The water acidification reduces nitrogen-containing compounds, especially toxic forms such as ammonia. The lower TAN in acidified water compared to control probably resulted from that the acetic acid is a weak acid and due to the high level of ammonia excreted by fish, neutralization is more appropriately considered to involve direct proton transfer from the acid to the base. The neutralization of acetic acid by ammonia may be written as:

$$CH_3COOH + NH_3 \rightarrow CH_3CO_2^{-} + NH4^{+}$$ **(Saabas & Lee, 2022)**

But, this results conflict with **Rebouças *et al. (*2016) ; Martins *et al. (* 2017).**

Initial body weight (IBW), final body weight (FBW), weight gain (WG) and specific growth rate (SGR) of Nile tilapia fingerlings in all groups exposed to different concentrations of ammonium chlorides (NH_4CL) and treated with CH_3COOH with different PH levels showed a significant increase than the Nile tilapia exposed to different concentrations of NH_4CL only. Growth performance in the acidified water also was better than control group. Therefore, it can be suggested that fingerlings of Nile tilapia can grow well in low PH. The results of growth performances in agreement with **Colt *et al.*, *(*2011); Silva *et al. (*2013); Reboucas *et al. (*2016) ; Al-Zayat (2019)** but disagree to **El-Sherif and El-Feky (2009); López-Olmeda *et al. (*2021).**

CONCLUSION

It could be concluded that the present study indicated that the acidification of aquaculture water with acetic acid at PH 5 and PH 6 is an effective technique to eliminate toxic substances such as ammonia from aquaculture and it may be a good way than water exchange cycle to save the water resources and may aid in solving the water scarcity problem in Egypt. The acidification of aquaculture water at PH 5 and PH 6 with CH_3COOH was the best than HCL acidification because the acetic acid was the cheapest and had the highest survival rate. Interestingly, the CH_3COOH had a potential role in improving the initial, final body weight and growth performance of Nile tilapia fingerlings.

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