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Effect of water aquaria changes on growth performance of Nile tilapia *Oreochromis niloticus* and the relationship between bacterial load and biological oxygen demand

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Abstract
In the present study, growth performance of Nile tilapia (*O. niloticus*) was evaluated. Nile tilapia were divided into four groups in two replications according to time of water change, after two days (control), after four days (T1), after six days (T2) and after eight days (T3). The feed was supplied at the ratio of 3% of wet body weight of fish fingerlings twice a day for a period of 12 weeks. Final body weight gain and final body length values of (T1) were significantly (P<0.05) higher than other treatments. Also, the values of the mean growth rate of (T1) were significantly (P<0.05) higher than other treatments. Final body depth values of (T1) were non-significantly (P>0.05) different with control, but it was significantly higher than (T2) and (T3) (P<0.05). The specific growth rate (SGR) values of (T1) were significantly higher than other groups (P<0.05). The best growth performance parameters of Nile tilapia were in (T1), which decreased water consumption too, decreased the cost of fish production by decrease the fuel consuming without affective on growth performance. During the first six weeks the log of total bacterial count in the water increased slightly by increasing the time in all fish groups (C, T1, T2 and T3). By the next weeks (W8, W10 and W12) log of total bacterial count in the water increased markedly until reaching the maximum values at the end of experiment after 12 weeks being 5.3, 5.28, 5.46 and 5.60 Log CFU/ml in C, T1, T2 and T3, respectively. Generally, the values of total bacterial count in water took the lowest values in C followed by T1 and T3 while T3 was the highest values. The BOD_5 in C ranged between 4.9 to 8.6 mgO_2/L. The lowest value of BOD_5 in T1 was 5.5 mgO_2/L and the highest value was 8.2 mgO_2/L. It was observed that the values of BOD_5 in T2 were fluctuating between 5.7 and 7.9 mgO_2/L. The values of BOD_5 in T3 were 6.3, 6.9, 7.2, 7.3, 7.8, 8.2 and 9.2 in W0, W2, W4, W6, W8, W10 and W12, respectively. The values of the correlation coefficient between the log of total bacterial count in water tanks of Nile tilapia during the experimental period and the biological oxygen demand were 0.678, 0.869, 0.879 and 0.896 in C, T1, T2 and T3, respectively, these values occurred between 0.6 and 1.0 and that means the correlation is strong.

Keywords: Growth performance, Nile tilapia, *Oreochromis niloticus*, Microbiological examinations and BOD

1. Introduction
Nowadays, the demand of fish food is increasing throughout the world due to the recognition of its nutritional value [1]. Today, aquaculture is the fastest growing food-producing sector in the world, with an average annual growth rate of 8.9% since 1970, compared to only 1.2% for capture fisheries and 2.8% for terrestrial farmed meat production systems over the same period [2]. The rise of food price and rapid human world population growth, increase the demand of fish consumption [3]. Rising consumer demand for seafood has fostered the development of modern aquaculture [4]. World fisheries production is projected at 164 million tons in 2020, and major increases in the quantity of fish produced will originate from aquaculture at an estimated annual growth rate of 2.8% [5]. Tilapias are a group of species with great economic importance; second only to carps in fishes' global production. Species of tilapia differ in their salinity tolerance, as is expressed in various production traits, such as growth, reproduction and survival. *O. niloticus* (Nile tilapia) dominates in fresh water culture due to its superior performance in this environment [6]. Tilapias are considered as the best species for culturing because of their high tolerance to both adverse environmental conditions and relatively poor water quality [7].

Fish culture is a good source of income and employment for hundreds of millions of people around the world. Aquaculture is the fastest-growing animal-food-producing sector in the world [8, 7]. Climate changes affected on freshwater resources and caused decline the water in the world have been associated with temperature and rainfall [9, 10]. Climate changes lead to changes undesirable to society (e.g. reduced average water availability), or to aquatic ecosystems (e.g. unfavorable changes in river flow regime). Also, it causes the rapid degradation of water quality for downstream users and absolute shortages during droughts [11]. Drought as a result of the evaporation of water and decline the water resources in the world, and building of dams in some region in the world. Fish production can also be increased through water exchange. The water is use in water exchange systems for providing oxygen and clean water from metabolites waste, while the water consumption with large quantities in aquaculture attributed at water exchange, surface evaporation and seepage [12]. The growth performance and feed conversion ratio were clearly affected by water exchange rate [13]. Increasing of fuel prices leads to increase the cost of fish production. For decreasing the water consumption and water exchange cost.

Biochemical Oxygen Demand (BOD) is the total amount of dissolved oxygen required (milligrams per liter or parts per million ppm) by microorganisms for biodegradation of organic matters. It is a common indicator used to measure organic water pollutants [14]**.** Fish and other aquatic animals depend on dissolved oxygen (DO, the oxygen present in the water) to live. The amount of DO in streams is dependent on the water temperature, the quantity of sediment in the stream, the amount of oxygen taken out of the system by respiring and decaying organisms, and the amount of oxygen put back into the system by photosynthesis and aeration [15]. The BOD test is one widely applied method to quantify the consumption of oxygen in the water from the decay of organic matter [16]. Small molecular weight compounds will start to be removed from the waste water immediately. Their removal time may be completed in 1–2 hours. This group of compounds is often referred to as the readily biodegradable or 'Soft' BOD. Other, higher molecular weight compounds will take several hours to be degraded and removed. Yet other compounds are more recalcitrant, and may still be presented after several days. This less readily biodegradable BOD is often referred to as 'Hard' BOD. The mechanism of their degradation and removal was by the microbial enzymes which digest them into small monomers [17]. The optimum value of good water quality is 4 to 6 mg/l of DO, which ensures healthy aquatic life in a water body. The seasonal BOD values were slightly higher in summer and low during winter and rainy season. Higher values of BOD in summer season due to higher microbial activity and elevated temperature [18,19]**.**Therefore, the present study is aimed to determine the optimum time for water change and examines the nutrient utilization and microbial activity of Nile tilapia.

Materials and methods

Experimental design and procedure

These analyses were carried out at Animal Production Laboratory of Department of Animal production, faculty of Agriculture, Damietta University. Tilapia fingerlings were obtained from Abbassa fish hatchery, General Authority for Fish Resources Development, Abbassa, Abo-Hammad, and Sharkia, Egypt. Initially, fish stayed in the glass tanks for one week for acclimation in the laboratory conditions. Tilapia fingerlings were divided to four groups with two replicates for each treatment that, comprising of twenty individuals (weight of 1.33–1.36 g/fish and length of 4.0–4.1 cm/fish) in each experimental tank containing 200 liter of water. The feed was containing 35% crude protein (CP) and supplied at the ratio of 3% of wet body weight of fish fingerlings twice a day for a period of 12 weeks (90 days).

In each experimental tank contain filtration unit for settlement of particulate matter. Too, tanks contain compressor air to supply oxygen into the experimental tanks. Also, Fish tanks were cleaned and collected the faces before water replacing in every group. The water supply was provided from a storage fiberglass tank where, the water was replaced with rate of 50% per once according to group. First group (control) was replacing water every two days and second group was replaced water every four days. While in third group, the water was replaced every six days. Finally, in fourth group, water was replaced every eight days. Growth was estimated by weight the fish in each tank. Too total lengths and body depth of the fish measured every two weeks.

The amount of the feed was adjusted once in two weeks intervals based on the body weight of the fish. Thus, the amount of daily feed ration (DFR) at each sampling time was calculated using the mean body weight (MBW) and the total number of the fish (N) and the feeding rate per day (FR/d) using the following formula: DFR=(MBW×N×FR)/d [20].

Proximate analysis of diet and fish

The tested diets and fish from each treatment were chemically analyzed according to the Standard Methods of [21] for moisture, protein, fat and ash. Moisture content was estimated by heating samples in an oven at 85ºC till constant weight and calculating weight loss. Nitrogen content was measured using a microkjeldahl apparatus and crude protein was estimated by multiplying nitrogen content by 6.25. Total lipid content was determined by ether extraction for 16 hr and ash was determined by combusting samples in a muffle furnace at 550 ºC for 6 hr. Crude fiber was estimated according to [22].

Data analysis

From the experimental data obtained in replicate tanks, weight gain and specific growth rate (SGR) were calculated as described by [23]**.** Condition factor (Cf) and Mean growth rate (MGR) were calculated according to [24].

Weight gain = W2 – W1

SGR = (ln W2 - ln W1/T2-T1) x 100

Mean growth rate (MGR) = [(W2–W1)/0.5(W2+W1) t] ×1000

$Cf= \{(W/L^3)*100\}$

Where; W2 = final weight of fish, W1 = initial weight of fish, T1 = begin of experiment (day), T2 = end of experiment (day), t=experimental period in days, W = Final mean body weight (g), L = Mean standard length (cm), F1 = number of fish at the end of experiment, F2 = number of fish at the beginning of experiment.

Microbiological examinations

Total bacterial count

The tested samples (water) were collected from animal production laboratory and transferred to the microbiology laboratory into the icebox. One ml of water samples was aseptically transferred to 9 ml of sterile water and mixed well for 2 min using a vortex (VM-300 power: 220 VAC, 50Hz,

0.16A/Made in Taiwan-Associated with Cannic, inc U.S.A.) to homogenate the obtained solution [25]. For Total bacterial count of water, poured plate method was used, after preparing suitable serial dilutions of water samples; one ml was transferred into sterile glass Petri dishes in triplicates. Approximate 15 ml of melted nutrient agar medium (45-50 °C) was poured in each plate, then thoroughly mixed and left for solidification. The plates were incubated at 30 °C for 48 hours in a digital incubator (Switc, MPM Instruments s.r.l., Bernareggio/Made in Italy). After the incubation period, separated developed colonies were counted per each plate of the same dilution. The total colonies count per gram or ml of samples was calculated as follows: Total bacterial count = average number of triplicate plates of the same dilution x reciprocal of the dilution used (CFU)/ml or g sample [26].

Biological oxygen demand (BOD_5).

Determination of biological oxygen demand was done using a dissolved oxygen meter (Model: YK-22DO, Power: 9 V battery, Lutron Electronic Enterprise Co., LTD Made in Taiwan). The initial dissolving oxygen (initial DO) was determined using a dissolved oxygen meter directly in the site. Other samples were collected in 125 ml soda glass bottles. These samples were firmly covered and placed in an incubator in the dark for 5 days at 20 °C. At the end of this time, the dissolved oxygen level was determined (final DO). BOD_5 was calculated as the method described by [27].

(BOD^{20}_5) mg/L = (Initial DO - Final DO) x Dilution Factor [28].

Statistical analysis

PROC GLM procedure of the Statistical Analysis Systems [29] was used to analyze the Least-squares means (LSM) and standard errors (SE) in each level of treatments and the differences between means were detected by Duncan`s multiple range test [30]. Regression coefficient analyzed on original data.

Results and discussion

Chemical evaluation of fish samples

Data in Table 1 show that the chemical analyses of experimental diet, which fed to Nile tilapia (*O. niloticus*). Dry matter, ash, organic matter, crude protein, crude fat, fiber and nitrogen free extract were 90.96, 9.65, 81.31, 35.4, 4.35, 6.0 and 35.56%, respectively.

Table 1: Chemical analyses (%) of experimental diet fed to Nile tilapia (*Oreochromis niloticus*).

Measurd parameters	(%) DM based
Dry matter	90.96
Ash	9.65
Organic matter	81.31
Crude protein	35.4
Crude fat	4.35
Fiber	6.0
Nitrogen free extract	35.56

Table 2 shows the mean body weight gain in all different groups at the end of treatment. Mean body weight gain in second week was significantly (P<0.05) lowest for T2 and T3, and non-significantly different for T1. It was significantly higher in T1 than T2 and T3. During the fourth, mean body weight gain of fish was significantly (P<0.05) highest for T1, T2 and T3 compared to control, but it was non-significantly different with T1, T2 and T3. While, Mean body weight gain in sixth week was (P<0.05) significantly higher for T3, but it was non-significantly (P<0.05) different with T1and T2 compared to control. It was in T3 significantly higher than T1 and T2. During eight week, mean body weight gain was significantly (P<0.05) lowest for T1 and T3, and it was non-significantly (P<0.05) highest for T2 compared to control. It was in T2 significantly higher than T1 and T3 (P<0.05). During tenth week, mean body weight gain was significantly (P<0.05) lowest for T2 and T3, and it was significantly highest (P<0.05) for T1 compared to control. It was in T1 significantly higher than T2 and T3 (P<0.05). During twelfth week, mean body weight gain was significantly (P<0.05) higher for T1 and significantly (P<0.05) lower for T2 and T3 compared to control. It was in T1 significantly (P<0.05) higher than T2 and T3.

The mean body length in all different groups at the end of treatment showed in (Table 3). Mean value of initial body length was non-significantly different with all groups. During the second week, mean body length of fish was significantly lowest (P <0.05) for T2 and T3 but it was non-significantly (P <0.05) lower for T1 compared to control. It was non-significant different with T1, T2 and T3. During fourth and eighth weeks, mean body length was non-significant with all groups. During the sixth week, the mean body length of fish was significant (P<0.05) for T3 and non-significantly higher (P<0.05) for T1 and T2 compared to control. It was non-significantly higher in T3 than T1 and T2 (P<0.05). The mean body length in tenth week was significantly highest (P<0.05) for T1 and significantly lowest (P<0.05) for T3, but it was non-significantly different for T2 compared to control. It was in T1 significantly higher than T3 and non-significantly higher than T2 (P<0.05). During the twelfth week, final mean body length of fish was significantly (P<0.05) higher for T1 and significant lower (P<0.05) for T2 and T3 compared to control. It was in T1 significantly (P<0.05) higher than T2 and T3.

Table 4 shows the mean body depth in all different groups at end of treatment. Initial body depth was non-significant with all groups. During second week of feeding, the mean body depth of fish was significantly higher (P<0.05) for T1 and T3 but it was non- significant higher (P<0.05) for T2 compared to control. It was in T1 and T3 non-significant higher than T2 (P<0.05). During fourth and tenth weeks, the mean body depth of fish was non-significant different for all groups. During the sixth week, the mean body depth of fish was significantly highest (P<0.05) for T3 and lowest (P<0.05) for T1 but it was non-significantly for T2 compared to control. It was in T3 significant higher than T1 (P<0.05), and non-significant higher than T2 (P<0.05). During eighth week, the mean body depth of fish was significantly lowest (P<0.05) for T1 and non-significant lowest (P<0.05) T2 and T3 compared to control. It was in T1non-significant lower than T2 and T3. During twelfth week, the mean body depth of fish was significant lowest (P<0.05) for T2 and T3 but it was non-significant different for T1compared to control. It was in T1 significant higher than T2 and T3 (P<0.05).

The mean of specific growth rate (SGR) in all different groups at end of treatment showed in (Table 5). During second week from treatment, the mean SGR of fish was non-significantly different between all groups. While, during fourth week, the mean SGR of fish was significantly highest (P<0.05) for T2, non-significantly different for T1 and T3 compared to control, it was in T2 significantly higher than

T1and T3 (P<0.05). However, during sixth week, mean SGR of fish was significantly highest (P<0.05) for T1, T2 and T3 compared to control. It was non-significantly different with T1, T2 and T3. During eighth week, the mean of SGR was significantly lowest (P<0.05) for T1and T2, and non-significantly different with T3 compared to control. It was in T3 significantly higher than T1 and T2 (P<0.05). During tenth week, mean SGR of fish was significantly lowest (P<0.05) for T2 and T3 but it was non-significantly highest (P<0.05) for T1 compared to control. However, it was in T1 significantly higher than T2 and T3 (P<0.05). During twelfth week, mean SGR of fish was significantly highest (P<0.05) for T1 and lowest (P<0.05) for T2 and T3 compared to control. However, it was in T1significantly higher than T2 and T3 (P<0.05).

Table 6 shows the mean growth rate (MGR) of fish in all different groups at the end of treatment. During second week, MGR of fish was significantly highest (P<0.05) for T1 and non-significantly different with T2 and T3 compared to control. It was in T1 significantly higher than T2 and T3 (P<0.05). During fourth week, MGR of fish was significantly highest (P<0.05) for T1, T2 and T3 compared to control. It was non-significantly different between T1, T2 and T3. During sixth week, MGR of fish was significantly highest (P<0.05) for T3 and T2, and it was non-significantly different with T1 compared to control. It was in T3 significantly higher than T1and T2 (P<0.05). During eighth week, MGR of fish was significantly highest (P<0.05) for T1and significantly lowest (P<0.05) for T2 and T3 compared to control. It was in T1 significantly higher than T2 and T3 (P<0.05). During tenth week, MGR of fish was significantly highest (P<0.05) for T1 and significantly lowest (P<0.05) for T2 and T3 compared to control. It was in T1 significantly higher than T2 and T3 (P<0.05). During twelfth week, MGR of fish was significantly highest (P<0.05) for T1 and significantly lowest (P<0.05) for T2 and T3 compared to control. It was in T1 significantly higher than T2 and T3 (P<0.05).

The mean of condition factor (Cf) in all different groups at end of treatment showed in (Table 7). During second week, mean (Cf) of fish was significantly highest (P<0.05) for T3, and non-significantly highest (P<0.05) for T1and T2 compared to control.

In other hand, it was in T3 significantly higher than T1 and T2 (P<0.05). During fourth week, mean (Cf) of fish was significantly lowest (P<0.05) for T1, T2 and T3 compared to control, but it was non- significantly different with T1, T2 and T3. During sixth week, mean (Cf) of fish was significantly lowest (P<0.05) for T3 and non-significantly highest (P<0.05) for T1 and T2 compared to control. However, it was in T3 significantly lower than T1 and T2 (P<0.05). During eighth, tenth and twelfth weeks mean (Cf) was non-significantly different with each all groups.

Table 8 shows the initial and final composition in the body of Nile tilapia fingerlings (O. *niloticus*) fed experimental diet.

Table 2: Biweekly variations of mean body weight gain (g) of Nile tilapia, *Oreochromis niloticus*, treated at different times.

TRT	W1	W2	W3	W4	W5	W6
C	1.463 ^{a}	1.031 ^{b}	2.320 ^{b}	4.997 ^{a}	8.765 ^{b}	8.362 ^{b}
T1	1.456 ^{a}	1.423 ^{a}	2.532 ^{b}	4.527 ^{b}	9.870 ^{a}	10.100 ^{a}
T2	1.200 ^{b}	1.593 ^{a}	2.775 ^{b}	5.114 ^{a}	7.588^{c}	5.857^{c}
T3	1.251 ^{b}	1.351 ^{a}	3.301 ^{a}	4.826 ^{b}	7.520^{c}	4.551^{d}
±SE	0.082	0.065	0.152	0.220	0.281	0.453

Mean values with different superscripts within a row differ significantly (P<0.05)

Table 3: Biweekly variations of mean body length (cm) of Nile tilapia *Oreochromis niloticus* treated at different times.

TRT	W0	W2	W4	W6	W8	W10	W12
C	4.1	5.5 ^{a}	5.8	7.0 ^{b}	8.5	10.5 ^{ab}	11.9 ^{b}
T1	4.1	5.4 ^{ab}	6.1	7.3 ^{ab}	8.6	10.8 ^{a}	12.2 ^{a}
T2	4.1	5.3 ^{b}	6.1	7.2 ^{ab}	8.7	10.4^{ab}	11.4 ^{c}
T3	4.1	5.3 ^{b}	6.0	7.4 ^{a}	8.7	10.3	11.3^{c}
±SE	0.090	0.080	0.093	0.110	0.119	0.119	0.113

Mean values with different superscripts within a row differ significantly (P<0.05)

Table 4: Biweekly variations of mean body depth (cm) of Nile tilapia *Oreochromis niloticus* treated at different times.

TRT	W0	W2	W4	W6	W8	W10	W12
C	1.2	1.5^{b}	1.8	2.2^{ab}	2.7^{a}	3.2	3.8^{a}
T1	1.2	1.6^{a}	1.8	2.1^{b}	2.5^{b}	3.3	3.8^{a}
T2	1.3	1.6^{ab}	1.8	2.2^{ab}	2.6^{ab}	3.2	3.5^{b}
T3	1.3	1.6^{a}	1.8	2.3^{a}	2.6^{ab}	3.2	3.4^{c}
±SE	0.024	0.025	0.030	0.042	0.043	0.044	0.043

Mean values with different superscripts within a row differ significantly (P<0.05)

Table 5: Biweekly variations of specific growth rate (SGR) values of Nile tilapia *Oreochromis niloticus* treated at different times.

TRT	W2	W4	W6	W8	W10	W12
C.	6.259	1.920^{b}	4.021^{b}	4.458^{a}	3.592^{a}	3.159^{b}
T1	5.555	2.082^{b}	4.749^{a}	3.733^{b}	3.940^{a}	3.941^{a}
T2	5.198	^{a} 2.620	4.622 ^{a}	3.984^{b}	3.045 ^{b}	^{c} 2.664
T3	5.580	2.080^{b}	4.886^{a}	4.243^{a}	3.075^{b}	2.133^{c}
±SE	0.293	0.110	0.253	0.140	0.140	0.214

Mean values with different superscripts within a row differ significantly (P<0.05)

Table 6: Biweekly variations of mean growth rate (MGR) of Nile tilapia *Oreochromis niloticus* treated at different times

TRT	W2	W4	W6	W8	W10	W12
C.	8.035[a]	3.669 [b]	5.210[c]	6.641	6.345[b]	3.813[b]
T1	8.045[a]	5.170 [a]	5.717[c]	6.087	7.198[a]	4.363[a]
T2	6.989[b]	5.579 [a]	6.051[b]	6.317	5.631[c]	2.884[c]
T3	7.101[b]	4.930 [a]	7.301[a]	6.241	5.518[c]	2.314[d]
±SE	0.290	0.290	0.249	0.219	0.184	0.202

Mean values with different superscripts within a row differ significantly (P<0.05)

Table 7: Biweekly variations of condition factor (Cf) of Nile tilapia *Oreochromis niloticus* treated at different times.

TRT	W0	W2	W4	W6	W8	W10	W12
C	2.121	1.555[b]	1.904 [a]	1.700 [a]	1.731	1.713	1.685
T1	2.207	1.623[ab]	1.654 [b]	1.608 [a]	1.637	1.632	1.701
T2	2.158	1.668[ab]	1.741 [b]	1.750[a]	1.701	1.684	1.717
T3	2.153	1.716[a]	1.763 [b]	1.544[b]	1.761	1.719	1.652
±SE	0.111	0.034	0.030	0.029	0.037	0.023	0.020

Mean values with different superscripts within a row differ significantly (P<0.05)

Table 8: Initial and final composition in the body of Nile tilapia fingerlings *Oreochromis niloticus* fed experimental diet (%).

Composition	Initial status	Final composition			
		Control	T1	T2	T3
Moisture	88.7±2.0	84.6±0.9	82.4±1.1	84.0 ±0.9	83.8±0.7
OM	9.30±1.0	12.64±1.06	13.86±0.97	13.76 ±0.62	13.37±0.68
Ash	1.99±0.06	2.78±0.36[ab]	3.72±0.42[b]	2.28±0.44[b]	2.89±0.33[ab]
Crude protein	7.44±0.06	8.48±0.6	9.67±0.48	8.85±0.48	9.03±0.64
Crude lipids	1.36±0.03	2.94±0.41	3.11±0.63	3.52 ±0.43	3.01±0.40
Nitrogen Free Extract	0.50±0.07	1.22±0.35	1.08±0.13	1.39±0.28	1.34±0.17

All values are mean of duplicate feeding groups and values in the same row with different superscripts are significantly different (P<0.05), Nitrogen Free Extract (NFE) = 100- (protein + fat t+ fiber + ash)

The body initial composition was lower than final composition in each all groups. Ash was significantly highest (P<0.05) forT1 and T3, and it was non-significantly lowest (P<0.05) for T2 compared to control in final composition. Moisture, crud protein (CP), Total lipids, nitrogen free extract (NFE) and organic matter (OM) were not affected by varying of water replacing in final composition.

The experiment was aimed at investigating growth performance of Nile tilapia *Oreochromis niloticus* fingerlings during water renewal in different times. The mean body weight gain and body length were improved and no mortality during the time in each experimental groups of this study confirm the suitability of chosen nutritional composition for tilapia juvenile. A strong relationship between survival rate and total length (TL) could indicate that the more the fish survive, the more they grow which could only be informative if other factors such as environmental variables and husbandry requirements in the hatchery remain constant [31].

The highest body weight gain and body length in treatment T1 about control and similar with control in body depth this is indicates that fish can consume the feed well. In this study the feed contained 35% CP. the optimum dietary protein level is 35% for Nile tilapia fingerlings [32]. water exchange rate every four day lead to improvement weight gain and agree with [13] who found that effect of water exchange rate (10 or 20% twice a weekly) of shrimp caused weight gain was highest in highest level of water exchange rate [33]. Reported similar results for shrimp. They showed that growth rate was clearly affected by water exchange rate. The improvement in growth attributed to completely consumed to feed.

The specific growth rate (SGR) was highest in T1. These results are in agreement to the works of [13] who found that effect of water exchange rate (10 or 20% twice a weekly) of shrimp caused specific growth rate was highest in shrimp receiving highest level of water exchange rate and lowest in shrimp receiving lowest level of water exchange rate. The growth and feed conversion ratio of a fish is remarkable tool to compute the acceptability of artificial feed [34]. This result is indicates that fish coefficient in consume sufficient feed to maintain more positive rates of growth. The highest specific growth rate was in agreement with results of body weight, body length and body depth, this point to feed utilization efficiency was high.

Condition factor (Cf) is related to both growth and feeding [35]. Condition factor (Cf) is frequently assumed to reflect not only characteristics of fish such as health, reproductive state and growth, but also characteristics of environment such as water quality [36]. Also, [37] reported that the condition factor provide a measure fatness and food conversion efficiency of fish. In general body composition of tilapia fed experimental diets resulted in improvement crude protein, lipid, moisture content and organic matter compared with the initial status. The improvement attributed to improve in conversion coefficient of diet. The results in the present study demonstrated that the best growth performance parameters were in after four days (T1) of Nile tilapia *Oreochromis niloticus*, may the improvement attributed to fond the diet and its remain for four day after clean that allowed consumed the feed well and agree with [35] they reported that feeding more than once and twice a day (three times) increased growth performance.

The relationship between log of total bacterial count and dissolving oxygen in water tanks of Nile tilapia during twelve weeks

1- The first aquarium (Control, C)

Data in Table 9 showing the effect of temperature and dissolving oxygen on the log of total bacterial count in Control. The temperature of water in the first aquarium (Control, C) was fluctuated between 26.4 and 30.0 ºC in the

sixth and twelfth week. Similar results were obtained by [14]. Who reported that, the temperature played a significant role in some physiological processes. The average temperature recorded was 28.4. Temperature between 30 °C and 35 °C might be responsible for high productivity. The initial dissolving oxygen (DO) in the beginning of the experiment (W0) was 10.5 mg O_2/L, this value decreased during the time until reached its minimum value being 9.4 mg O_2/L at the end of the experiment (W12). The maximum value of final DO was 5.6 mg O_2/L in the beginning of the experiment (W0) and the minimum value was 0.8 mg O_2/L at the end of the experiment (W12). The values of BOD_5 gradually increased by the time from 4.9 mg O_2/L in the W0 to 8.6 mgO_2/L in W12. The log of total bacterial count in water tank during the first six weeks increased slightly by increasing the time. By the next weeks (W8, W10 and W12) log of total bacterial count in the water increased markedly until reached the maximum values at the end of the experiment after 12 weeks being 5.3.

2- The second aquarium (T1)

Data in Table 10 showing, the effect of temperature and dissolving oxygen on the log of total bacterial count in the second aquarium (T1). The lowest temperature was 27.8 ºC in W0 while the highest value was 29.9 ºC in W12. The values of initial DO were between 8.9 and 10.4 mg O_2/L in W4 and W12, respectively. The maximum value of final DO was 4.0 mg O_2/L in the beginning of the experiment (W0) and the minimum value was 2.1 mg O_2/L in W4 [14]. Reported that, a pond with DO ranged in between 3.0-5.0 ppm was unproductive, whereas a good production pond should have DO concentration above 5.0 ppm. However, a very high concentration of oxygen might lead to a state of super saturation that eventually leads to the lethal of fish in the pond. The values of BOD_5 gradually increased by the time from 5.5 mgO_2/L in the W0 to 8.2 mgO_2/L in W12. The log of total bacterial count in water tank increased by the time from 4.15 in W0 to 5.28 in W12.

3- The Third aquarium (T2)

Data in Table 11 showing, the effect of temperature and dissolving oxygen on the log of total bacterial count in the third aquarium (T2). The temperature of water was fluctuated between 26.5 and 39.8 ºC. The initial DO at the beginning of the experiment (W0) was 10.0 mg O_2/L, which decreased during the time and its minimum value was 9.4 mg O_2/L in W4. The maximum value of final DO was 4.3 mg O_2/L in the beginning of the experiment (W0) and the minimum value was 1.8 mg O_2/L at the end of the experiment (W12). The values of BOD_5 gradually increased by the time from 5.7 mgO_2/L in the W0 to 7.9 mgO_2/L in W12. The log of total bacterial count in water tank increased by the time from 4.3 to 5.46 in W0 and W12, respectively. Our results are in a good agreement with those of [14] who reported that, the highest BOD recorded was 4.2 mg/L and the average value was 3.33 mg/L. The unpolluted natural water should have a BOD value of 5 mg/L or less.

4- The fourth aquarium (T3)

Data in Table 12 showing, the effect of temperature and dissolving oxygen on the log of total bacterial count in the fourth aquarium (T3).

Table 9: Effect of temperature and dissolving oxygen on the log of total bacterial count in the first aquarium (Control, C)

C	W0	W2	W4	W6	W8	W10	W12
Temperature ºC	28.9	28.8	27.4	26.4	29.1	29.6	30.0
Initial DO	10.5	10.2	9.8	10.1	10.0	9.7	9.4
Final DO	5.6	3.7	3.2	3.0	2.6	2.3	0.8
BOD_5	4.9	6.5	6.6	7.1	7.4	7.4	8.6
Log of total bacterial count	4.04	4.26	4.33	4.29	4.56	5.19	5.3

Table 10: Effect of temperature and dissolving oxygen on the log of total bacterial count in the second aquarium (T1)

T1	W0	W2	W4	W6	W8	W10	W12
Temperature	27.8	28.5	28.1	27.9	28.2	29.5	29.9
Initial DO	9.5	10.4	8.9	9.7	9.4	10.3	10.4
Final DO	4.0	4.5	2.1	2.9	2.5	2.9	2.2
BOD_5	5.5	5.9	6.8	6.8	6.9	7.4	8.2
Log of total bacterial count	4.15	4.21	4.35	4.57	4.6	5.1	5.28

Table 11: Effect of temperature and dissolving oxygen on the log of total bacterial count in the third aquarium (T2)

T2	W0	W2	W4	W6	W8	W10	W12
Temperature	28.6	27.6	28.3	26.5	28.4	30.4	29.8
Initial DO	10	10	9.4	9.9	9.6	9.5	9.7
Final DO	4.3	4	3.1	3.4	2.5	2.0	1.8
BOD_5	5.7	6.0	6.3	6.5	7.1	7.5	7.9
Log of total bacterial count	4.30	4.25	4.38	4.60	4.71	5.32	5.46

Table 12: Effect of temperature and dissolving oxygen on the log of total bacterial count in the fourth aquarium (T3)

T3	W0	W2	W4	W6	W8	W10	W12
Temperature	28.4	28.1	28.2	27.8	29.5	28.8	29.6
Initial DO	9.8	10.4	10.1	9.7	9.9	10.3	10.5
Final DO	3.5	3.5	2.9	2.4	2.1	2.1	1.3
BOD_5	6.3	6.9	7.2	7.3	7.8	8.2	9.2
Log of total bacterial count	4.29	4.4	4.81	4.85	4.93	5.52	5.6

The lowest value of temperature was 27.8 ºC in W6 and the highest value of temperature was 29.6 ºC in W12. The values of initial DO were between 9.7 and 10.5 mg O_2/L in W6 and W12, respectively. The maximum value of final DO was 3.5 mg O_2/L in the experiment (W0) and the minimum value was 1.3 mg O_2/L in W12.

[19] reported that, DO level was more than 4 mg/L at all sites. Further, DO level was higher in winter followed by summer and rainy season. The reason could be low temperature, turbulence of surface water by high wind action etc., and its level drops in summer due to a high metabolic rate of organisms and limited turbulence in the reservoir. The values of BOD_5 gradually increased by the time from 6.3 mgO_2/L in W0 to 9.2 mgO_2/L in W12. The log of total bacterial count in water tank increased by the time from 4.29 in W0 to 5.6 in W12. Similar results were obtained by [38] who studied the total bacterial count in water, and they found that, total bacterial count varied from not detectable to 4.33 Log CFU/ml.

Our results are similar to those obtained by [39], who found that total bacteria, was 3.75 Log CFU/ml in water. Obtained results were less in microbial count than those obtained by [40] who study the count of total bacteria of *O. niloticus* in an aquarium experiment and found that, total bacterial count was 4.64 Log CFU/ml in water. On the other hand, [41] found that total bacterial count in water of puffer fish (*Fugu niphobles*) housed in glass aquaria ranged from 4.0–5.0 Log CFU/ml. [42] studied the microbiological assessment of Nile tilapia fingerlings in glass aquaria for 16 weeks, and they found that, total bacterial count in the water reached its maximum in the sixth week being 6.90 Log CFU/ml.

The relationship between log of total bacterial count and the biological oxygen demand

The correlation coefficient between log of total bacterial count in water tanks of Nile tilapia and the biological oxygen demand was presented in Fig. 1. The lowest value of correlation coefficient was in the first aquarium (C) being 0.678, this means that, the correlation weak. The values of correlation coefficient in the second aquarium (T1), third aquarium (T2) and fourth aquarium (T3) were 0.869, 0.879 and 0.896, that means that the correlation was strong between log of total bacterial count and BOD_5. [43] Reported that, some authors observed a positive correlation between BOD and Total bacterial count in a river ecosystem highly polluted by industrial pollutants. In contrast, other authors have found a negative correlation between BOD and bacterial indicators in a little polluted water.

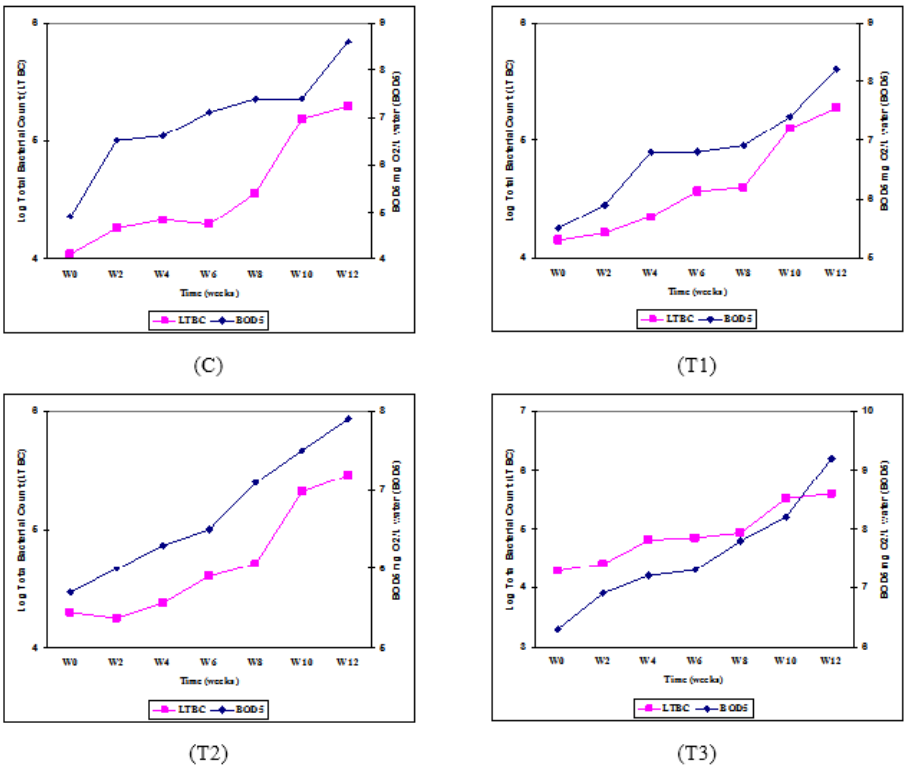

Fig 1: Relationship between total bacteria count and biochemical oxygen demand (BOD) in fish tanks

Where: (C) (control) the first tank of fish group, which replaced water every two days. (T1) the second group, which replaced water every four days. (T2) the third group, which replace water every six days. (T3) the fourth group, which replaced water every eight days

Prediction study

Table 13 showing the production cost of Nile tilapia as a prediction study. The highest total cost (pound) of Nile tilapia was in the first group (control) (C) which replaced water every two days being (1620+225)= 1845 pound. But the lowest total cost (pound) of Nile tilapia was in the fourth group (T3) which replaced water every eight days. Table 13 clearly showed that, there was an economic feasibility for use the second (T1), third (T2) and fourth (T3) groups compared with control (C). So that, the authors recommended T2 because the microbial contamination is lower that other treatments. This treatment also reduces the amount of water consumed from 33225 to 15505 m^3, thus contributing to solve the water crisis. In the present study values showed that T1

was the best of all groups in the gain or loss (Pound), resulting increased in the amount of fish production/fed (Ton), it can be suggested that increasing in amount of fish in T1 resulting four days was allowed to fish eating most of feed before cleaning operation, but in control, the cleaning operation after two days, it cannot eat most of feed. So, the performance parameters in T1of Nile tilapia, *Oreochromis niloticus*, were better than control, this is in agreement with [44] who reported that final body weight referred to feed intake. Increase the palatability of the diet lead to increased feed intake, and increased food consumption has impact on the final body weight**.** In contrast, T2 and T3 long time for replaced water every six and eight days caused change in feed quality and bacterial activity, and might be caused decreased growth performance parameters. This is in agreement with [45] who they showed that over feeding can be detrimental to the health of the fish and may cause a marked deterioration in water quality, reduced weight, poor food utilization, and increased susceptibility to microbial infection.

We concluded that, the best water renewal was every four days, that allow decreasing the water consumption without affective on growth performance of Nile tilapia *Oreochromis niloticus*, and decrease the cost of fish production by decrease the fuel consuming.

Table 13: Predicted results of Nile tilapia (*Oreochromis niloticus*) production cost

Fish groups	The first group (control) (C) which replaced water every two days	The second group (T1) which replaced water every four days	The third group (T2) which replace water every six days	The fourth group (T3) which replaced water every eight days
The Number of renewable water /month	15	7	5	4
The amount of renewable water/ month	33225 m^3	15505 m^3	11075 m^3	8860 m^3
The amount of diesel fuel cost consumed/ month (pound)	300*1.8=540*3= 1620	140*1.8=252*3= 756	100*1.8=180*3= 540	80*1.8= 144*3= 432
The amount of oil cost consumed/ 3 month (pound)	75*3=225	37*3= 111	25*3=75	18*3=54
The labor cost (pound)	3*2500= 7500	3*1500=4500	3*1500=4500	3*1500=4500
The amount of fish production/fed (Ton)	9.436	10.455	8.470	8.040
Fish price /fed (pound)	47175	52270	42350	40200
Fish feed amount (Ton)	6.728	6.817	6.724	8.970
Feed price (pound)	33640	34085	33620	44850
The total cost (pound)	42985	39452	38735	49836
The gain or loss (Pound)	+ 4190	+ 12818	+ 3615	- 9636

References

1. Tingman W, Jian Z, Xiaoshuan Z. Fish product quality evaluation based on temperature monitoring in cold chain. Afr. J. Biotechnol. 2010; 9:6146-6151.
2. Subasinghe RP, Curry D, McGladdery SE, Bartley D. Recent technological innovations in aquaculture. Review of the State of World Aquaculture, FAO Fisheries Circular. 2003, 59-74.
3. FAO. The State of World Fisheries and Aquaculture, Food and Agricultural Organization of the United Nations, Rome, Italy, 2012.
4. Sciacca S, Ferrante M, Conti GO. Mutagens and Carcinogens in Water Resources (Chapter 5). In K. M. Buchanan (Ed.), Water disinfection. Nova Science Publisher, 2011. ISBN: 78-1-61122-021-6.
5. FAO. OECD-FAO Agricultural outlook 2011–2020. Chapter 8. Fish. 2011, 147-158.
6. Cnaani A, Hulata G. Improving salinity tolerance in tilapias: past experience and future prospects. Isr. J. Aquaculture. Bamidgeh. 2011; 63:533.
7. Noor EL, Deen AIE, Mona SZ. Impact of climatic changes (oxygen and temperature) on growth and survival rate of Nile tilapia (*Oreochromis niloticus*). Report and Opinion. 2010; 2:192-195.
8. El-Sayed AFM. Tilapia Culture, CABI Publishing Wallingford Oxford shire, UK, 2006.
9. De Wit M, Stankiewicz J. Changes in surface water supply across Africa with predicted climate change. Science, 2006; 311:1917-192.
10. Bates BC, Kundzewicz ZW, Wu S, Palutikof JP. Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 2008.
11. Alcamo J, Döll P, Henrichs T, Kaspar F, Lehner B, Rösch T *et al*. Development and testing of the WaterGAP 2 global model of water use and availability. Hydrol. Sci. J. 2003; 48(3):317-337.
12. Verdegem MCJ, Eding EH, Rooij JM, Verreth JAJ. Comparison of effluents from pond and recirculating production systems using formulated diets, World Aquac. 1999; 30:28-36.
13. Gaber MM, Omar EA, Abdel-Rahim M, Nour AM, Zaki MA, Srour TM. Effects of stocking density and water exchange rates on growth performance of Tiger Shrimp, Penaeus Semisulcatus cultured in earthen ponds. J. Aquaculture. Res. 2012; 3:7.
14. Soon LK, Lihan S, Dasthagir FFG, Mikal KM, Collick F, Hua NK. Microbiological and physicochemical analysis of water from Empurau fish (Tor Tambroides) farm in Kuching, Sarawak, Malaysian Borneo. Inte. J. Sci. & Tech. Res. 2014; 3(6):285-292.
15. Igbinosa EO, Uyi OO, Odjadjare EE, Ajuzie CU, Orhue

PO, Adewole EM. Assessment of physicochemical qualities, heavy metal concentrations and bacterial pathogens in Shanomi Creek in the Niger Delta, Nigeria. Afr. J. Envir. Sci. and Tech. 2012; 6(11):419-424.
16. Sullivan AB, Snyder DM, Rounds SA. Controls on biochemical oxygen demand in the upper Klamath River, Oregon. Chem. Geol. 2010; 269:12-21.
17. Davies PS. The Biological Basis of Wastewater Treatment. Strathkelvin Instruments Ltd, Glasgow, UK, 2005.
18. Olutiola PO, Famurewa O, Sonntag HG. Introduction to General Microbiology: A Practical Approach. 2nd Ed., Bolabay Publications, Ikeja, Nigeria, 2000.
19. Basavaraja D, Narayana J, Kiran BR, Puttaiah ET. Fish diversity and abundance in relation to water quality of Anjanapura reservoir, Karnataka, India. Int. J. Curr. Microbiol. App. Sci. 2014; 3(3):747-757.
20. Nandlal S, Pickering T. Tilapia fish farming in Pacific island countries: Tilapia hatchery operation, Noumea, New Caledonia. PMid: 2004; 22(1):6-13.
21. AOAC. Association of Official Analytical Chemists Official Methods of Analyses. 15th Ed. In: K. Helrich Ed. Inc., Arlington, VA, USA, 1990.
22. Goering HK, Soest PGV. Forage Fiber Analysis (apparatus, reagent, procedures, and some applications). US Dept. Agric. Handbook, Washington, D.C., USA. 1970, 379.
23. Sveier H, Raae AJ, Lied E. Growth and protein turnover in Atlantic salmon (Samo salar L.); the effect of dietary protein level and protein particle size. Aquaculture. 2000; 185:101-120.
24. Eyo VO, Ekanem A. Effect of feeding frequency on the growth, food utilization and survival of African catfish (Clarias gariepinus) using locally formulated diet. Afr. J. Environ. Pollute. Health. 2011; 9:11-16.
25. Ozogul Y, Ozogul F, Kuley E, Ozkutuk AS, Gokbulut C, Kose S. Biochemical, sensory and microbiological attributes of wild turbot (Scophthalmus maximus), from the Black Sea, during chilled storage. Food Chem. 2006; 99:752-758.
26. Anon. Compendium of Methods for the Microbiological Examination of Foods. 3rd Ed., American Public Health Association. Washington, D.C., USA, 1992.
27. Stirling HP. Chemical and Biological Methods of Water Analysis for Aquaculturists. Institute of Aquaculture, University of Stirling, Scotland, 1985.
28. APHA. American Public Health Association Standard Methods for the Examination of Water and Wastewater, Amer. Publ. Heal. Assoc., Amer. Water Works Assoc. and Water Poll. Contr. Fed., Washington, DC, 2005.
29. SAS. Statistical Analysis System (2004).Version. 90. SAS Institute Inc. Cary, NC.
30. Duncan DB. Multiple range and multiple F-test. Biometrics. 1955; 11:1-24.
31. Musa SM, Aura CM, Ngugi CC, Kundu R. The effect of three different feed types on growth performance and survival of African catfish fry (Clarias gariepinus) reared in a hatchery. ISRN Zoology. 2012, 1-6.
32. Khattab YAE, Ahmad MH, Shalaby AME, Abdel-Tawwab M. Response of Nile tilapia (*Oreochromis niloticus* L.) from different locations to different dietary protein levels. Egypt. J. Aqua. Biol. and Fish. 2000; 4(4):295-311.
33. Allan GL, Maguire GB. The effects of water exchange on production of Metapenaeus macleayi and water quality in experimental pools. J. World Aquaculture Soc. 1993; 24:321-328.
34. Ekanem AP, Eyo VO, Ndome CB. The Effect of Diet with Different Inclusion Level of cassava leaf meal (CLM) Manihot utilissima on the growth performance of Heteroclarias Fingerlings. J. of Sci. and Multidisciplinary Res. 2010; 2:58-67.
35. Başçınar N, Çakmak E, Çavdar Y, Aksungur N. The effect of feeding frequency on growth performance and feed conversion rate of Black Sea Trout (Salmo trutta labrax Pallas, 1811). Turkish J. Fisheries and Aquatic Sciences. 2007; 7:13-17.
36. Liao H, Pierce CL, Whahl DH, Rasmussen JB, Leggett WC. Relative weight (wt) as a field assessment tool; relationships with growth, prey biomes, and environmental Condition. Trans. Amer. Fish. Soc. 1995; 124:387-400.
37. Power DM. The physiology of growth. Trout News, 1990; 10:20-23.
38. Fulford MR, Walker JT, Martin MV, Marsh PD. Total viable counts, ATP, and endotoxin levels as potential markers of microbial contamination of dental unit water systems. Br. Dent. J. 2004; 196:157-169.
39. Al-Harbi AH, Uddin N, Quantitative and qualitative studies on bacterial flora of hybrid tilapia (*Oreochromis niloticus* X O. aureus) cultured in earthen ponds in Saudi Arabia. Aquac. Res. 2003; 34:43-8.
40. Shalaby AM, Khattab YA, Abdel Rahman AM. Effects of garlic (Allium sativum) and chloramphenicol on growth performance, physiological parameters and survival of Nile tilapia (*Oreochromis niloticus*). J. Venom. Anim. Toxins incl. Trop. Dis. 2006; 12(2):173-201.
41. Sugita H, Iwata J, Miyajima C, Kubo T, Noguchi T, Hashimoto K, Deguchi Y. Changes in microflora of a puffer fish, Fugu niphobles, with different water temperatures. Mar. Biol. 1989; 101:299-304.
42. Abdelhamid MA, Maghraby NA, Mehrim AI, Soliman AAA. Physiological, biochemical and microbiological assessment for non conventional feedstuffs by Nile tilapia fish Egyptian J. Nutrition and Feeds. 2012; 15(1):359-366.
43. Kagalou I, Tsimarakis G, Bezirtzoglou E. Interrelationships between bacteriological and chemical variations in lake Pamvotis-Greece. Microbe. Ecol. Health Dis. 2002; 14:37-41.
44. Bichi AH, Ahmed MK. Growth performance and nutrient utilization of African catfish (Clarias gariepinus) fed varying dietary levels of processed cassava leaves. Bayero J. Pure and Applied Sciences, 2010; 3(1):118-122.
45. Priestley SM, Stevenson AE, Alexander LG. The influence of feeding frequency on growth and body condition of the Common Goldfish (Carassius auratus). J. Nutr. 2006; 136:1979S-1981S.