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EFFECT OF DIFFERENT AERATION SYSTEMS ON NILE TILAPIA (*Oreochromis niloticus*) PRODUCTION

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ABSTRACT

This study was carried out during the season of 2014 at the Central Laboratory of Aquaculture Research, Abbassa, Abu-Hammad District, Sharkia Governorate, Egypt, to evaluate effect of different aeration systems namely air stone, shower, vinture and agitation systems on Nile tilapia fingerlings (*O. niloticus*) growth performance and water quality. These aeration systems were used under different stocking densities of 100, 150 and 200 fish/m^3 and different feed frequencies (once and twice daily), under intensive condition of aquaculture and taking into consideration the net profit. The obtained results revealed that the shower aeration system exhibited the highest net profit 3.2, 28.5 and 53.7LE/m^3, with all fish stock densities, compared with other systems. It is also maintain water quality parameter in safety limits for success aquaculture, the data obtained with shower system, fish density (FD) 100 fish/m^3 and feed frequency (FF) twice daily for dissolved oxygen (DO), NH_3 and pH were 6.31mg/l, 0.014mg/l, 7.49, respectively. And for final weight, feed conversion ratio (FCR), relative growth rate (RGR%), specific growth rate (SGR%) and survival rate %, the data were 34.7g, 1.24, 330.2, 1.69 and 95, respectively.

Key words: Aeration systems, growth performance, water quality, total cost.

INTRODUCTION

Aquaculture pond aeration is vital to the energetic health and vitality of fish, where without enough oxygen, fish become stressed and their growth rate go down. Additionally, the lack of oxygen at the bottom of the pond will allow the build-up of fish waste and other organic nutrients.

It is known that the intensive fish culture system often need to be provided by the artificial aeration systems, these systems vary from emergency aeration: operated only when the oxygen level drops to dangerous values, through ordinary night-time aeration, to continually operating aeration systems in highly stocked ponds.

Aeration is the process of bringing water and air into close contact by exposing drops or thin sheets of water to the air or by introducing small bubbles of air.

However the aquaculture aerators are similar to those used in wastewater aeration, actually the wastewater aerators generally are too expensive for using in aquaculture, and less expensive modifications of wastewater aerators have been developed for aquaculture. Boyd (1998) indicated that all basic types of mechanical aerators have been used in aquaculture, but vertical pumps, pump sprayers, propeller-aspirator-pumps, paddle wheels, and diffused-air systems are most common in pond aquaculture. He added that gravity aerators, nozzle aerators, and pure oxygen contact systems are used in fish and crustacean hatcheries and in highly intensive production systems such as raceways and tanks.

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Peterson and Pearson (2000) found that, the dissolved oxygen capacity of water is limited to a few mg/l, in contrast to the 21% oxygen content of air. Natural re-aeration at the surface of a water body is limited by molecular diffusion, unless turbulence and extended surface area are provide by wind, waves, or currents. They added that the mechanical aeration allows much higher biomass concentrations than could be supported in a natural waterway. Aerators serve as the 'lungs' of an intensive aquaculture pond; pumping oxygen into the water column; and stripping carbon dioxide out.

The aeration is an effective method for improving water quality, and can accelerate oxidation and decomposition of pollutants by providing sufficient DO in water (Raul, 2007).

Many countries are still suffering of vital diseases due to shortage of protein, so no one can deny the importance of fish as a source of animal protein and important source for national income.

Ministry of Agriculture and Land Reclamation (2007) reported that total fish production in Egypt is about 970,000 tons, of which about 375,000 tons (38.72%) are obtained from fisheries and 595,000 tons (61.28%) from aquaculture.

El-Naggar *et al.* (2008) cleared that fisheries and aquaculture in Egypt is an important component of the agricultural sector and a significant source of animal protein.

MSSP (2001) found that the most species of fish production in Egypt are tilapia (40% of production from all sources) and grey mullet (about 14%). These two groups account for more than half of all fish produced.

It is obvious that, Nile tilapia is the most common fish in the Egyptian market. Hence, the main objectives of this study is to evaluate different types of artificial aeration systems for Nile tilapia fingerlings production through investigating their influence on water quality and growth performance of fish as intensive fish culture systems.

MATERIALS AND METHODS

All the laboratory experiments were carried out during the season of 2014 from 1jule to 30 September at the Central Laboratory of Aquaculture Research Abbassa, Abu-Hammad District, Sharkia Governorate, Egypt.

Materials

Fish tanks

Circular fish tanks made from fiberglass with a diameter of 80 cm, and a depth of 60cm were used to accomplish all experiments of this study.

Fish

Tank were stocked with Nile tilapia (mono sex) with an average initial weight of 7.5±0.5g, fingerlings were purchased from the hatchery, Central Laboratory of Aquaculture Research Abbassa, Abu-Hammad District, Sharkia Governorate, Egypt.

Fish feed

Fish were fed by hand once or twice a day on prepared sinker commercial pelleted fish feed (30% crude proteins) by the ratio of 3% of total biomass. The amount of feed was readjusted according to weight every two weeks of fish samples. The Composition and proximate chemical analysis of experimental diet are shown in Table 1.

Aeration Systems Description

Air stone system

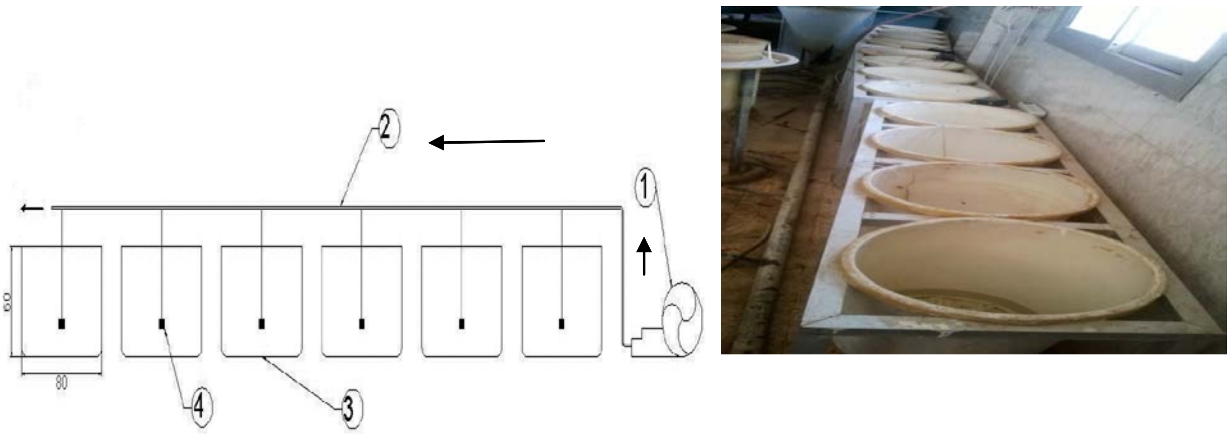
The air stone system consisted mainly of blower (Model, LD 013 H43 R14, power 1.5kW, max. flow 175m^3/hr.), pipes made from PE and air stone as seen in Fig. 1. Every fish tank was provided with air flow 40.75 m^3air.hr/$m^3$of water.

Vinture system

The system consisted mainly of venture 1inch, PVC valves 1 inch, PVC Elbows, PVC Character T, PVC pipe 1inch and water pump (RJ 050 0 0.5 HP) power (0.5HP), Volt. 220, flow capacity 32 l/min., head charge 38 m where the system used the maximum flow of the pump, where water remains with the air distance of less than 3.5 m for non-water saturation with nitrogen,

Table 1. Composition and proximate chemical analysis of experimental diet

Diet composition	(%)	Chemical analysis of diet	(%)
Fish meal (70%)	10.4	**Moisture**	8.77
Soybean meal (44%)	42.98	**Crude protein**	30.1
Yellow corn (8.5%)	20.32	**Crude fat**	7.18
Starch	4.0	**Crude fiber**	5.30
Wheat bran (WB)	15.49	**Ash**	7.18
Vegetable oil	1.50		
Cod fish oil	2.31		
Vitamin mixture	1.0		
Mineral premix	2.0		
Total	100		



1-Blower. 2-Tube. 3-Tank. 4-Air stone.

Fig. 1. The air stone aeration system

according to Dick and Glasscock (2003) the depth of air diffuser in the aeration well must not exceed 3.5 meters, as there then is a risk of super saturation with nitrogen as shown in Fig. 2.

Shower system

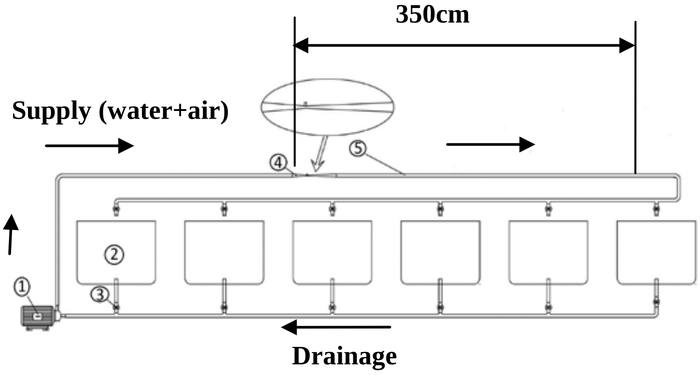
The system consisted mainly of shower (diameter 8 cm and holes 1.5 mm), submerged pump (model (sp-2500) power (32W), Volt. 220/110, flow capacity 400 l/hr., head charge 2 m.), PVC pipe 0.5 inch PVC Elbows, PVC Character T and PVC valves 1inch and 0.5 inch, where flow rate of the system was 330 l/hr., as shown in Fig. 3.

Agitation system

The system consisted mainly of a heavy duty motor with one impeller attached to the end of the rotating shaft, with rotate at 1650 rpm 220 Volt DC, 37.3 W 50H, inside the epoxy coated quarter-inch screen basket in bubbles so providing enough oxygen on the superficial layer of water though fish ponds (Fig. 4).

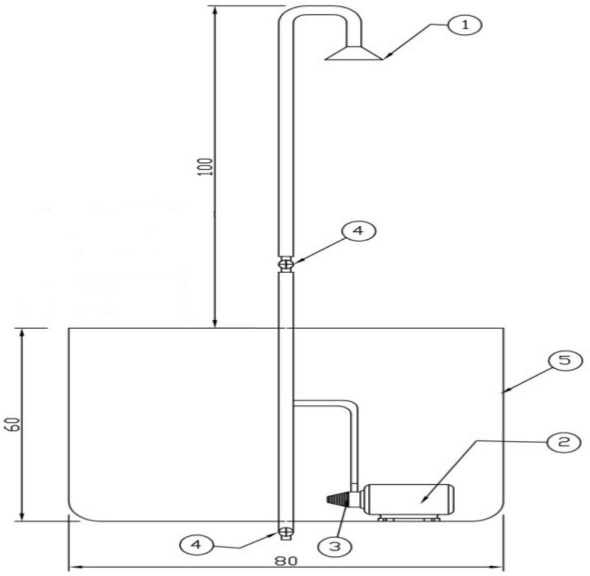
Oxygen and temperature meter

Its model is: DOH-SD1and has measurement rang 0.00 – 20.00 mg/l of dissolved oxygen. In addition it was used to measure temperature of water.



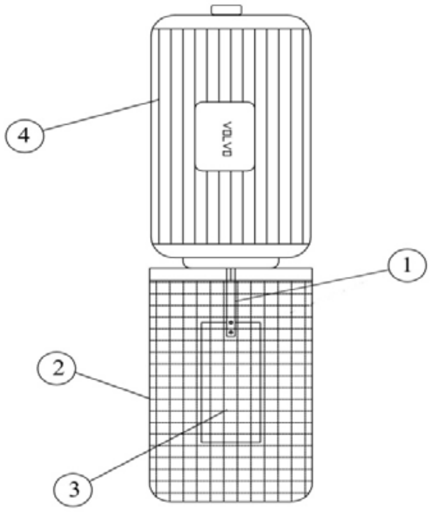
1-Water pump. 2-Tank. 3-Valve. 4-Venture. 5-Tube.

Fig. 2. The vinture aeration system



1-Shower. 2-Submerged pump. 3-Filter. 4-Valve. 5-Tank. 6-Drainage valve.

Fig. 3. The shower aeration system



1-Rotating shaft. 2- Epoxy 3-impeller. 4- Motor

Fig. 4. The agitation aeration system

pH meter

It is a digital mini-pH meter (Model AD110).

Methodology

Preliminary experiments

Each of investigated aeration systems were operated 12 hours a day intermittently in order to reach dissolved oxygen (DO) concentration 7 ±0.2 (close to saturation level) for all treatments and 30% of water tank was replaced with fresh water every two days.

Flow rate of venture system was 1500 l/hr. It was necessary that flow rate not less than 1500 l/hr., to exceed the critical velocity of water into the venture that made discharge, which led to the entry of air into water pipe.

Flow rate of shower system was 1350 l/hr., to reach the above mentioned DO level.

Air flow rate for air stone system was 40 $m^3$of air per1$m^3$of water per hour to reach also to the above mentioned DO level.

The least length blades of agitator was10 cm. It was immersed underneath the water surface of tank in agitation system reach the above mentioned DO concentration.

The main experiment

The main experiments were carried out to evaluate the effect of different aeration systems on Nile tilapia growth, and water quality using 200 liter of water in every tank under the following variables.

- Aeration systems.
- Feed frequency once and twice daily.
- Fish stock densities of 100, 150 and 200 fish/ m^3.

The studied aeration systems namely, venture system, shower system and agitation system in addition to air stone system as a control system.

Measurements

Water quality measurements

Dissolved Oxygen:

Water dissolved oxygen (DO) was daily monitored at 10 am by using oxygen meter.

Water pH

Water pH was daily recorded at 400 ppm with pH meter. Samples were measured by methods described in Boyd and Teichert-Coddington (1992).

Unionized ammonia (NH_3)

The percentages of unionized ammonia (NH_3) was calculated from multiplying the total ammonia value by the appropriate factor according to the following equation:

$$NH_3\text{-}N = A/100 \times \text{total ammonia}$$

Where A is a coefficient related to water pH and temperature at sampling time determined from the table at different pH values and temperatures (Boyd, 1995).

Total ammonia concentration were analyzed by Nessler method (APHA, 1985).

Water temperature

Water temperature (C°) was recorded daily by using Oxygen and temperature meter.

Fish growth measurements

Final body weight (BW)

Fish were collected from each tank every two weeks, and were put in bucket filled with water and weight in 90 days in order to get the individual weight.

Feed conversion ratio (FCR)

The feed conversion ratio (FCR) was calculated for each tested treatment by using the following equation:

$$FCR = \frac{\text{Feed consumed during the period}}{\text{Gain in live weight during the same period}}$$

FCR = Feed intake (g) / Weight gain (g). (Pillary, 1990).

Relative growth rate (RGR,%)

The relative growth rate was measured using the following equation:

$$RGR = \frac{\text{Final weight - Intial wegith} \times 100}{\text{Intial weight}}$$

Specific growth rate (SGR, %)

SGR was calculated according to Jauncey and Rose (1982) as follows:

SGR = In W2 – In W1/perid in days × 100

Production cost

The cost of experimental units included costs of each of water pump, plastic materials, fish, fish feeding, electric, aeration equipment and tank.

Estimation of operation costs

The cost analysis was performed considering the conventional method of estimating both fixed and variable costs.

Calculation of fixed costs

Depreciation costs

Deprecation is expressed by the equation:

$$\text{Deprecation cost} = \frac{\text{Initial price - Salvage value}}{\text{useful life in hours}},$$

(Shepley and Schantz, 1984).

Salvage value has been assumed as 0.1 of the initial price.

Interest costs

$$\text{Interest} = \frac{\text{Unit price} + \text{Salvage value x 0.18}}{\text{2 x Yearly operation hours}},$$

(Shepley and Schantz, 1984).

Miscellaneous costs

Miscellaneous cost includes expenses for insurance fees, license fees, taxes …*etc*.

Miscellaneous costs = (V + F) x 0.05

Where:

V = Variable costs.

F = Fixed costs.

0.05= coefficient of miscellaneous costs assumed as a percentage of variable and fixed costs.

Calculation of variable costs

Labor cost

The cost of labor varies with location, hence the prevailing wage rate for single labor was found to be 5 $LE.Mg^{-1}$.

Electricity costs

The cost of electricity was determined according to the following:

Electricity consumption = 0.3 LE.kW.hr.

Determination of operation cost

The electric power consumption was calculated through the following equation:

$$P = I.V. \cos\theta os$$

I = Line current strength in amperes.

V = Potential difference (Voltage) being equal to 220V.

cos ϴ = power factor being equal to (0.84).

η =mechanical efficiency assumed (0.95).

Determination of specific of energy consumed

Specific energy consumed

$$= \frac{\text{Power consumed (kW)}}{\text{Actual productivity (m}^3\text{/hr.)}}$$

Repair and maintenance costs

Repair and maintenance costs are expression based on the accumulated use of the equipment and are set to be equal to the accumulated repair and maintenance divided by the lest price of the equipment. The repair and maintenance costs were determined as follows:

Repair and maintenance costs= 90% deprecation.

Net profit

The economical profit of fish yield was calculated by using following formula (Younis *et al.*, 1991).

$$P = (Yt \times d) - Ct$$

Where :

P = Net profit , LE /m^3,

Yt = Total yield , kg/m^3,

D= Yield price, 10 LE/kg, and

Ct = Total production costs, LE/m^3

Statistical Analysis

The obtained data were subjected to three-way ANOVA, to test effects of aeration system, feeding rate, and stocking density as the three studied factors. Duncan multiple range test was used as a post-hoc test to compare between means at $P \leq 0.05$. All the tests were done using SPSS software, version 15 (SPSS, Richmond, Virginia, USA) according to Dytham (1999).

RESULTS AND DISCUSSION

The obtained results were discussed under the following heading.

Water Quality

The ability to maintain water quality parameters such as dissolved oxygen, temperature, pH and NH_3 in safety limits is the key for successful aquaculture.

Dissolved oxygen (DO)

In general the average dissolved oxygen after an experimental period of 12 week for all treatments was affected significantly ($P<0.05$) by fish density, feed frequency, aeration systems and the interactions between feed frequency (FF)aeration systems (AS), as seen in Table 2.

Regardless the effects of both fish density and aeration systems, it can be seen that feed frequency had affected significantly ($P<0.05$) on DO. Where feeding twice daily showed significant ($P<0.05$) increase in DO compared with feeding once a day. These results may be attributed to decreasing amount of uneaten feed that compete fish on DO, and consume large amount from DO during operation of analysis.

Also, regardless the effects of both aeration systems and feed frequency, it noticed that fish density affected significantly ($P<0.05$) on DO, fish groups with stock density (100 fish/m^3) showed significant ($P<0.05$) increase in DO, compared with that fish stoke density of 150 and 200 fish/m^3. These results may be due to increase of biomass that consumed large amount of DO.

Finally, regardless the effect of both fish density and feed frequency, it is cleared that aeration systems affected significantly ($P < 0.05$) on DO, where the most effective system was agitation system (agitator) which gave 6.98 mg/l, followed by the shower system which gave 6.31 mg/l compared to other aeration systems (air stone and vinture) as shown in Fig. 5. These results trends may be due to increase rpm of agitation and increase blending of between the water and air leading to the production of large amount of DO.

On the other hand the high DO concentration during the treatment of shower unit may be referred to increase the contact surface area between the water and air because of small drips that had large surface area with air.

Based on the above discussion the highest DO value was 6.98 mg/l with agitation system, fish density 100 fish/$m^3$and feed frequency twice daily. While lowest DO value was 4.29 mg/l due to using vinture system, fish density 200 fish/m^3 and feed frequency once daily.

Table 2. Three way ANOVA of water quality(WQ) parameters affected by aeration systems (AS), feed frequency (FF), fish density (FD) and their interactions

WQ. parameter / Treatment	Alk	Hard	pH	Ammonia	Temp	DO
FF	0.916	0.558	0.367	0.0001	0.745	0.0001
AS	0.349	0.755	0.298	0.017	0.0001	0.0001
FD	0.469	0.930	0.312	0.0001	0.276	0.0001
FF × AS	0.916	0.384	0.365	0.632	0.536	0.0001
FF × FD	0.952	0.656	0.315	0.114	0.917	0.182
AS × FD	0.962	0.568	0.463	0.759	0.173	0.320
FF × AS × FD	0.997	0.699	0.536	0.621	0.984	0.557

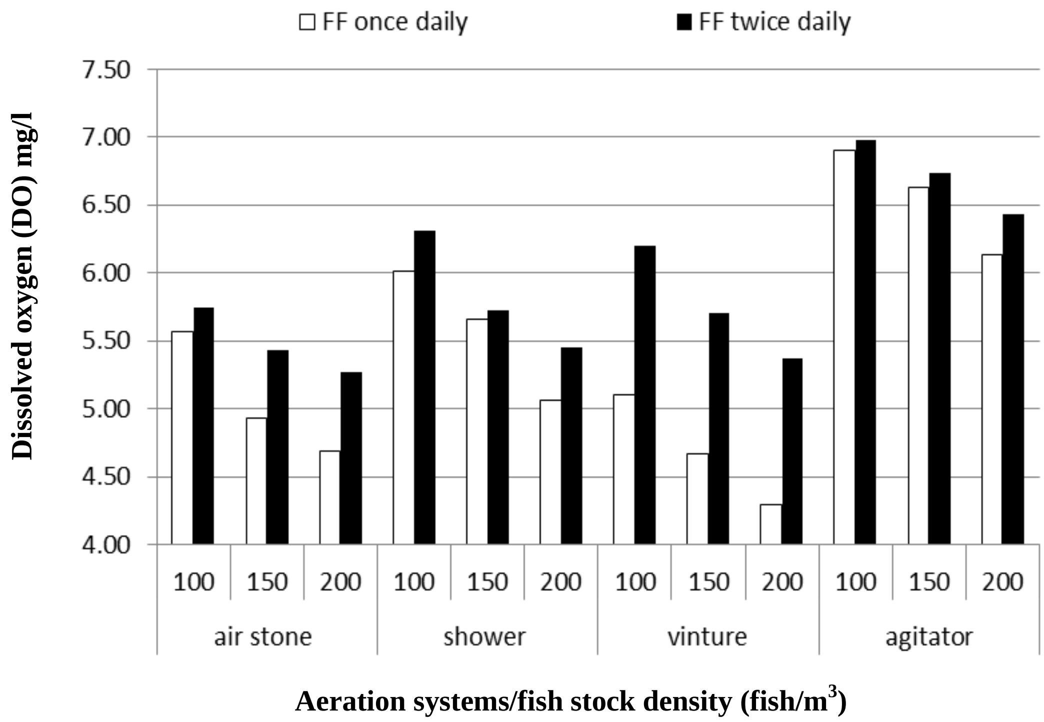


Fig. 5. Effects of the studied variables on the average of DO mg/l of water using after 12 weeks

From the obtained data, it is cleared that DO content in the four systems were in the safety limits for successful fish production as reported by Boyd (1990) and Shaker and Mahmoud (2007). The interactions between all treatments of the experiments did not show significant effect on ($P > 0.05$) dissolved oxygen concentration.

pH

At the end of experimental period (12 weeks) fish groups for all studied variables and their interactions did not show significant ($P>0.05$) effects on pH (Table 2). Where pH was ranged from 7.24 to 7.76, as shown in Fig. 6. These results may be due to high dissolved oxygen that happened in all treatments.

The data obtained from this study indicated that the range of pH in all treatments of the experiment was within the favorable limits needed for the growth and survival of fish and comply with the results of Shaker and Abdel Aal (2006), who reported that fish generally can tolerate a pH range from 6 to 9.5, although a rapid pH change of two units or more is harmful, especially to fry.

Unionized ammonia (NH_3)

The obtained data indicated that unionized ammonia (NH_3) is affected significantly ($P<0.05$) by all variables of the experiment. While their interactions did not show significant effects ($P>0.05$) on NH_3, as shown in Table 2.

Regardless the effects of both aeration systems and feed frequency, it is noticed that fish density affected significantly ($P<0.05$) on unionized ammonia (NH_3), fish group with stock density (100 fish/m^3) showed significant ($P<0.05$) decrease in NH_3 compared with stock densities of 150 and 200 fish/m^3. These results trends may be due to the large amount of faeces that was produced from high densities.

Also regardless the effect of aeration systems and fish density, it is seen that feed frequency affected significantly ($P<0.05$) on unionized ammonia (NH_3), Where feeding twice daily showed significant ($P<0.05$) decrease in NH3compared with that fed once daily. This result means that feed frequency adversely proportional with unionized ammonia (NH_3). These results may be due to the large amount of uneaten food that resulted from addition the quantity of feed once a day. Regardless the effect of feed frequency and fish density, aeration systems affected significantly ($P<0.05$) on unionized ammonia (NH_3). Where agitation system (agitator) showed significant ($P<0.05$) decrease in NH_3 compared with other systems (vinture, shower and air stone). These results may be due to high oxygenation and high ability of blending water with air especially water near the bottom of tank that contain fesses and uneaten food.

Finally regardless the effect of both aeration systems and feed frequency, it is obvious that fish density affected significantly ($P<0.05$) on unionized ammonia (NH_3), Where FD 100 fish/m^3 showed significant ($P<0.05$) decrease in NH_3 compared with FD 150 and 200 fish/m^3. This result may be due to large amount of feaces that resulted from high FD compared with low FD, so these results means that FD proportional with unionized ammonia (NH_3).

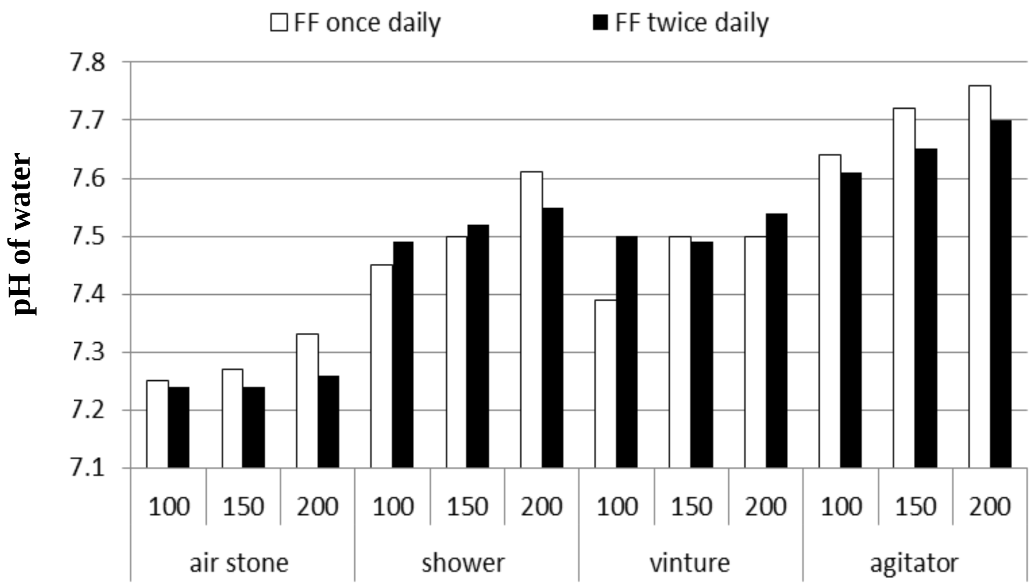
Based on the above the least NH_3 value was 0.013mg/l by using agitation system fish density 100 fish/m^3 and feed frequency twice daily, while the highest value was 0.032 mg/l as using vinture system, fish density 200 fish/m^3 and feed frequency once daily, and also as using agitation system, fish density 200 fish/m^3 and feed frequency once daily as shown in Fig. 7. Where NH_3 proportional to fish stock density and inversely with feed frequency, these results may be due to the large amounts of faeces that were produced from high densities, the large amount of uneaten food that resulted from addition the quantity of feed once a day and the high ability of agitator to mix water with air especially water near the bottom of tank that contain fesses and uneaten food.

Growth Parameters

Final weight

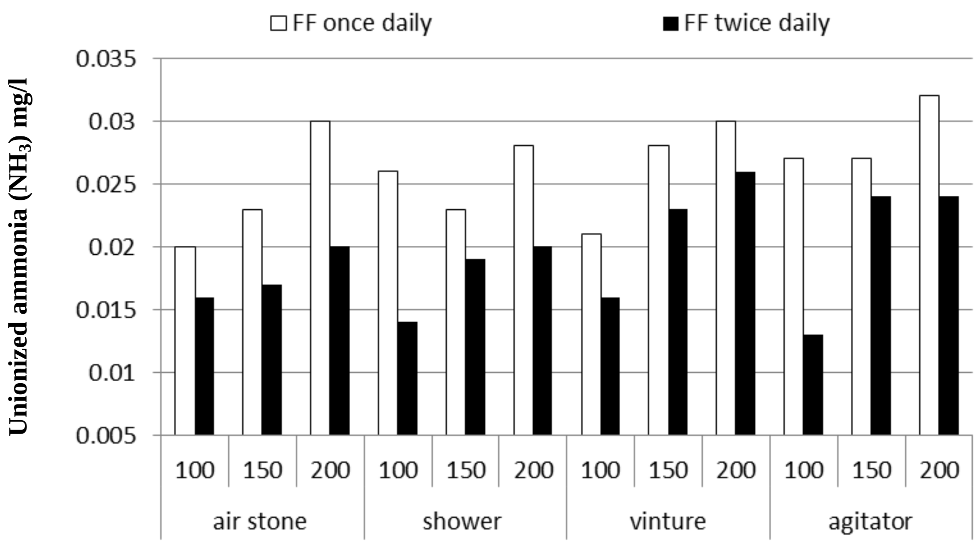
Average of initial body weight for finger lings of Nile tilapia in the start of the experiment was 7.5 ± 0.5g for all treatments groups, with insignificant differences between all groups during distribution of fish among treatments.

Data showed that final body weights were affected significantly by aeration systems (AS), feed frequency (FF), fish density (FD), and their interactions (Table 3).



Aeration systems/fish stock density (fish/m^3)

Fig. 6. Effects of the studied variables on the average pH of water, after 12 weeks



Aeration systems/fish stock density (fish/m^3)

Fig. 7. Effects of studied variables on NH_3 mg/l, after 12 weeks

From data obtained, the highest final body weight was 36.8 g with agitation system, fish density 100 fish/m^3 and feed frequency twice a day. While lowest final body weight was 20.8g with aeration system that used air stone, fish density 200 fish/m^3 and feed frequency once a day as seen in Fig. 8.

These result may be due to the high ability of agitator to blending water with air especially water near the bottom of tank that contain faeces and uneaten feed which affect negatively on water quality. These results are in agreement with Naeem (2005).

Lack of the rivalry among individual fish on feed and space, during fish stock density 100 fish/m^3 which cause increase in final body weights. These results are in accordance with Abdel Hakeem (2001), and fish had eaten the whole amount of diet that introduced, which divided twice daily, that led to decreasing of uneaten food that analysis and damage water quality.

The interaction between (FF×AS), (FF×FD), (AS × FD) and (FF × AS × FD) were affected significantly ($P<0.05$) on the final body weight.

Food conversion ratio (FCR)

Fish group with stock density of 100 fish/m^3 showed significant decrease ($P<0.05$) in FCR compared with fish stock density 150 and 200 fish/m^3.These results may be due to the rivalry among individual fish on feed and space , which may cause the depression in final body weights. Fish groups that were fed twice daily showed significant decrease ($P<0.05$) in FCR, compared with that were fed once daily. These results may be due to fish had eaten the whole amount of diet that introduced, which divided to twice a day, that led to decreasing of uneaten food that has negative effect on water quality. Regardless the effect of fish density and feed frequency, aeration systems affected significantly ($p<0.05$) on FCR. Where agitation system showed significant ($P<0.05$) decrease in FCR, compared with other systems (vinture, shower and air stone). These result may be due to the ability to blending water with air especially water near the bottom of tank that contain faeces and uneaten food which affect negatively on water quality. Based on the above results, the least value of FCR was 1.23 with agitator, fish density (100 fish/m^3) and feed frequency twice daily. While the highest value was 1.77 with vinture system, fish density (200 fish/m^3) (Fig. 9) and feed frequency once daily. These results agree with Abdel Hakim *et al.* (2001).

Specific growth rate (SGR%)

The SGR values were affected by all variables and their interactions as shown in Table 3. Regardless the effect of aeration systems and feed frequency, fish density affected significantly ($P<0.05$) on SGR.After experimental period (12week) fish groups with stock density (100 fish/m^3) showed significant ($p<0.05$) increase in SGR compared with that stocked at 150 and 200 fish/m^3. These results may be due to the rivalry among individual fish on feed and space, which may cause the depression in SGR. Regardless the effect of feed frequency and fish density, aeration systems showed significant effect ($P<0.05$) on SGR, Where agitation system (agitator) showed highest values of SGR compared with other systems (vinture, shower and air stone) at the end of experiment. These result trend may be due to the ability to blending water with air especially water near the bottom of tank that contain faeces and uneaten feed which affect negatively on water quality. Regardless the effect of aeration systems and fish density, feed frequency affected significantly ($P < 0.05$) on specific growth rate, where groups that were fed twice daily, showed highest values of SGR compared with that fed once daily. These results may be due to fish had eaten the whole amount of diet that introduced, which divided to times a day, that led to decreasing of uneaten food that analysis and damage water quality. Based on the above results, the highest value was 1.71 with agitation system, fish density 100 fish/m^3 and feed frequency twice daily. While lowest value was 1.11 with aeration system that used air stone, fish density 200 fish/m^3 and feed frequency once daily as shown Fig. 10. These results are in agree with the results of Eid and El-Gamal (1997) who reported that SGR of Nile tilapia reared in cages at densities 50, 75, 100, 125 and 150 fish/m^3 for 120 days were 1.14, 1.34, 1.21, 1.17 and 1.02, respectively.

Table 3. Three way ANOVA of growth of Nile tilapia is affected by aeration systems (AS), feed frequency (FF), fish density (FD) and their interactions

Growth parameter / Treatment	Initial. Wt.	Final. Wt.	Wt. gain	RGR	SGR	Initial. length	Final. length	K	FCR	Surv rate (%)
FF	0.597	0.0001	0.0001	0.0001	0.0001	0.983	0.006	0.0281	0.0001	0.155
AS	0.959	0.0001	0.0001	0.0001	0.0001	0.748	0.0001	0.021	0.0001	0.665
FD	0.887	0.0001	0.0001	0.0001	0.0001	0.933	0.0001	0.0217	0.0001	0.922
FF × AS	0.741	0.003	0.021	0.445	0.290	0.931	0.028	0.001	0.003	0.974
FF × FD	0.869	0.0001	0.0001	0.077	0.159	0.668	0.817	0.076	0.733	0.913
AS × FD	0.972	0.0001	0.012	0.824	0.756	0.993	0.907	0.306	0.027	0.996
FF × AS × FD	0.863	0.003	0.298	0.012	0.295	0.916	0.962	0.368	0.001	0.978

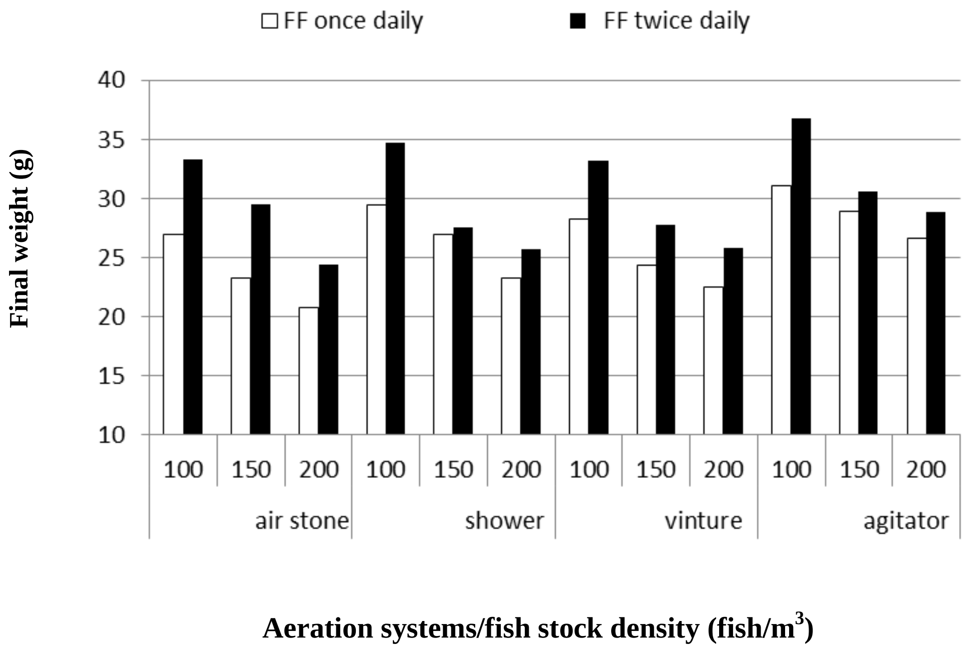


Fig. 8. Effects of investigated variables on the final weight (g) of Nile tilapia after 12 weeks

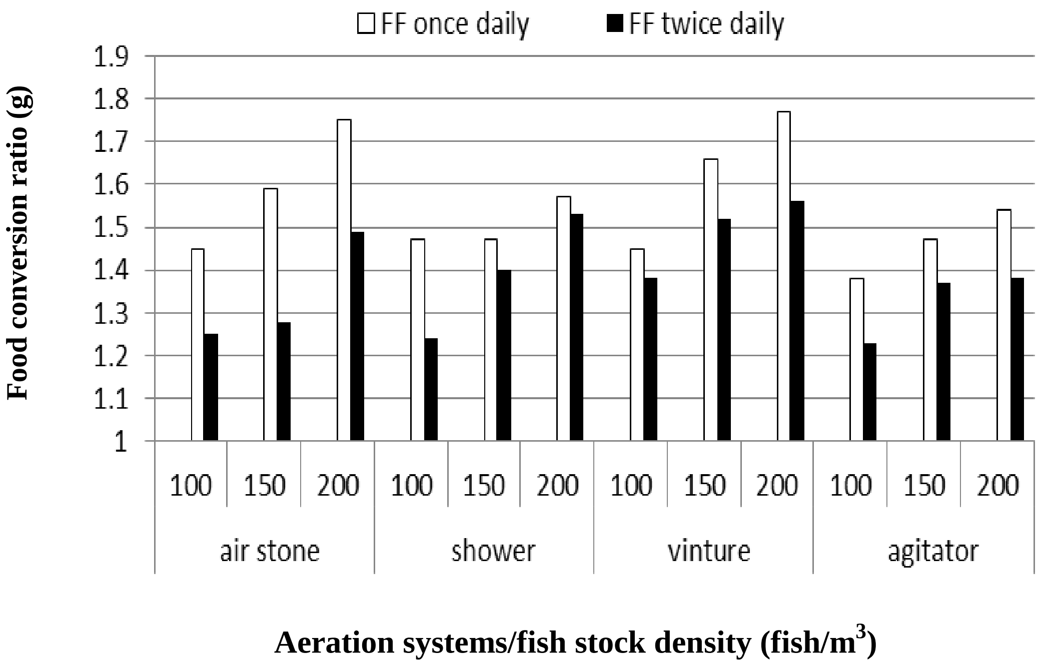


Fig. 9. Effects of studied variables on feed conversion ratio (FCR) of Nile tilapia after 12 weeks

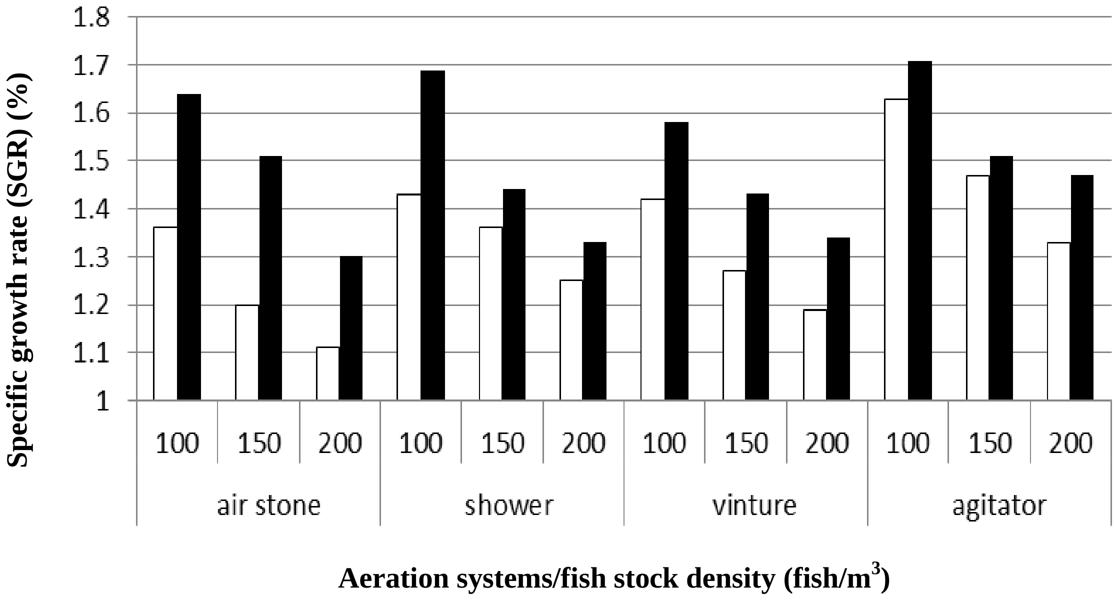


Fig. 10. Effects of investigated variables on SGR of Nile tilapia after 12 weeks

Relative growth rate (RGR%)

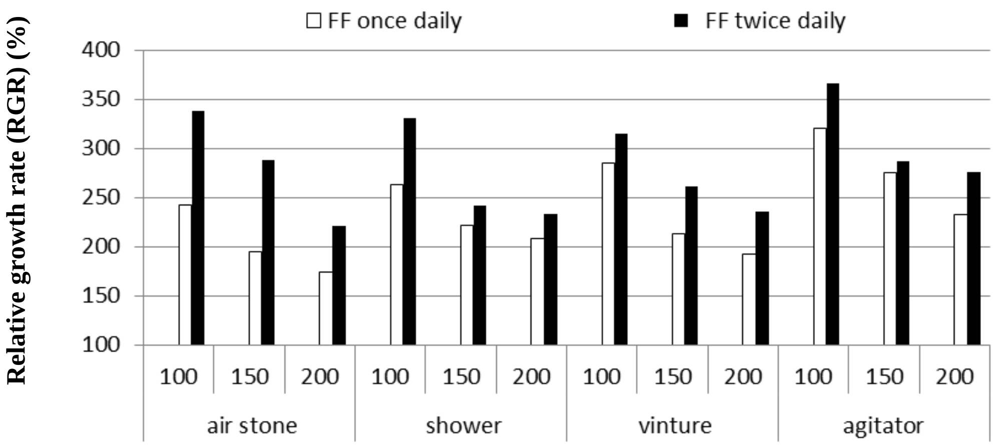
Data in Table 3 indicated that relative growth rate was affected significantly by all variables (Table 3). Regardless the effect of aeration systems and feed frequency, fish density affected significantly ($P < 0.05$) on RGR. After experimental period (12weeks) fish group with stock density of 100 fish/m^3 showed significant ($P<0.05$) increase in RGR compared with fish stock densities 150 and 200 fish/m^3. These results means that fish density inversely proportional with final weight, these results may be due to the rivalry among individual fish on feed and space, which may cause the depression in RGR. Regardless the effect of feed frequency and fish density, aeration systems showed significant effects ($P<0.05$) on RGR, where agitation system (agitator) showed highest values of RGR compared with other systems (vinture, shower and air stone) at the end of experiment. These result may be due to the ability to blending water with air especially water near the bottom of tank that contain faeces and uneaten feed which affect negatively on water quality. Regardless the effect of aeration systems and fish density, feed frequency affected significantly ($P<0.05$) on RGR, where groups that were fed twice daily showed highest values of RGR compared with that fed once daily. These results may be due to fish had eaten the whole amount of diet that introduced, which divided to times a day, that led to decreasing of uneaten food that analysis and damage water quality. Based on the obtained results, the highest RGR value was 365.8%with agitation system, fish density (100 fish/m^3) and feed frequency twice a day, while the lowest value was 173.6 with aeration system that used air stone, fish density (200 fish/m^3) and feed frequency once a day (Fig. 11). These results are in agree with Refsite (1977) who found that the growth trend for the different density groups clearly showed that fish held at low densities grow better than those at higher densities.

Survival rate (%)

Data listed in Table 3 and shown in Fig. 12 show that the experiment variables and their interactions did not show significant ($p>0.05$) effects on survival rate, where these rates ranged from 94.7 to 96.3%. These results may be due to that the environmental factors were in the safety limits for fish live.

Net Profit

Net profit was calculated per cubic meters when production is sell as fingerlings of Nile tilapia after 12 weeks. Where price of one thousand of Nile tilapia fingerlings at average weight 35g is 700 LE. Shower system with FD of 100, 150 and 200 fish/m^3 gave profit of 3.2, 28.5 and 53.7 LE as seen in Fig. 13. Also venture system with the same previous FD gave profit of 1.3, 25.5 and 49.7LE. Air stone system with FD of 150 and 200 fish/m^3 gave profite of 13.5 and 38.2 LE and aeration system of agitation was unprofitable with FD 100 and 150 fish/m^3, and also FD 100 fish/m^3 with aeration systems of air stone.



Aeration systems/fish stock density (fish/m^3)

Fig. 11. Effects of studied variables on RGR of Nile tilapia after 12 weeks

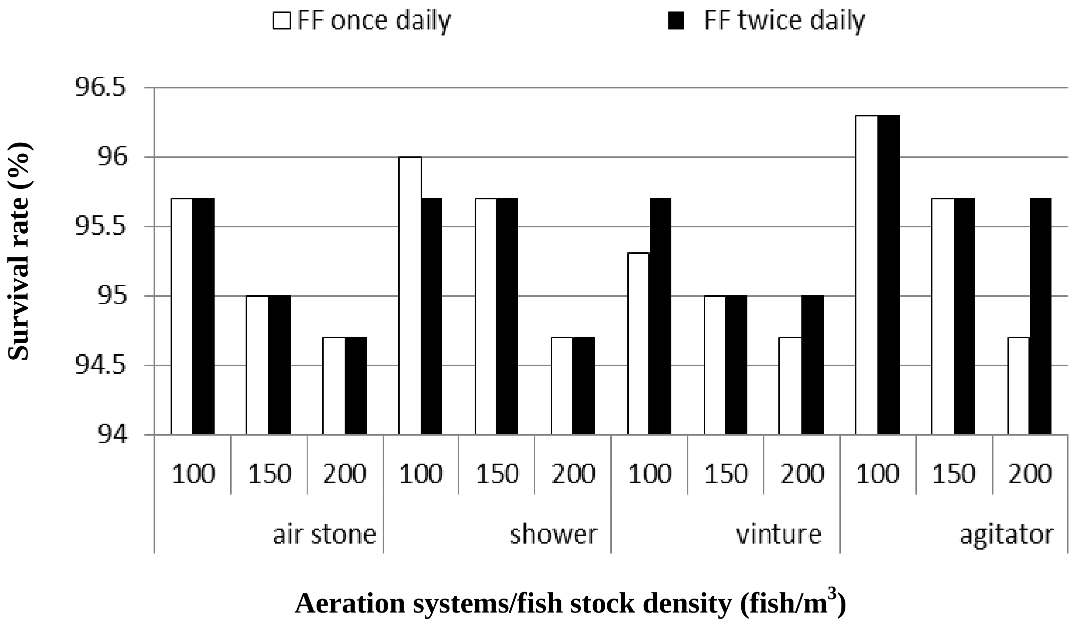


Fig. 12. Effects of studied variables on Survival rate (%) of Nile tilapia after 12 weeks

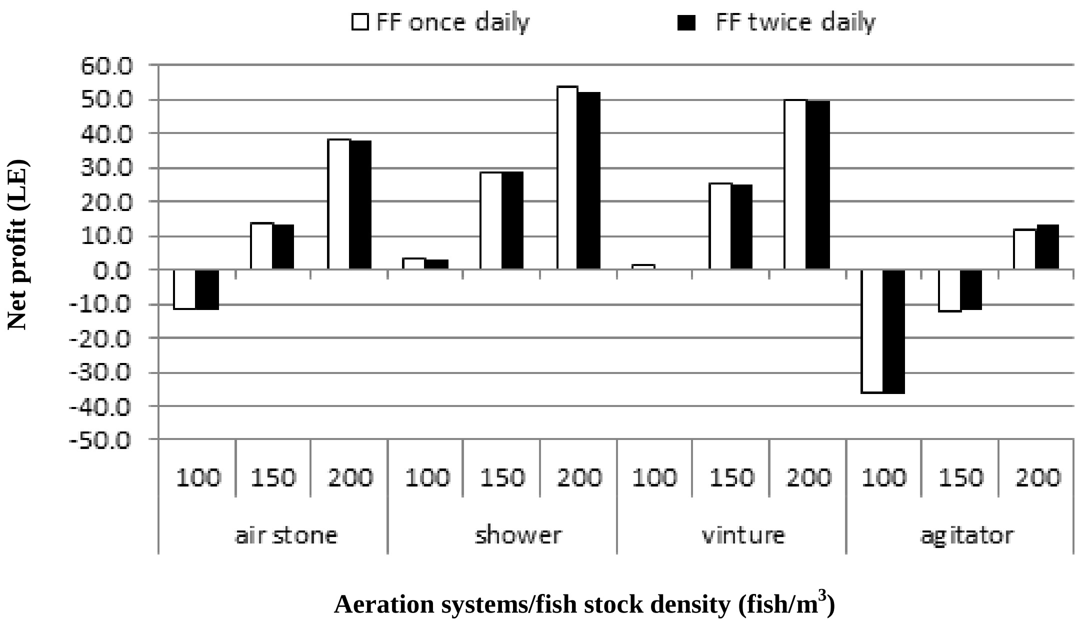


Fig. 13. Effects of studied variables on net profit of Nile tilapia after 12 weeks

Conclusion

According to the obtained results it is recommended to use shower system as aeration system, because it gave the lowest energy consumption, and highest net profit (0.12 KW.hr./m^3 and 53.7 LE/m^3), respectively. Feed frequency twice daily showed better growth performance than once daily. Using fish stock density of 200 fish/m^3 showed the best net profit compared with the other fish stock densities 100 and 150 fish/m^3 in case of breading of Nile tilapia fingerlings production. Using fish stock density less than 150 fish/m^3 with implementation aeration system of air stone or venture will be unprofitable, and else using FD less than 200 fish/m^3 with aeration system of agitation will be unprofitable.

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تأثيــــر نظـــم تهـــويــــة مختلفــــة علــــى إنتـــــاجيــــة أســــماك البلطــــي النيلـــــي

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أجريت تجارب هذه الدراسة في المعمل المركزي لبحوث الثروة السمكية بالعباسة خلال الفترة من ١ يوليو ٢٠١٤م إلى ٣٠ سبتمبر٢٠١٤م، لتقييم تأثير نظم تهويه مختلفة (نظام الأحجار الهوائية، نظام الدش، نظام الفنشوري، نظام التقليب) على إنتاج أسماك البلطي النيلي وجودة المياه، كذلك تم دراسة تأثير كثافات سمكية مختلفة ١٠٠ ، ١٥٠ و ٢٠٠ سمكه/م^{٣} وعدد مرات تغذية مختلفه (مرة ومرتان يوميا)، وذلك باستخدام اصباعيات وحيدة الجنس بمتوسط وزن٧.٥٠±٥, جم، وتمت تغذيتها علي عليقه ٣٠% بروتين بمعدل ٣% من الوزن الحي يومياً، ومن النتائج المتحصل عليها يمكن التوجيه باستخدام نظام التهويه بالدش حيث أعطي أعلي ربحيه مع الكثافات الثلاثة ١٠٠ ، ١٥٠ و٢٠٠ سمكه/م^{٣}، ٣.٢ ، ٢٨.٥ و ٥٣.٧ جنيه/م^{٣}، وكذلك كان الأقل استهلاكا للطاقة (٠.١٢ كيلو وات. ساعة/ م^{٣}) مقارنة بالنظم الأخرى، وكذلك حافظ علي جودة المياه في الحدود المثلي للاستزراع السمكي الناجح، حيث كانت النتائج الأفضل من حيث جودة المياه ومعدلات النمو مع الكثافة ١٠٠سمكة/م^{٣} والتغذية مرتان يوميا، وهذا مقارنة بالكثافات الأخرى فعند استخدام النظام الموصي به كان تركيز الأكسجين الذائب والأمونيا غير المتأينة والرقم الهيدروجيني (٦.٣١مجم/لتر، ٠.٠١٤ملليجم/لتر، ٧.٤٩) علي التوالي، وبالنسبة لمعدلات النمو كان الوزن النهائي ومعدل التحول الغذائي ومعدل النمو النسبي ومعدل النمو النوعي ومعدل البقاء ٣٤.٧جم ، ١.٢٤ ، ٣٣٠.٢%، ١.٦٩%، ٩٥% على التوالي.

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