Impact of Aquaponic System on Water Quality and Health Status of Nile Tilapia *Oreochromis niloticus*

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Abstract

The present study was carried out to evaluate the impact of aquaponic system on physicochemical water constituents and health status of *Oreochromis niloticus*. One hundred and twenty apparently healthy fish were collected and divided equally into two treatments representing aquaponic system and the aquaria (control).Water quality was measured on basis of daily [EC, pH, DO and Temperature], three time weekly [un-ionized ammonia (NH_3), Nitrite (NO_2) and Nitrate (NO_3)], twice weekly (Alkalinity, Total phosphate, Total Hardness, Calcium (Ca), Magnesium (Mg) and Chloride (Cl)] and once weekly [Sodium (Na), Potassium (K), Iron(Fe), Lead (Pb) and Cadmium (Cd)]. Results of water analysis revealed improvement of water quality parameters in aquaponic system including significant beneficial increase in pH value with DO and significant decrease in toxic ammonia, nitrite and temperature. On the other hand, the total hardness, Ca, Mg, Cl, Na, K and heavy metals showed non-significant decrease in aquaponic system. Ten fish from each system were experimentally infected with *Aeromonas veronibiovar sobria* to detect the mortality rates for evaluating the health state of the fish. Challenged fish in control system showed mass mortalities in all fish, while in aquaponic fish mortality represented as 10% at 4^{th} day until the end of the experiment.

Keywords: Aquaponic system, Water quality, Nitrogenous compounds, *Oreochromis niloticus*, Experimental infection

Introduction

Water quality is very essential and vital requirement for aquaculture production to maintain and produce high quality profitable product, which by its role will reflect on human health. Therefore, any impairment in water quality will alter development, growth, reproduction, or even cause mortality to the cultured species ***(Barker et al, 2009).***

Aquaponic is an innovative technique for food production which resulted from integration of aquaculture and hydroponics in a single system to produce both fish and vegetable crops whereas

Aquaponic system uses fish wastes to provide essential nutrients to the plants ***(Homme, 2012 and Salam et al, 2014)***, aquaponic system was designed to conserve water resources with control of water quality, the production schedule and the fish product ***(Endut et al, 2009).*** Eutrophication and other environmental problems could be resulted from untreated water containing ammonia discharged into the ecosystem ***(Hu et al, 2015).*** Therefore, aquaponic system can be an alternative to reduce the effect of the inorganic nitrogen accumulation that can be a detrimental factor to the fish growth, whereas, ammonia in aquaponic system is converted into nitrite and nitrate by nitrification bacteria (Nitrosomonas and Nitrobacter sp.) and nitrate are absorbed by plants as nutrients ***(Liang and Chien, 2013).*** In addition, plant can be considered as a bio-filter for the fish in a symbiotic relationship with mutual benefit by absorbing nutrient from farming waste with the action of bacteria in reducing the ammonia through the nitrification process ***(Salam et al, 2014 and Wahyuningsih et al, 2015).***

The choice of Tilapia to be used experimentally in aquaponic system could be referred to their rapid growth rate and resistance to poor water quality and disease, in addition to their tolerance to wide range of environmental conditions ***(Shamsuddin et al, 2012).*** Aeromonas septicemia is a fetal infectious disease of cold blooded animals like fish, reptiles, and amphibians and in human caused by a motile mesophilic ubiquitous aerobic bacteria ***(Das et al, 2013).***

The main objective of the current work was to determine and compare different water parameters that could affect *O. niloticus* or cause its stress between aquaponic and the control systems that resembles water ponds. Besides, detecting the health status of *O. niloticus* in both systems.

Materials and Methods

Experimental fish

One hundred and twenty apparently healthy Nile tilapia "*Oreochromis niloticus*" with an average body weight of 40±10 g were collected from Fish Research Center, Suez Canal Univ. during the period from November 2014 to January 2015. The experimental fish were allocated into two treatments (60 fish for each one): the first group (Aquaponic) reared under recirculating treatment tanks for fish culture, which integrated with green pepper plantand the second group reared in aquaria without plant (control) with weekly water exchange interval.

Diet: The fish were fed twice daily at rate of 3% of their body weight on commercial diet (pellets) containing 30% crude protein (El-Morshidy Company-Egypt).

Aquaponic system:

The aquaponic system used in this study was consisted mainly of fish rearing plastic tank of 1000 L total water volume, and hydroponic system as trays of green pepper plants with their soilless media. The deep-water hydroponic unit was installed to allow the fish effluent to flow over the plant roots so the plant can extract its essential nutrients. The hydroponic half tanks (1.5 m long by 0.8 m wide by 50 cm deep) and a raft system, consisting of floating sheets (1 m long by 0.5 m wide by 5 cm thick) of polystyrene, were installed with plastic tubes. One air pump and air stones were used to aerate the fish rearing tanks.

Preliminary water analysis:

Fish of both treatments (aquaponic and control) were kept in plastic tanks supplied with aerated de-chlorinated fresh water for adaptation period of 14 days prior to start the experiment. Water was tested before beginning of the experiment for the following parameters: electrical conductivity 0.51 *S*/cm, TDS 341 mg/L, pH 7.44, dissolved oxygen 6.37mg/, total hardness 130 mg/L CaCo3, total Calcium 22.44 mg/L, total magnesium 18.24 mg/L, chloride 43.99 mg/L, Total alkalinity 72 mg/L, sodium 48 mg/L, potassium 20 mg/L. Nitrogenous compounds (including, ammonia, nitrite and nitrate), total phosphate iron, cadmium and lead were not detected.

Water analysis:

Water quality was measured on daily [EC, pH, DO and Temperature (n=50)], three time weekly [un-ionized ammonia(NH_3), Nitrite (NO_2) and Nitrate (NO_3) n= 18], twice weekly (Alkalinity, Total phosphate (TP), Total Hardness, Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Chloride (Cl^-) n=12] and once weekly [Sodium (Na), Potassium (K), Iron(Fe^{2+}), Lead(Pb^{2+}) and Cadmium (Cd) n=6] basis. Sampling procedures and analytical methods for both physical and chemical determinations were carried out according to ***APHA (1998).*** Samples were transferred to the laboratory without delay for immediate measuring of pH using pH meter (Jenway, 370 pH meter, U.K), DO and Temperature using DO meter (Crison OXI 45 P, EU) ,EC µS/cm by means of conductivity meter (Jenway, 4520 conductivity meter, U.K) according to ***APHA (1998).*** TDS mg/l was calculated from Electrical conductivity µS /cm according to ***Anderson and Cummings (1999).***

Samples for nitrogenous compounds determination were refrigerated and analyzed within 24 hrs. The amount of toxic unionizedammonia (NH_3) was obtained by measuring the total ammonia nitrogen (TAN) by colorimetric determination of ammonia in solution (Phenate method) ***(Koroleff, 1976)*** then obtaining NH_3 based on water temperature and pH. By multiplying this fraction by the TAN to find the concentration (mg/L) of toxic un-ionized ammonia ***(Emerson et al,***

1975). Nitrite was determined using diazotation method ***(EPA, 1979)*** and nitrate was determined by using UV screening spectrophotometric method according to ***APHA (1998)*** using1100 Techocomp UV/visible Spectrophotometer.

According to ***APHA (1998)*** the following parameters were measured: Total Phosphate was determined by using ascorbic acid spectrophotometric method ,Total alkalinity were determined using titrimetric method ,Total hardness, calcium and magnesium were determined using Ethylene diamine tetra acetic acid (EDTA) titrimetric method and Chloride was determined using (Argentometric method). Sodium and potassium were measured by inductively coupled plasma-optical emission spectrometry (ICP-OES) Perkin-Elmer product, model Optima 5300 DV. Trace element including Iron, lead and cadmium were analyzed using an Atomic Absorption Spectrophotometer (Thermo Electron Corporation, type S4AA sys. NC 942340030042) according to ***AOAC (1995).***

Bacterial strain:

A well-identified bacterial strain of *Aeromonas veronii* bv. *sobria* was kindly supplied from Prof. Dr. Eissa I.A.M., Fish Diseases and Management, Faculty of Vet. Med., Suez Canal Univ. It was prepared by cultivation in TSA medium for 24 hr at 28 °C, then collected, washed, and suspended in sterile normal saline (0.85% NaCl) and matched against McFarland standard tubes.

Experimental infection

Ten *O. niloticus* fish from each system were experimentally infected by an intra-peritoneal (I.P.) injection with 0.1 ml X10^7 CFU ***(Li and Cai, 2010)*** of the *Aeromonas veronibiovar sobria* bacterial suspensions**.** Fish mortalities were reported daily for 8 days post injection with bacterial suspension.

Statistical Analysis:

Results were expressed as means ± SE for each treatment. Treatments were tested for differences by performing the ANOVA and fisher's least protected significance test, also Correlation Coefficient and Factor Analysis were performed using IBM SPSS software computer program version 16, NY, USA (Inc., 1989-2010). Differences were considered statistically significant at $p<0.05$.

Results and Discussion

1. Physicochemical parameters of water samples

Water quality is a crucial for fish health and its production. The water physicochemical characteristics of both control and aquaponic systems were investigated and presented in Table (1). The statistical analysis using a factorial analysis reported in Table (2) and illustrated in Figs (1& 2).

The pH is the most interactive parameter with the other water quality parameters, therefore it was measured daily and showed significant ($p\leq0.05$) increase in aquaponic system (7.876±0.022) as compared to control (7.688±0.021). Importance of pH referred to its interdependency character with such parameters as alkalinity, and hardness. It can be toxic itself at a certain level, and it can influence the toxicity as well of hydrogen sulfide, cyanides, heavy metals, and ammonia ***(Klontz, 1993).*** This result of pH can be strengthen by its correlation with other constituents, whereas, in aquaponic system, pH revealed strong positive association (0.879) in component 2 (33.442 explained total variance %) and correlated negatively with TP,NH_3, NO_2^-, Ca^{+2}, Cl^-,Fe^{+2}, Pb^{+2} and Cd (-0.065, -0.493, -0.304, -0.037, -0.102, -0.219, -0.189 and -0.415, respectively); On the other hand, pH in control showed non obvious effect with negative loading in its components. At the same time, pH can alter health of the fish when increase or decrease than permissible limit, but in this results of pH of both control and aquaponic was within permissible limit according to ***Boyd (1998)*** who reported that the optimum pH for water fresh fish is usually between pH 7.5 and 8.5. Alkalinity is the reliable indicator for pH. Alkalinity of both systems (Table 1) was found to be within acceptable limit according to ***Lawson (1995).***

"DO is an important parameter for identification of different water masses" ***(Ibrahim and Ramzy, 2013).*** In addition nitrifying bacteria are aerobic and need oxygen to produce nitrate (NO_3^-) ***(Henriksen et al, 1981).*** However, DO concentration lied within permissible limit according to ***Lioyd (1992)*** in both systems. DO level reported significant ($p\leq0.05$) improvement in aquaponic system with mean value of 6.22±0.05 mg/L as compared to control (6.12±0.03 mg/L) (Table 1). This could be a result of interaction of DO with temperature and TDS, whereas, DO in aquaponic system showed positive loading {moderate in component 1 (0.559) and strong in component 2(0.801)} and negatively correlated with TDS {(-0.228) in component1 and with temperature (-0.404) in component 2} (Table 2 and Fig 2). Therefore, these results might prove the inverse relationship as the temperature and TDS increases, the solubility of oxygen in the water decreases. Moreover, these results were in accordance with results of temperature, which were reported significant ($p\leq0.05$) decrease in aquaponic with mean value of 18.634±0.363 C (Table 1).Temperature in both systems still within permissible limit according to ***Kohinoor (2000)*** *and* ***Anita and Pooja (2013)*** who found that water temperature ranged from 18.5 to 32.9°C and15-30°C, respectively is suitable for fish culture, and it will cause stress to fish at water temperature <12, >35 °C.

The nitrogenous compounds, concentrations fluctuation with water exchange intervals and interaction with other constituents and with each other were recorded in Tables (1, 2 and 3) and Figs (1 and 2).Total ammonia nitrogen (TAN) in the water consists of unionized ammonia (NH3)and ionized ammonia (NH4) ***(Van Rijn et al, 2006).*** Concerning toxic ammonia (NH_3), the maximum concentration in the aquaponic system (0.105 mg/L) was about half of the maximum one in the control (0.295 mg/L) (Table 1), which in agreement with ***EPA (1999)*** who reported that The maximum limit of ammonia concentration for aquatic organisms is 0.1 mg, adding that the level of ammonia (<0.2 mg L1) suitable for pond fishery ***(Anita and Pooja, 2013).*** The major source of ammonia in the aquaculture is feed ***(Hargreaves and Tucker, 2004)*** and a total of nitrogen input into the system as feed, up to 30% maybe captured as fish flesh, and 40% or more captured as plant biomass ***(Fox et al, 2013).*** According to ***Ebeling et al (2006),*** from 80% of nitrogen excreted, 90% contained as ammonia and 10% as urea.

Constant pattern was observed in NH_3 in aquaponic with a negative association with other water elements in all components (Table 2). Moreover, in control system, one day after water exchange the amount of toxic ammonia in both systems was nearly the same (Fig. 1). Meanwhile, in days between water exchanges (in control) there was a trend toward increase in mean values in a duplicate manner than in aquaponic system (Fig.1). This could be associated with the results of pH with slightly alkaline level in aquaponic, in turn increase efficiency of nitrification which is the reason for relatively high pH in most aquaculture facilities. Temperature and pH increment will shift the equilibrium of TAN into ammonia, which is a more toxic element, therefore, "aquaponic approach provided one of the best water quality control in the industry" ***(Savidov, 2004).*** Concerning the nitrite concentrations, there was a significant decrease ($P \leq 0.05$) in aquaponic system with mean values of (0.3765±.11678 mg/L) (Table 1). After one day of water exchange, the nitrite level in control showed a trend toward increase (Fig. 1). Meanwhile, in days between water changes, an increase pattern in mean value of nitrite in control system which was significantly differed ($P \leq 0.05$) in a comparison with aquaponic system (Fig.1). Nitrite is the intermediate product of nitrification process, which is, occur by the action of highly aerobic, gram-negative, chemoautotropic bacteria found naturally in the system ***(Lawson, 1995).*** In aquaponic the conversion rate is quickly so the nitrite level was found to be low into the permissible limit (0.5 mg/L) according to ***Swann (1997)***. Nitrate is relatively non-toxic to Tilapias

(Ibrahim and Ramzy, 2013 and Salam et al, 2013). The pattern of nitrate concentration all over the cycle, or even after one day or between water exchange was nearly constant with one direction of non-significant increase in aquaponic system (Fig.1) which located within the permissible limit according to ***Piper et al (1982)***.The nitrate concentrations in both groups are partially in agreement with the results of ***Stone and Thomforde (2004)*** who found that nitrate is relatively nontoxic to fish and not cause any health hazard except at exceedingly high levels (above 90 mg/ L) and ***Santhosh and Singh (2007)*** who said the favorable range of (0.1 mg/L to 4.0 mg/L) in fish culture water. In addition, levels of nitrate higher than nitrite due to the fast conversion of NO_2^- to NO_3^- ions by nitrifying bacteria ***(Abdel-Satar et al, 2010)*** as nitrate could provide sufficient source of nitrogen for plant ***(Savidov, 2004).*** Results of the other chemical constituents including hardness, Ca^{2+}, Mg^{2+}, Cl^-, Na^+, K^+ and heavy metals (Table 1) showed non-significant decrease in aquaponic than control and reported levels in both systems within the acceptable limits. These results could be attributed to slight increase in Aquaponic pH, whereas, higher pH could favor precipitation of Ca^{2+}, Mg^{2+}, Fe ***(Savidov, 2004).***

2. Experimental infection

The mortality rates in Aquaponic and control systems in a time period of 8 days after fish intra-peritoneal (I.P.) injection by *Aeromonas veronii biovar sobria* were reported in Table (3). Mortality percentage in control group post challenge was observed as in the 2nd day 30%, followed by 20% for 3rd and 4th days and finally at the 5th day 30% completing 100% of the fish. Concerning mortality rate in aquaponic group fish post challenge, the result that observed was only one fish representing 10% at 4th day till the end of the experiment. These mortalities in control system could be attributed to higher toxic ammonia and nitrite which increase the stress and the susceptibility to the infection. Clinical signs in the experimentally infected fish showed exophthalmia, detached scales and hemorrhages all over the body surface, while postmortem examination in those fish revealed congested liver as found in Plate (1). These results are partially in agreement with those obtained by ***Eissa et al (2011); Roberts (2012); Fard et al (2014)***.

From the present study, it was concluded that Aquaponic system overcome poor water quality by improving vital parameters which reflected on fish health and releasing possible stress on challenged fish with bacteria which illustrated in form of low mortality rates.

Table 1: *Physicochemical constituents of the examined water samples for control and aquaponic system*

System		Control			Aquaponic			Permissible limit
Parameter		Min.	Max.	Mean± SE	Min.	Max.	Mean± SE	mg/L
pH		7.44	7.93	7.688±0.021	7.49	8.23	7.876*±0.022	6-9 (Popma and Masser, 1999)
Alkalinity mg/L		16	400	94±44.33	8	200	43.67±15.36	5-500 (Lawson, 1995)
DO (mg/L)		5.76	6.41	6.12±0.03	5.65	6.99	6.22*±0.05	≥5 (Lioyd 1992) 3-5 (Anita and Pooja 2013)
Temperature°C		16.3	22.9	19.779*±0.237	12.8	23.4	18.634±0.363	11-42° C (FAO, 2012)
EC (S/cm)		0.51	1.06	0.681±0.024	0.53	0.8	0.676±0.11	0.1-2 (Stone and Thomforde ,2004)
TDS mg/L		341.7	710.2	456.65±1.23	355.1	536	453.37±8.023	≤500 (Ibrahim and Ramzy 2013)
Nitrogenous compounds	Toxic Ammonia(NH_3)	0.001	0.295	0.068±0.025	0.0003	0.105	0.036±0.009	0.05 (Lawson, 1995) 0.1 max. tolerable level (Pillay and Kutty, 2005)
	Nitrite NO_2^-(mg/L)	0.107	1.782	0.937*±0.136	0.02	1.238	0.377±0.117	0.5(Swann, 1997) ≤1 (Pillay and Kutty, 2005)
	Nitrate NO_3^- (mg/L)	0	1.918	0.476±0.171	0	3.557	1.005±0.265	≤ 10 (Pillay and Kutty, 2005)
Total P(mg/L)		0.54	1.64	1.29±0.126	0.68	1.56	1.17±0.07	0.03-2 (Anita and Pooja, 2013)
Total Hardness (mg/L)		140	230	182±10.16	130	230	165.83±8.02	20 –300 (Santhosh and Singh, 2007)
Ca^{2+} (mg/L)		22.44	40.08	27.76±2.31	24.05	68.14	31.66±3.68	25-100 (Wurts and Durborow, 1992)
Mg^{2+} (mg/L)		18.24	33	27.06*±1.78	14.4	26.4	20.84±1.06	≤ 150 (WHO, 2011)
Cl^- (mg/L)		43.99	84.97	55.61±4.44	36.66	57.98	46.87±1.77	60 (Anita and Pooja, 2013)
Na^+ mg/L		48	73	56.4±4.31	50	66	56.4±3.38526	-
K^+ mg/L		20	68	39±7.87	22	49	32.4±4.85386	-
Fe^{2+} mg/L		0	0.13	0.0328±0.025	0	0.07	0.0214±0.01471	0.0 to 0.15 (Piper *et al.* 1982)
Pb^{2+} mg/L		0	0.11	0.0262±0.022	0	0.06	0.0175±0.0126	0.03 (Piper *et al.* 1982) ; (Swann 1997)
Cd mg/L		0	0.0009	0.0009±0.001	0	0.0006	0.0006±0.001	0.004 (Piper *et al.* 1982) ; Swann (1997)

*Means within a row are significantly different (P ≤ 0.05).

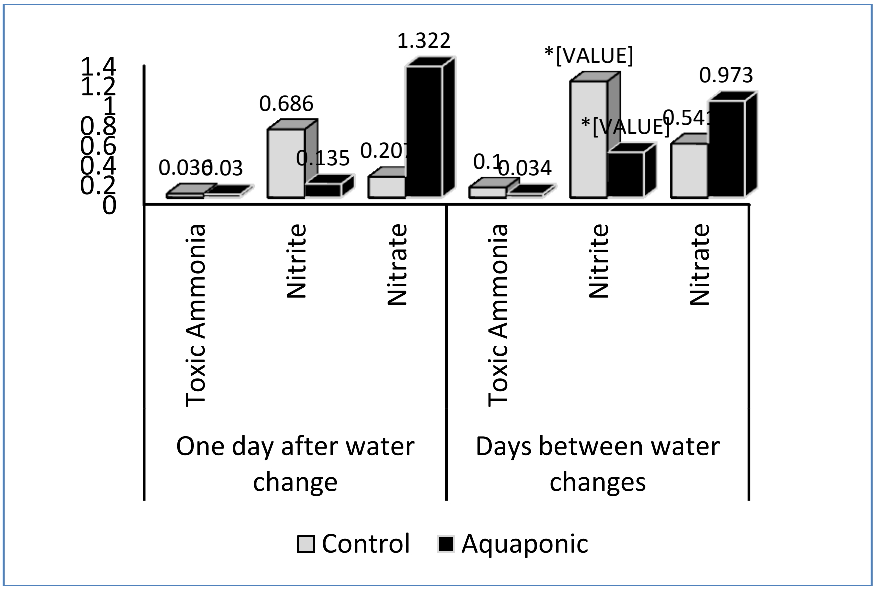


Figure 1: *Concentration of nitrogenous compoundsand their flactuation in control and aquaponic systems*

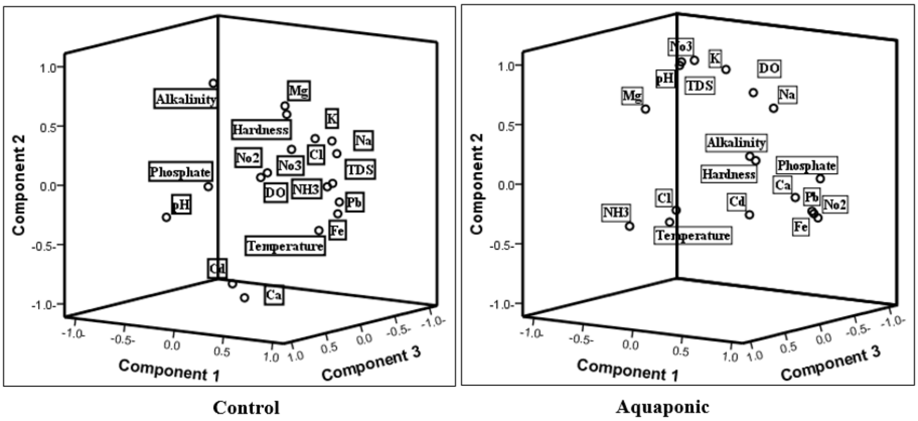


Figure (2): *Component plot in rotated space for water chemistry data in control and Aquaponic systems*

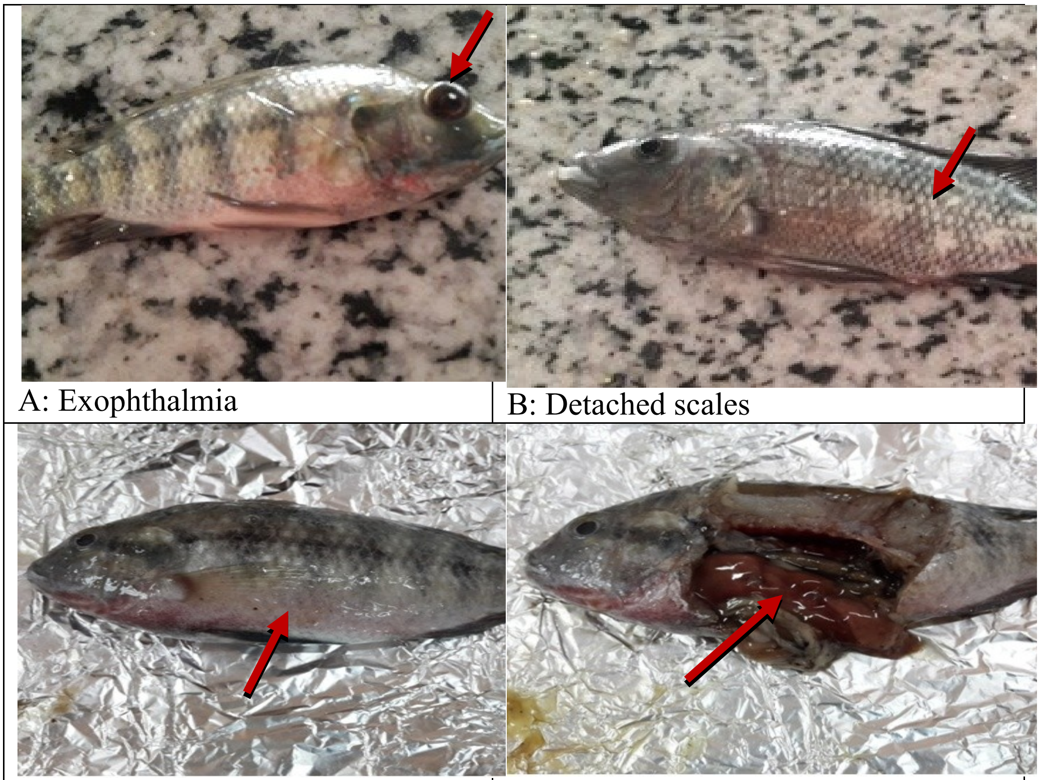
Table 2: *Varimax rotated factor-loading matrix for control and aquaponic systems*

System	Control				Aquaponic			
Components	1	2	3	4	1	2	3	4
pH	-0.456	-0.282	0.572	-0.621	-0.433	0.879	-0.184	0.079
Alkalinity	-0.085	0.865	0.422	0.256	0.284	0.189	-0.173	0.924
DO	0.445	0.134	0.492	0.736	0.559	0.801	0.170	-0.130
Temperature	0.106	-0.539	-0.835	-0.037	-0.396	-0.404	0.014	0.824
EC and TDS	0.455	-0.063	-0.535	0.709	-0.228	0.968	0.084	0.064
NH_3	0.884	0.051	0.155	0.438	-0.843	-0.493	-0.047	-0.211
No_2	0.397	0.145	0.327	0.846	0.823	-0.304	-0.386	-0.287
No_3	-0.260	0.090	-0.961	0.013	-0.106	0.991	0.071	-0.033
Phosphate	0.242	0.104	0.962	0.073	0.542	-0.065	-0.821	0.168
Total Hardness	0.618	0.665	0.361	0.215	0.780	0.294	0.451	0.318
Ca	0.001	-0.983	0.092	0.158	0.980	-0.037	0.165	0.109
Mg	0.575	0.727	0.327	0.183	-0.238	0.644	0.588	0.428
Cl	0.508	0.368	-0.206	0.751	0.309	-0.102	0.925	-0.195
Fe	0.963	-0.174	0.115	0.169	0.956	-0.219	-0.137	-0.140
Pb	0.967	-0.077	0.099	0.221	0.974	-0.189	-0.084	-0.097
Cd	-0.084	-0.866	0.146	-0.471	-0.089	-0.415	-0.699	-0.575
Na	0.897	0.315	0.035	0.307	0.721	0.678	0.110	0.088
K	0.828	0.410	0.007	0.382	0.252	0.958	0.126	0.048
% Explained variance	33.492	23.944	22.471	20.094	36.964	33.442	16.141	13.453
Cumulative %	33.492	57.435	79.906	100.000	36.964	70.406	86.547	100.000

Strong loading values ≥ 0.75, , moderate loading values (0.5-0.75) and weak loading values 0.5–0.3) ***Chen-Wuing Liu et al (2003)***

Table 3: *Mortality percentage in O. niloticus challenged by Aeromonas veronii biovar sobria*

Day post challenge	Control	Aquaponic
Day1	0	0
Day2	3 (30%)	0
Day3	2 (20%)	0
Day4	2 (20%)	1(10%)
Day5	3 (30%)	0
Day6	-	0
Day7	-	0
Day8	-	0
Total	10 (100%)	1(10%)



A: Exophthalmia

B: Detached scales

C: Hemorrhages allover the body surface

D: Congested internal organs

Plate (1) *: Signs and lesions in experimentally infected O. niloticus with Aeromonas veronibiovar sobria*

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الملخص العربي

تقييم تأثير نظام الاكوابونيك على جودة المياه و الحالةالصحية لأسماك البلطي النيلي

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أجريت هذه الدراسه لتقييم تاثير نظام الاكوابونيك على خصائص وجودة المياه وصحة اسماك البلطى النيلى، حيث تم استخدام ١٢٠من اسماك البلطى النيلى السليمه ظاهرياً وتم تقسيمهم بالتساوى الى مجموعتين: مجموعه لنظام الاكوابونيك و المجموعه الضابطه.تم قياس جودة المياه يوميا لبعض العناصرمنها التوصيل الكهربائى، الاس الهيدروجينى، الاكسجين الذائب ودرجة الحراره، ثلاث مرات أسبوعيا للامونيا السامه، النيتريت والنترات، مرتين أسبوعيا للقلويه، الفوسفور الكلى، عسر الاء الكلى، الكالسيوم ، الماغنسيوم والكلوريد ومره أسبوعيا للصوديوم، البوتاسيوم، الحديد ، الرصاص والكادميوم.وقد أظهرت النتائج تحسن ملحوظ فى عناصر المياه فى مجموعه الاكوابونيك مع وجود فرق معنويبالزيادة لصالح الاس الهيدروجيني مع مستوى الاكسجين المذاب وأيضاً أظهرت النتائج فرقاً معنوياً بالنقصان فى نظام الاكوابونيك فى تركيز للأمونيا السامة و النيتريت. من جهة أخرى نتائج عسر المياه، الكالسيوم، الماغنسيوم، الكلوريد، الصوديوم والبوتاسيوم مع المعادن الثقيله أظهرت انخفاض غير معنوى في الاكوابونيك. تم استخدام ١٠أسماك من كل نظام لحقنهم اصطناعيا بميكروب الايروموناس فيرونى بيوفارسوبريالبحث نسبه النفوق بين أسماك البلطى النيلى فى كلا النظامين و قد تبين أن معدل النفوق خلال الخمسة أيام الأولى من بعد حقن الميكروببالمجموعة الضابطه سجل معدل نفوق بنسبة ١٠٠% مقارنه ب ١٠ % معدل نفوق فقط فى اليوم الرابع فى نظام الاكوابونيك. وتبين في الخلاصه ان نظام الاكوابونيك يحسن كفاءة المياه مما يؤثر بالايجاب و يقلل من الضغوط التى توثر على صحه الاسماك وبالتالي انخفاض معدل النفوق.