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EVALUATION OF AN AERATION SYSTEM FOR FISH CULTURED IN CLOSED SYSTEMS

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ABSTRACT: This study was Carried out at Central Laboratory for Aquaculture Research in (2017), to determine the best levels of oxygen supply on growth performance and oxidation status of Nile tilapia (*Oreochromis nilollcus*), Grey mullet (*Mugil cephalus*) and Common carp (*Cyprinus carpio*) fingerlings stocked at (85%, 10% and 5%), respectively, total of fingerlings with initial weight of weighting (10±0.30) g/fish were reared in tanks *i.e.,* supplied with normal water, air pumping and filtration system applied throughout the experimental period, with 3 replicates to evaluate the effect of perforated pipe location *i.e.,* 0 and 100 cm from the bottom of tanks, distance between holes such as : 10cm, air pressure levels *i.e.,* 0.2 and 0.4 bar on water quality, growth rate of fish and net profit. The obtained results revealed that the perforated pipe located at 100 cm with distance between holes such as: 10 cm and air pressure (P) of 0.4 bar gave the highest average of water quality like pH (7.72±.30 and 8.18±2.48 mg/l), dissolved oxygen (7.42±.29 and 8.38±2.54 mg/l), water temp (27C ±.81), ammonia (0.29±.01 and 0.28±.08 mg/l), total hardness (171.4±6.85 and 170.9±51.97), total alkalinity (165.3 ± 6.61 and 180.7±54.95 mg/l), nitrate (0.01±.0004 and 0.01±.003), nitrite (0.11±.004 and 0.12±.03) for air pressure levels (0.2 and 0.4) bar respectively. Compared with control result which were 6.7±.30, 4.45±2.54, 0.32±01, 25.0±2.16, 340±2.71, 370±12.7, 0.12±008 and 0.40±0.001 for pH, dissolved oxygen, water temp, ammonia, total hardness, total alkalinity, nitrate and nitrite. The highest average of growth rate values; final body weight (74.9±22.77, 77.4±1.16 and71.9±3.59 g), final body length (19.2±5.83, 18.2±.27 and 16.4±0.32 cm), final body weight gain (5±0.20, 4.4±0.06and 4.6±0.09g), final condition factor (1.36±0.05, 1.38±0.23and 2.61±0.26g/cm^3) and final feed conversion ratio (1.56±0.47, 1.62±0.02 and1.68 ± 0.03 g/fish), Final SGR were (1.93±0.58, 1.68±0.02 and 2.0 ±0.04%) and final survival rate (%) were (91.8±2.9 , 88.9±2.6 and 90.2±1.2) for Nile tilapia (Oreochromis nilollcus), Grey mullet (Mugil cephalus) and Common carp (Cyprinus carpio) and distances between holes of 10 cm and pressure levels of 0.4 bar Respectively. Finally, it could be concluded that, under the similar conditions: The Air pressure (P) level of 0.4 bar, perforated pipe location of 100 cm and distance between holes 10 cm were the best parameters where it gave Significantly high water quality, growth performance (P<0.0001) and survival of fish (P<0.0001) was observed in aerated tanks as compared with the non-aerated tanks.

Key words: Aeration system, tank culture, dissolved oxygen, fish survival.

INTRODUTION

Today aquaculture considered an important source of production for meeting the worlds increasing demand for protein, aquaculture development projects are being initiated in many part of the world especially in the developing countries. In aquaculture, one of the management strategies for better use of the available natural resources is the employment of high animal stocking densities (**Seginer, 2009**).

These intensive and super intensive systems require the use of specific equipment and appropriate management practices to obtain

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good growth performance. In these systems, the mechanical aeration of water is indispensable for maintaining adequate concentrations of dissolved oxygen in water. In contrast, farming intensification leads to a deterioration of water quality, producing effluents that negatively influence the receiving water bodies. According to **Stigebr *et al.* (2011)**, the use of stocking densities higher than the environmental carrying capacity negatively affects the growth rate of the farmed animals and water quality. Aquaculture is the fastest growing fishes based food-producing sector, particularly in developing countries like Bangladesh and its production contributes to the livelihoods, employment and also fulfills the nutritional demand for millions of people. Bangladesh has achieved 6th position among the world's major aquaculture producing countries (**FAO, 2016**) and the total production of fish is around 3.6 million MT in 2014-2015, of which inland fisheries contributed 83.71% comprising 55.93% from aquaculture and 27.79% from capture fisheries (**DoF, 2016**).

Since in intensive aquaculture system, ponds are heavily stocked with fish as well as with high feed supply and in these artificially fed fish ponds, many problems like organic pollution, deficiency of oxygen, increased level of free carbon dioxide and total increase in ammonia-nitrogen, nitrite-nitrogen ratio are frequently occurring. However, the problem of oxygen depletion in rearing of freshwater fish species is a major threat and main limiting factor in intensive aquaculture because it leads to hypoxia which affects fish growth, food conversion levels and feeding efficiency etc. (**Mallya, 2007**) and fish always show high feed efficiency when they are fed at required DO in water (**Boyd, 1998**). The present study has taken tilapia as an experimental species for investigation the impacts of DO on tilapia's growth and production which is sensitive to the availability of DO in the water body as reported by **Abdel-Tawwab *et al.* (2014)**. Dissolved oxygen is one of the most important parameter and a primary limiting factor controlling the growth and survival of fish. Anoxia is one of the major causes of fish kills in fertilized ponds during summer conditions. **Swingle (1968) and Grizzel *et al.* (1969)**. Improving the efficiency of aquaculture can be achieved not only through the aeration program.

So the main aim of this system is to determine the best study factors help to supply fish farms with the enough dissolved oxygen. For maximizing the productivity of fish with using the technology of aeration system the aim can be achieved by the following objectives:

1. Preparing a tank suitable for fish requirements.
2. Preparing the oxygen unit and test the dissolved oxygen distribution.
3. Evaluating the effect of distance between air holes and air pressure levels and perforated pipe location in tanks.

MATERIALS AND METHODS

The present study was carried out at the Central Laboratory of Aquaculture Research Abbassa, Abu-Hammad, and Sharkia Governorate, Egypt. During the season of 2017.

System Description

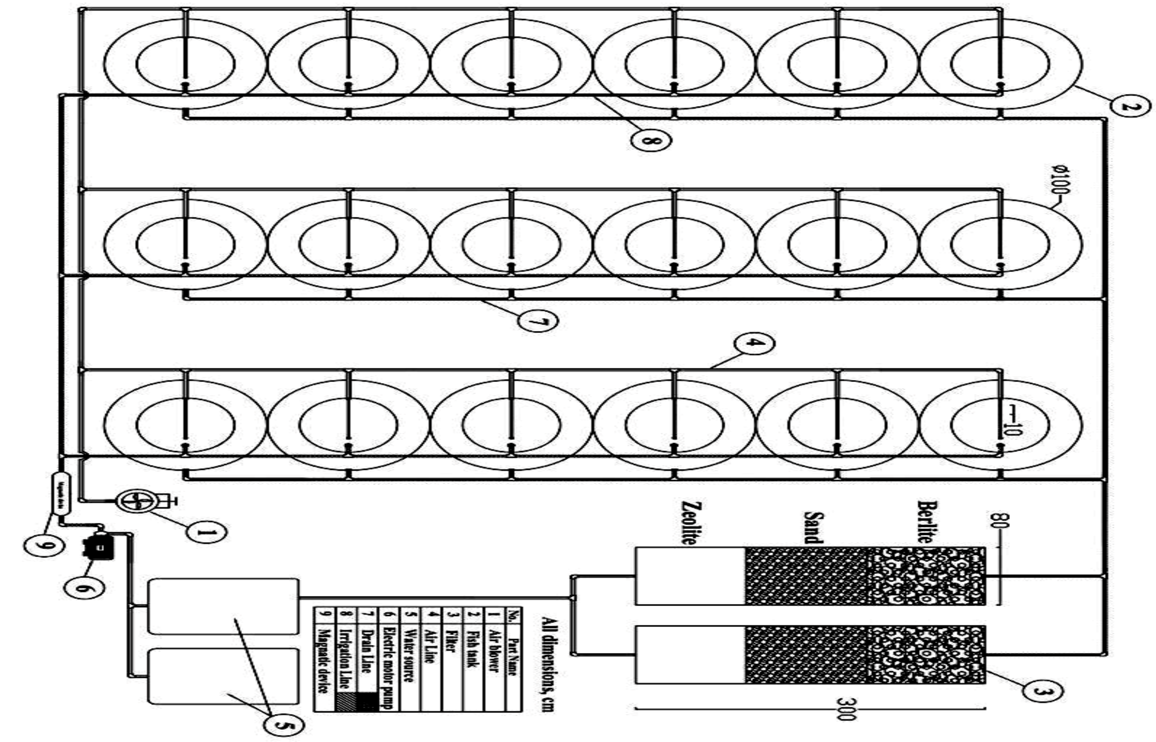
Aquaculture unite consists mainly of fish rearing system and filtering unit as shown in Fig. 1. Circular tanks were used during this experiment and supplied with the air supply wich system consists of six main parts namely, air compressor, air hose, control valve, manometer, perforated pipe and timer. Tanks were made of fiber glass with a diameter of (1 m) and depth of 1.2 cm. using aeration pipe with distances between holes of (10 cm) with diameter of holes1mm as shown in Fig. 2, Perforated pipe location of (0 and100cm) from the bottom of tank as shown in Fig. 3. Using air compressor aeration was contain 24 a day.

Fishes

Tank was stocked with 85% of Nile tilapia, 10% of grey mullet mono sex and 5% of common carp with an average initial weight of 10±0.30 g Fingerlings were purchased from the hatchery of Central Laboratory for Fish Research, Abbasa, Sharqia governorate.

Fish feed

Fish were fed by hand to visual satiation three times, a day with prepared pelleted feeds commercial pelleted fish feed 24.70% crude proteins by the ratio of 3% of total biomass and the amount of feed was readjusted according to monthly fish samples.



1. Air blower	2. Circular tank	3. Filtering unit	4. Air line
5. Water source	6. Eletric motor pump	7. Drain line	8. Irrigation line

Fig. 1. Aquaculture unit

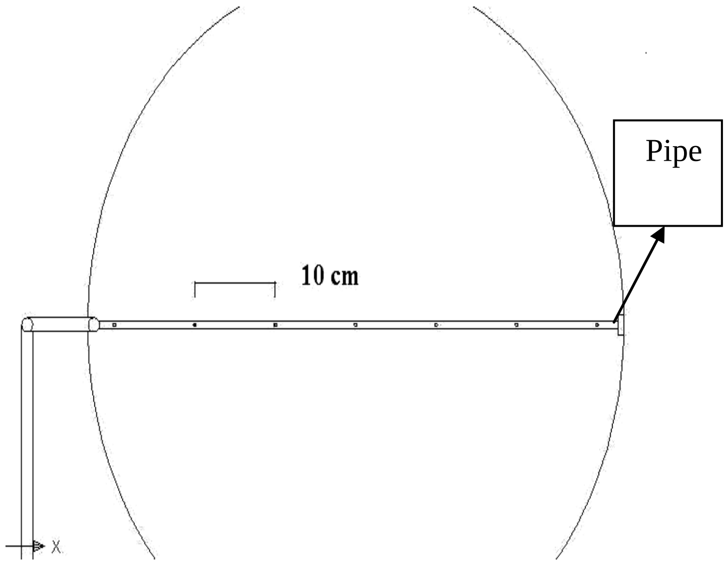


Fig. 2. Experimental perforated pipe location

Air compressor

An air compressor was used to the perforated pipes push air into the water tank through model C.C.P. Parma- Flow Rate Maximum 125 m^3/h- 2800 rpm - 2.5 hp 380V 50Hz.

Pump

The pump which was used in the experiments Meroċ Type with maximum flow rate of 36 m^3/h.

Air hose

The air hose was made from rubber showed in Fig. 3. It has dimensions of 8m length and (8×17) mm inner and outer diameters with permission endurance 20 bar pressed air. The air hose has two ends, the first one connected to the cast-iron compressor pipe and the second end connected to the perforated pipe. It used to transport the air from the compressor to the perforated pipe on air path from compressor to perforated pipe. The air hose provided with control valve and manometer.

Control valve

The control valve made from cast iron used to control the pressure at the amount of the air passing to the tanks the control valve diameter is 12.7 mm connected with the air hose by copper link.

Perforated pipe

The Perforated pipe showed in Fig. 2 made from PVC with 12.7 mm inner diameter and 1 m length was used to distribute the air in the tank. The perforated pipe was connected with air hose by elbow, to lay it in horizontal position inside the tanks.

Thermometer

Water temperature was measured at 9:00 – 10:00 am using thermometer Yellow spring instrument (Y S I Model 58).

Oxygen meter

Dissolved oxygen values were measured at 9:00 -10:00 am by dissolved oxygen meter (Oxi 197/oxi 197-s rang 0.00 – 20.00 mg/l resolution 0.01mg/l).

PH meter

pH was measured using a glass electrode pH-meter Digital mini–PH meter (Model 55).

Experimental Design

The experiment was started from 1/4/2017 to 15/07/2017 in tanks. With 2 treatments and 3 replicates for all treatments.

The Experiment Procedures

The experiment include of the following studied variables:

1. Perforated pipe location (H) zero and 100 cm from the bottom of water tank
2. Air pressure levels (P) 0.2 and 0.4 bar.

The experimental data out can be summarized as follows:

1. Adjust the perforated pipe at the selected depth relative to the horizontal position.
2. Fill the tanks with water to 100 cm water head.
3. Start pumping air from the air compressor by contact its electric circle.
4. Adjust the pumped air pressure using the control valve and manometer.
5. After stability of all system parts, the data under three replicated were taken.

The Aim of the Experiment

The aim of the study was to design an intensive fish culture unit to evaluate some of the engineering and environmental variables on intensive aquaculture, on a scientific basic to Increase fish growth rate Thus increasing the productivity of the fish yield of the unit area and determine the best parameters suitable to supply the fish farm with oxygen for whole growth performances of Nile Tilapia (*Oreochromis niloticus*), Common carp (Cyprinus carpio) and Grey mullet (*Mugil cephalus*).

Measurements

Water quality analysis

Water temperature

Water temperature (Ċ) was recorded daily at using thermometer

Dissolved Oxygen

Water dissolved oxygen (DO) was daily monitored at 9 am at using oxygen meter.

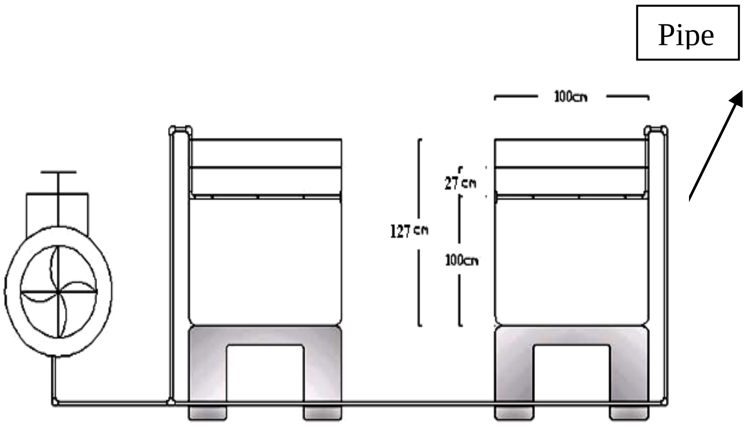


Fig. 3. Side view of the diffused aeration device

Water pH

Water pH was daily recorded at 400 ppm with pH meter. Samples were measured by methods described by **Boyd (1982)**.

Total ammonia (NH4 +NH_3)

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

Total hardness (TH)

Water total hardness was determined using an EDTA titration based on method 2340C from standard methods for the analysis of water and waste water (**Clesceri *et al.*, 1999**).

Total Alkalinity

Total alkalinity was determined using pH titration procedure based on method 2320 from standard methods for the analysis of water and waste water (**Clesceri *et al.*, 1999**).

Growth performance parameters

Body weight (BW)

Fishes were collected from each tank every two weeks and were put in bucket filled with water and weight in 3 months in order to get the individual weight.

Body length (BL)

Body length was measured at the end of experimental by the ruler.

Body weight gain (BWG)

Body weight gain was calculated using the following equation.

BWG = Final weight (g)-Initial weight (g).

Feed conversion ratio (FCR%)

The feed conversion ratio (FCR) was calculated monthly by using the following equation:

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

$$FCR=\frac{\text{Dry feed given (g)}}{\text{Wet weight gain (g)}}$$

These are often reported as ratio of dry weight of feed to wet weight of the animal, and this explains the anomalous values sometimes quoted in the literature, such as a ratio of 1: 1 or even less (**Pillary, 1990**).

Specific growth rate (SGR%)

SGR was calculated according to **Jauncey and Rouse (1982)** using the following equation:

$$SGR=\frac{\text{LnFW - LnIW}}{\text{Time (day)}}\times 100$$

Condition factors (K)

Condition factor was estimated according to **Bagenal (1998)** as following :

$$K=\frac{100\ [\text{bodyweight (g)}]}{\text{Total length cm}^3}$$

Survival rate (%)

$$\text{Survival (\%)}=\frac{\text{Final number of fish}}{\text{Initial number of fihs}}$$

Cost production

The cost of experimental unit was based on the oxygen pump, water pump, plastic, fish, fish feeding, electric and tank.

Net profit

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

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

Where:

P: net profit, LE /m^3:

Yt: total weight gain, kg/m$^{3.}$

d: yield price, 10 LE/kg and

Ct : Total production costs, LE/m^3

Statistical Analysis

Statistical evaluations of results were carried out according to **Harvey Computer Program (1990).** Duncan's Multiple Range test was applied to detect the significance of difference of various parameters among the treatments (**Duncan, 1955**).

RESULTS AND DISCUSSION

Effect of Perforated Pipe Location and Air Pressure Levels With Distance Between Holes 10 cm on Water Quality

Data in Figs. 4 and 5 showed that effect of air pressure levels with distance between holes 10 cm on water quality parameters were (7.72 ± 0.30 and 8.18 ± 2.48 mg/l) for PH, dissolved oxygen (7.42±.29 and 8.38±2.54 mg/l), water temp (27°C±.81), ammonia (0.29±.01 and 0.28 ± 0.08 mg/l), total hardness (171.4±6.85) and (170.9±51.97), alkalinity (165.3 ± 6.61mg/l) and (180.7 ± 54.95), NO_2 were (0.01±.0004 mg/l and (0.01±.003 mg/l), NO_3 were (0.11±.004 mg/l and 0.12±.03 mg/l) compared with control result which were 6.7±.30, 4.45±2.54, 0.32±01, 25.0± 2.16, 340±2.71, 370±12.7, 0.12±008 and 0.40± 0.001 for pH, dissolved oxygen, ammonia, water temp, total alkalinity, total hardness, nitrite and nitrate. The results showed significant differences between dissolved oxygen measurements. While, measurements of ammonia and pH values represented high significant ($p < 0.05$). increasing the pumping air pressure level affect directly on water quality parameters, **Masser and Thomas (1999)** 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 mechanical filters, which are important in decomposing waste products, are not efficient over a wide pH range. **Ridha and Cruz (1998)** who cited that, the dissolved oxygen concentration was always above 5 mg/L during seed production of Oreachromis nilotcus. The concentrations of the un-ionized ammonia (toxic form) NH3-N in the present study was lower than those recorded in fertilized fish ponds at Lake. **Tiwari *et al.* (2006)** found that the maximum mean of ambient and green house air temperature of 20.34 and 24.26 were observed in the month of November, while the lowest recorded 10.74 and 15.98 in the month December in open and green house condition, respectively.

Effect of Perforated Pipe Location and Air Pressure Levels with Distance between Holes 10 cm on Growth Performance of Fishes

Data presented in Fig. 6, 7, 8, 9, 10, 11 and 12 showed the growth performance of fish reared in tank, the highest average of growth rate values; final body weight of reared fishes under pipe location of zero cm and air pressure levels (0.2 and 0.4) bar which were (64.6±1.93) to (70.9±1.41)g, (62.1±26.44) to (71.9±4.31)g and (60.1±4.80) to (68.5±4.79)g for tilapia; common carp and mullet at air pressure (0.2 and 0.4) bar respectively, but final body weight of reared fishes under pipe location of 100 cm and air pressure of (0.2 and 0.4) bar which were (68.2± 2.72) to (74.9±22.77) g, (67.9±.67) to (77.4± 1.16) g and (66±1.32) to (71.9±3.59)g for tilapia; common carp and mullet at air pressure (0.2 and 0.4) bar respectively compared with the control body weight which were (54.4±1.6), (55.9±1.60) and (55.2±1.60) g for tilapia ,carp and mullet receptivity, final body length of reared fishes under pipe location of zero cm and air pressure of (0.2 and 0.4) bar which were (16.5±0.49) to (18.5±.37) cm, (15.3±6.51) to (17.8 ± 1.06) cm and (13.8±0.85) to (14.5±1.01) cm for tilapia; common carp and mullet at air pressure (0.2 and 0.4) bar respectively, but the

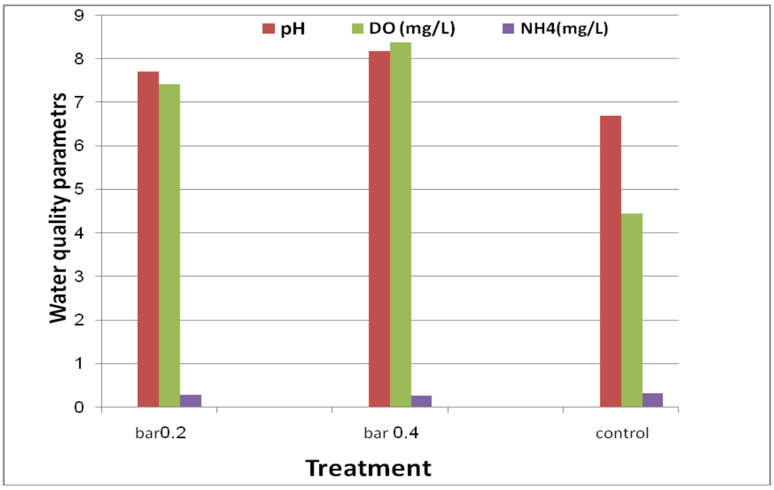


Fig. 4. Water quality components at different levels of air pressure and control treatments

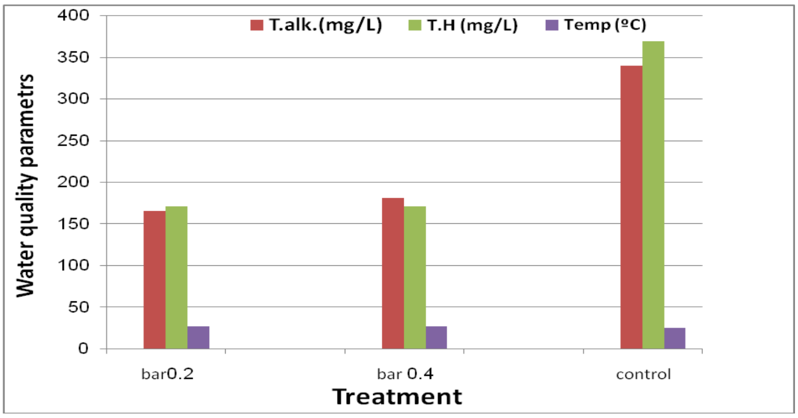


Fig (5): **water quality components at different levels of air pressure and control treatments.**

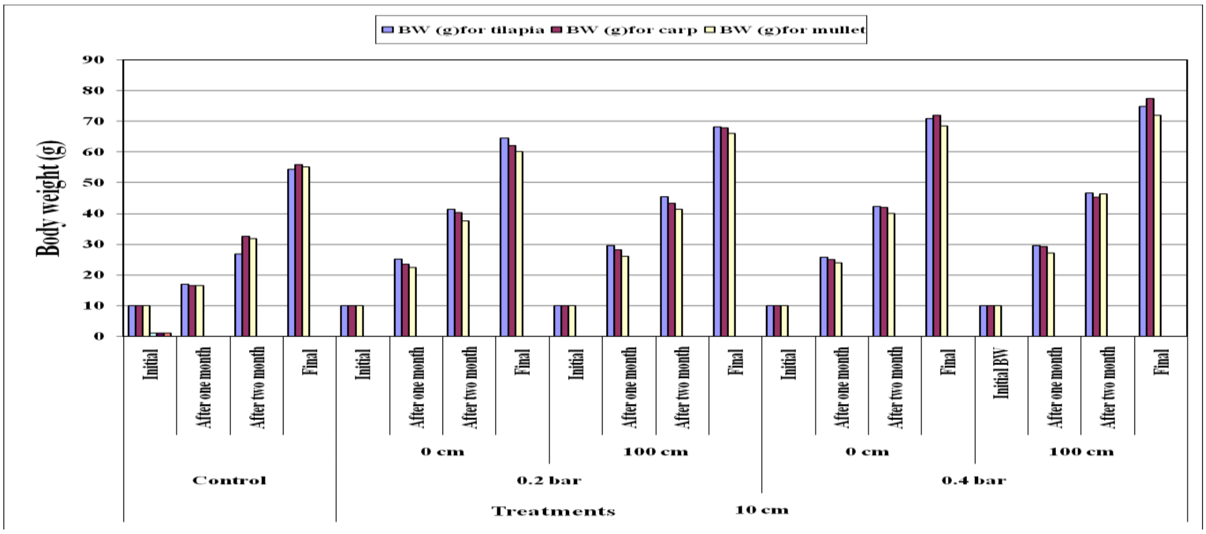


Fig. 6. Body weight of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

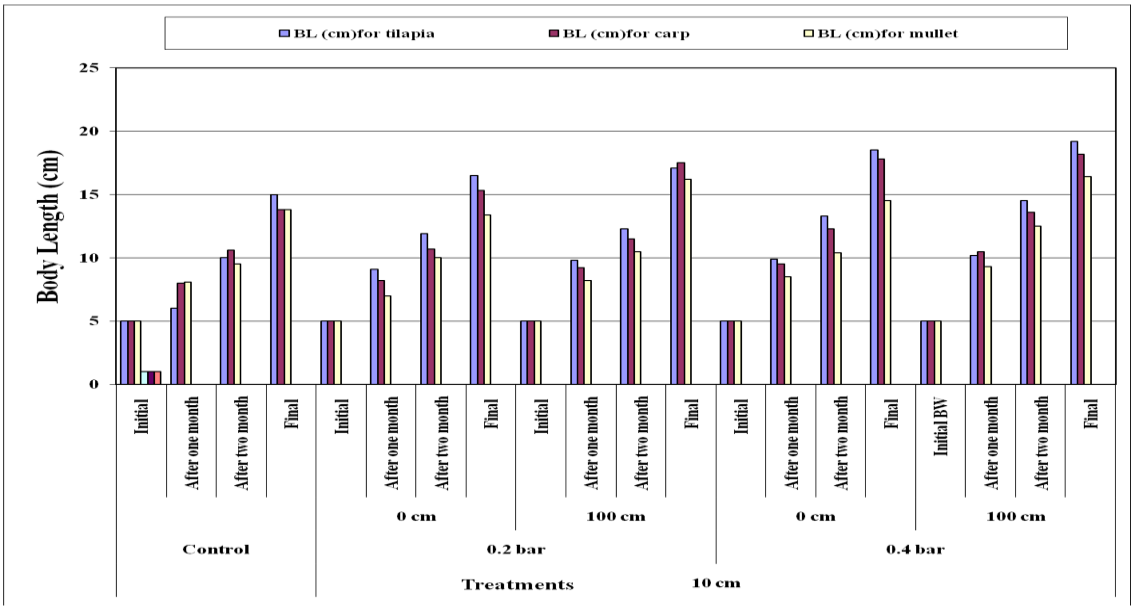


Fig. 7. Body length of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

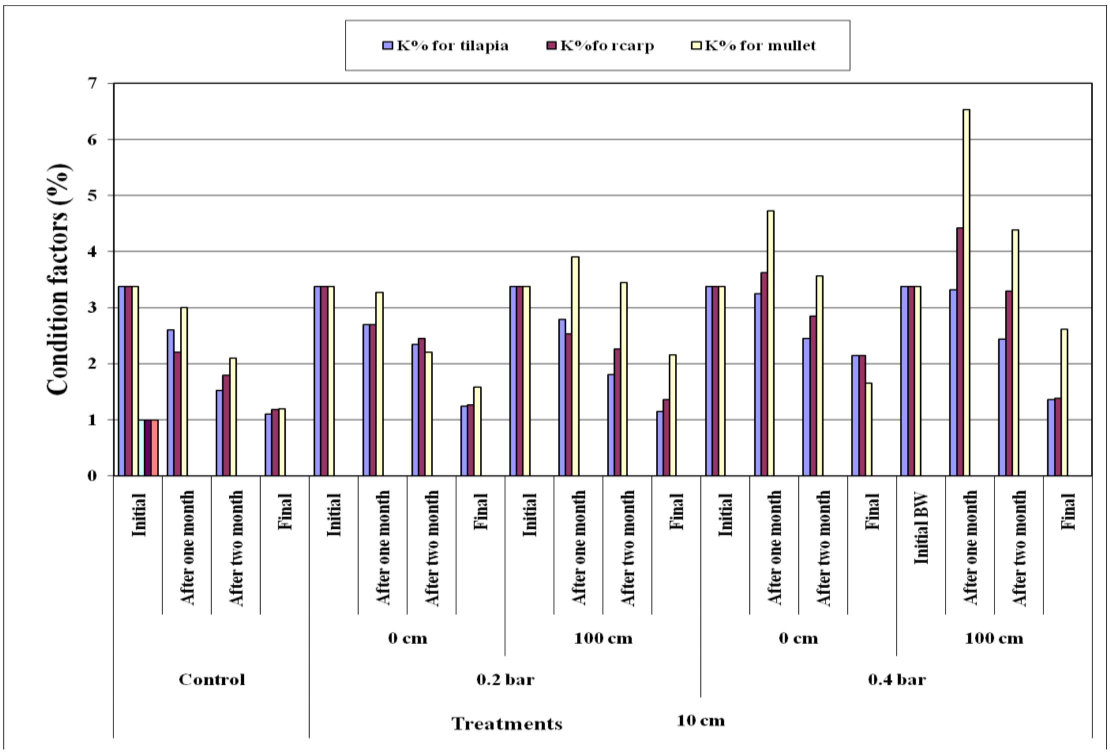


Fig. 8. Condition factor of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

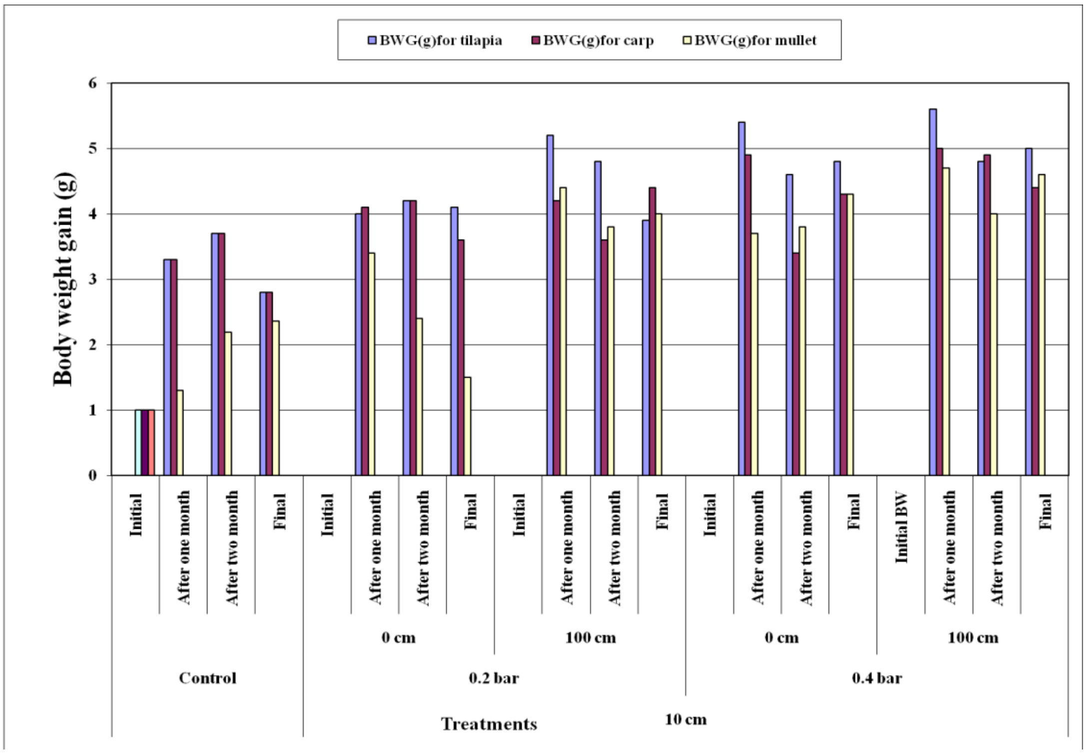


Fig. 9. Body weight gain of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

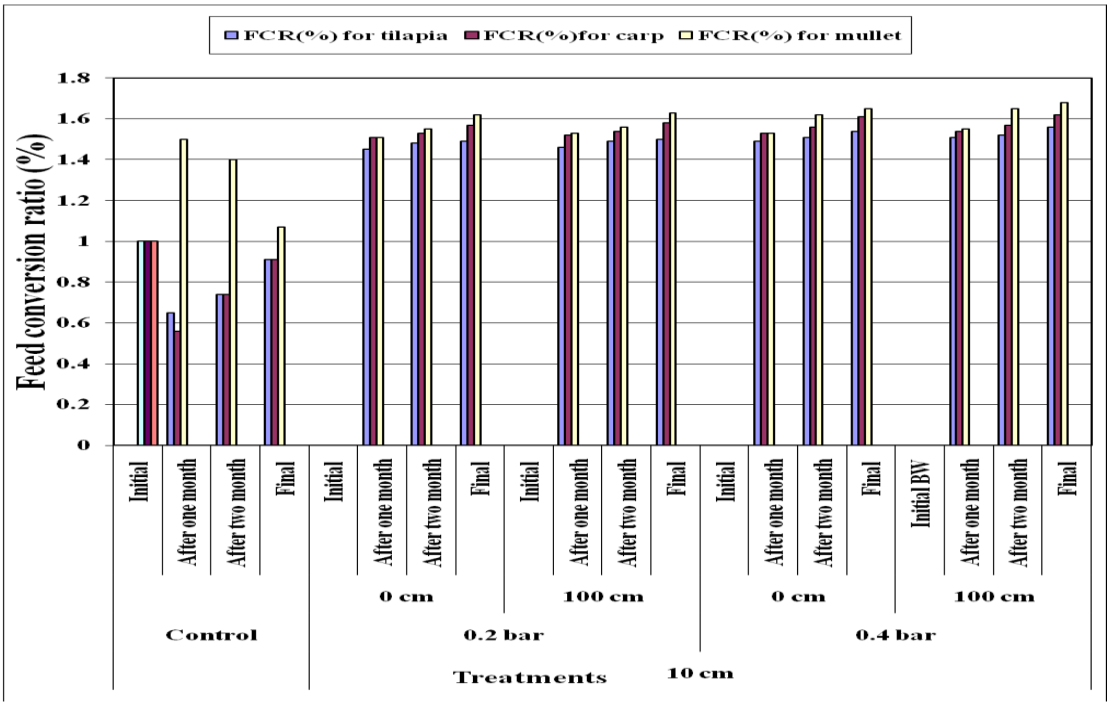


Fig. 10. Feed conversion ratio of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

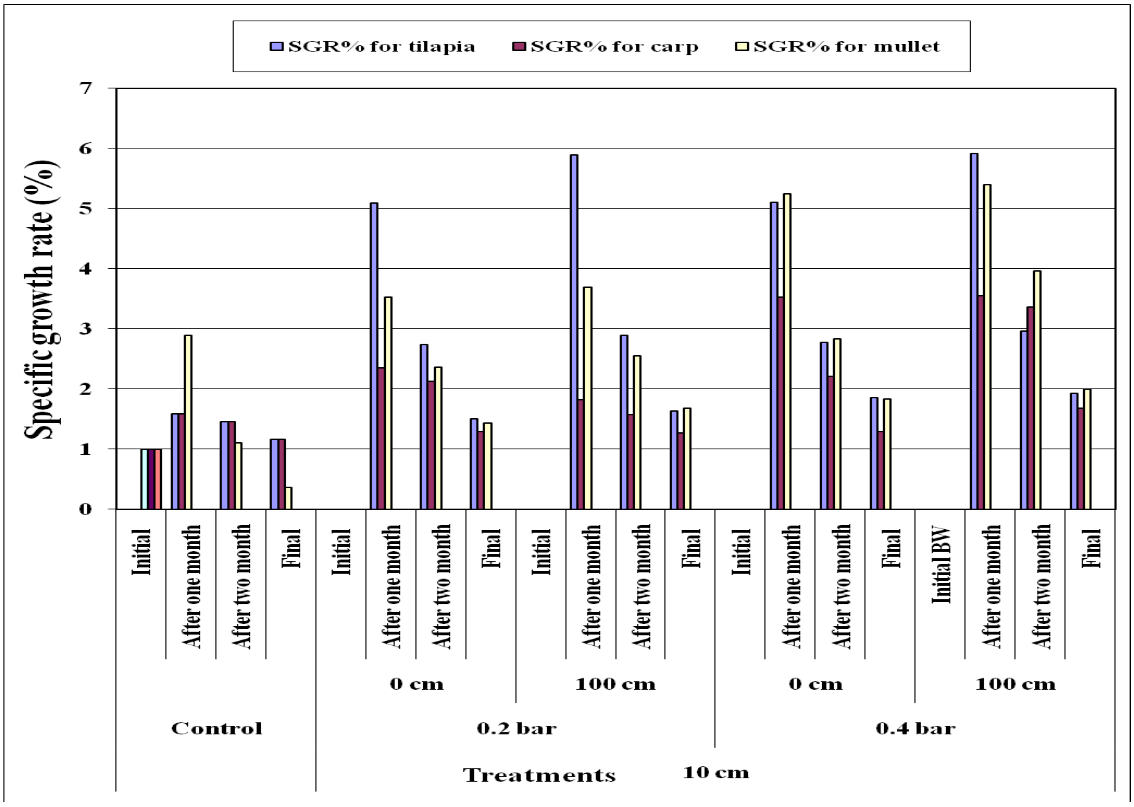


Fig. 11. The specific growth rate of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

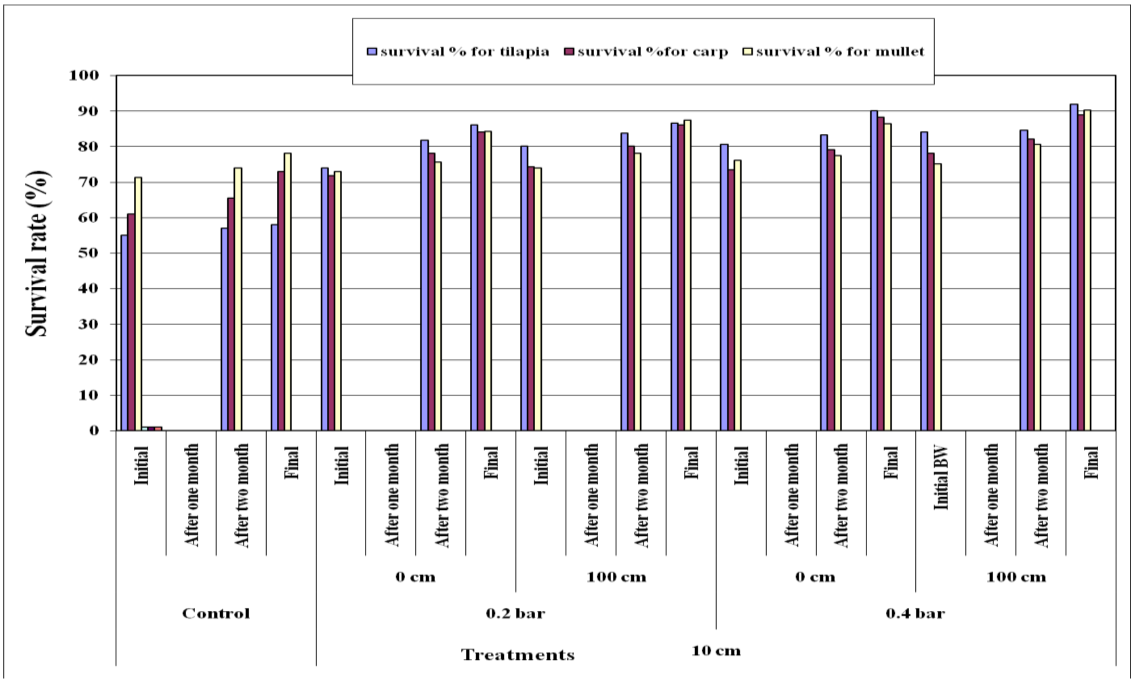


Fig. 12. The survival rate (%) of tilapia, common carp and mullet at two levels of air pressure, two pipe location with distances between holes 10 cm

Economical analysis

The net production /m^3

Final body length of reared fishes under pipe location of 100cm and air pressure of (0.2 and 0.4) bar which were (17.1±.68) to (19.2±5.83) cm, (17.5±.17) to (18.2±.27) cm and (16.2±.81) to (16.4±.32) cm for tilapia; common carp and mullet at air pressure levels (0.2 and 0.4) bar respectively, compared with the control body length which were (15.0±.45), (13.8±.43) and (13.4±1.07) cm, final body weight gain of reared fishes under pipe location of zero cm and air pressure of (0.2 and 0.4) bar which were (4.1± 0.08) to (4.8±.14) g /fish, (3.6±.21) to (4.3±1.83) g/fish and (1.5±.10) to (4.3±.34) g/fish for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, but final body weight gain of reared fishes under pipe location of 100cm and air pressure of (0.2 and 0.4) bar which were (3.9±1.18) to (5±.20) g/fish, (4.4± 0.04) to (4.4±.06) g/fish and (4.0±.20) to (4.6± 0.09) g/fish for tilapia; common carp and mullet respectively at pumping air pressure (0.2 and 0.4) bar, compared to the control body weight gain which were(2.8±.08), (2.8±0.08) and (2.36 ± 0.08) g/fish, final condition factor (K) of reared fishes under pipe location of zero cm and air pressure of (0.2 and 0.4) bar which were (1.24± 0.03) to (2.14±0.45), (1.27±5.5) to (2.14±0.40) and (1.58±.90) to (1.65±.93) for tilapia; common carp and mullet respectively at pumping air pressure (0.2 and 0.4) bar, but final condition factor (K) of reared fishes under pipe location of 100 cm and air pressure of (0.2 and 0.4) bar which were (1.15±.34) to (1.36±.05), (1.36±.14) to (1.38±0.23) and (2.16±.73) to (2.61±.26) for tilapia; common carp and mullet respectively at pumping air pressure (0.2 and 0.4) bar, compared with the control condition factor (K) which were (1.10±0.02), (1.19± 0.91) and (1.2±0.43), final feed conversion ratio (FCR) of reared fishes under pipe location of zero cm and air pressure of (0.2 and 0.4) bar which were (1.49±0.04) to (1.54±0.03)%, (1.57± 0.66) to (1.61±0.09)% and (1.62±0.11) to (1.65 ± 0.13)% for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, but final feed conversion ratio (FCR) of reared fishes under pipe location of 100cm and air pressure of (0.2 and 0.4) bar which were (1.50±0.05) to (1.56±0.47)%, (1.58±0.01) to (1.62±0.02)% and (1.63±0.08) to (1.68±0.03)% for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, compared to the control feed conversion ratio (FCR) which were (0.91±0.02), (0.91±0.02) and (1.07±0.02)%, higher SGR values followed in a significant ($p<0.05$) increasing which were (1.54±0.046) to (1.86±0.03%), (1.29±0.07) to (1.3±0.07%) and (1.43±0.11) to (1.83±0.09%) for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, but higher SGR values followed in a significant ($p<0.05$) increasing which were (1.63±0.06) to (1.93± 0.58)%, (1.27±0.013) to (1.68±0.02)% and (1.68± 0.11) to (2.0 ±0.04)% for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, compared to the control the specific growth rate (SGR) which were (1.17±0.03), (1.17±0.49) and (0.37± 0.037)%. higher survival rate (%) values followed in a significant ($p<0.05$) increasing which were (86±1.2) to (90±2.5) %, (84.1±0.6) to (88.2±1.6) % and (84.15±0.3) to (86.4±1.3) % for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, but higher survival rate (%) values followed in a significant ($p<0.05$) increasing which were (86.5±2.1) to (91.8±2.9)%, (86±0.8) to (88.9±2.6)% and (87.4±0.6) to (90.2±1.2)% for tilapia; common carp and mullet respectively at air pressure (0.2 and 0.4) bar, compared with the control which were (58±0.8) ,(73±0.2) and (78.11±0.2)%.

The economical analysis for the present study is presented in Table 1. Total production per cubic meter from the fingerlings of tilapia; common carp and mullet were 4.69, 4.38 and 4.89 kg/m^3 and were 5.48, 5.45 and 5.05 kg/m^3 at pumping air pressure (0.2 and 0.4) bar respectively with significant differences among the pipe location and air pressure tested under pipe location of zero cm , air pressure of (0.2 and 0.4) bar but were found to be 4.86 , 4.97 and 4.89 kg/ m^3 and 5.95 to 5.99 and 5.58 kg/ m^3 for tilapia; common carp and mullet respectively at pumping air pressure (0.2 and 0.4) bar for pipe location 100 cm compared with the control treatment which were 2.57, 3.27 and 3.44 kg/m^3 the results were 20.41, 20.87 and 20.53 tan/ faddan, 24.99, 25.16 and 23.43 tan/fadden under pipe location of 100 cm and air pressure of (0.2 and 0.4) bar.

Table 1. Effect of different levels of air pressure, perforated pipe location and distances between holes on some economical parameters

Item	Tilapia				Common Carp				Grey Mullet			
	0.2 bar		0.4 bar		0.2 bar		0.4 bar		0.2 bar		0.4 bar	
	0cm	100cm	0cm	100cm	0cm	100cm	0cm	100cm	0cm	100cm	0cm	100cm
1- Costs L.E/fed.												
a- Costs of fish stocking												
N.tilapia	29.75		29.75		29.75		29.75		29.75		29.75	
Common carp	3.5		3.5		3.5		3.5		3.5		3.5	
Mullet	1.75		1.75		1.75		1.75		1.75		1.75	
b-Costs of feed.	59.25	64.12	96.8	75.9	58.5	67.2	96.6	80.85	44.17	42.6	49.27	54.37
c- Costs of Tank	5400		5400		5400		5400		5400		5400	
d- other (Pumps & electric)	2500		2500		2500		2500		2500		2500	
Total costs	7994.25	7999.12	8031.8	8010.9	7993.5	8002.2	8031.6	8015.8	7979.17	7975.8	7984.27	7989.37
2-Return												
a -Total fish production (kg/fed.) for distance between holes 10cm	19.69	20.41	23.01	24.99	18.39	20.87	22.89	25.16	20.53	20.53	21.21	23.43
c-Total income for distance between holes 10cm *	492250	510250	575250	624750	459750	521750	572250	629000	513250	513250	530250	585750
e-Net return L.E/fed for distance between holes 10cm	484255.7	502250.8	567218.2	616739	451756	513747.8	564218.4	620984	505270.8	505274.2	522265.7	577760.6

Table 2. The net production cost for Tilapia, Common carp and Mullet reared in tanks

Treatment			Net production	Tilapia	Carp	Mullet
Control			Fish production (kg/m^3)	2.57	3.27	3.44
			Fish production (tan/faddan)	10.79	13.73	14.44
Distance between holes	Air pressure levels	Pipe location				
10 cm	0.2 bar	0 cm	Fish production (kg/m^3)	4.69	4.38	4.89
			Fish production (tan/faddan)	19.69	18.39	20.53
		100 cm	Fish production (kg/ m^3)	4.86	4.97	4.89
			Fish production (tan/faddan)	20.41	20.87	20.53
	0.4 bar	0 cm	Fish production (kg/m^3)	5.48	5.45	5.05
			Fish production (tan/faddan)	23.01	22.89	21.21
		100 cm	Fish production (kg/m^3)	5.95	5.99	5.58
			Fish production (tan/faddan)	24.99	25.16	23.43

Table 3. Economic visibility of *Oreochromis niloticus*, *Cyprinus carpio* and *Mugil cephalus* reared in Tanks during experimental period (14weeks)

Treatment			Area	Tilapia	Carp	Mullet
Control			Total feed intake (g/Fish)	4.37	5.89	4.82
			Feed cost (LE/Fish/m^3)	32.77	44.17	36.15
Distance between holes	Air pressure levels	Pipe location				
10 cm	0.2 bar	0 cm	Total feed intake (g/Fish)	7.9	7.8	5.89
			Feed cost (LE/Fish/m^3)	59.25	58.5	44.17
		100 cm	Total feed intake (g/Fish)	8.55	8.96	5.68
			Feed cost (LE/Fish/m^3)	64.12	67.2	42.6
	0.4 bar	0 cm	Total feed intake (g/Fish)	9.31	9.28	6.57
			Feed cost (LE/Fish/m^3)	96.8	96.6	49.27
		100 cm	Total feed intake (g/Fish)	10.12	10.78	7.25
			Feed cost (LE/Fish/m^3)	75.9	80.85	54.37

Total feed intake

Total feed intake as esplanade in Table 2 revealed that total feed intake were 7.9, 7.8 and 5.89 kg/m^3, 9.31, 9.28 and 6.57 kg/m^3 at pumping air pressure (0.2 and 0.4) bar for tilapia, common carp and mullet respectively with significant differences among the pipe location and air pressure tested compared with the control result were 4.37, 5.89 and 4.82 kg/m^3 but the total feed cost of fishes were, 59.25, 58.5 and 44.17, 96.8, 96.6 and 49.27 LE/ kg/m^3at pumping air pressure levels (0.2 and 0.4) bar Respectively. under pipe location of zero cm and air pressure of (0.2 and 0.4) bar compared with the control result were 32.77, 44.17 and 36.15 LE/ kg/m^3. but under pipe location of 100 cm and air pressure of (0.2 and 0.4) bar total feed intake 8.55, 8.96 and 5.68 kg/m^3, 10.12, 10.78 and 7.25 kg/m^3 for tilapia, common carp and mullet respectively at pumping air pressure (0.2 and 0.4) bar respectively Compared with the control result were 4.37, 5.89 and 4.82 kg/m^3 but the total feed cost of fishes were 64.12, 67.2 and 42.6 but were 75.9 , 80.85 and 54.37 LE/ kg/ m^3 at pumping air pressure levels (0.2 and 0.4) bar Respectively compared with the control results were 32.77, 44.17 and 36.15 LE/ kg/m^3.

Conclusion

From the previous results it can be concluded that , The fish tank aeration using the perforated pipe of 100 cm with air pressure 0.4 bar is suitable for the Nile tilapia (Oreochromis niloticus), Common carp (Cyprinus carpio) and Grey mullet (Mugil cephalus) fingerlings. At the previous conditions obtaining the highest growth more than the traditional system and keep the dissolved oxygen more than the low limit for fish survaival.

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تقييـــــــم نظــــــــام تهـــــــوية لاســــــتزراع الأســــــماك فـــي الأنظمـــة المغلقــــــــــــة

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أجريت هذه الدراسة بالمعمل المركزي لبحوث الثروة السمكية بالعباسة عام (2017م) وذلك بهدف دراسة العوامل الهندسية التي من شأنها التأثير على جودة التهوية والمحافظة على نسبة الأكسجين المثلى والتي يجب ألا تقل عن 3 ملجم/لتر حتى لا يفقد السمك القدرة على أداء العمليات الحيوية بكفاءة مما يقلل من الإنتاج. و وكانت عوامل الدراسة هي: ارتفاع الأنبوب المثقب من قاع الحوض (صفر - 100 سم)، ضخ الهواء بضغوط 0.2 – 0.4 بار، وكانت أهم النتائج المتحصل عليها هي: تأثير ارتفاع الأنبوب المثقب ومعدل ضخ الهواء عند مسافة بين الثقوب مقدارها 10 سم على جودة المياه: أعلى انتظامية لتوزيع الأكسجين داخل الحوض عند وضع الأنبوب المثقب على ارتفاع 100 سم ، ومسافة 10 سم بين الثقوب ، ضغط هواء 0.4 بار مقارنة بالمياه الغير معاملة، زيادة ارتفاع الأنبوب المثقب من 0 إلى 100 سم يزيد كمية الأكسجين الذائب في الماء عند استخدام ضغط هواء 0.2، 0.4 بار على التوالي مقارنة بالمياه الغير معاملة، لم يلاحظ إختلافَ معنوي في درجاتِ الحرارة للمياه أثناء فترةِ التجربةِ بين المعاملات الثلاثة، وجود فرق معنوي للأس الهيدرجينى عند وضع الأنبوب المثقب على ارتفاع 100 سم ، ومسافة 10 سم بين الثقوب، ضغط هواء 0.4 بار مقارنة بالمياه الغير معاملة، لوحظ اختلاف معنوي كبير للأمّونيا الكلية عند وضع الأنبوب المثقب على ارتفاع 100 سم، ومسافة 10 سم بين الثقوب ، ضغط هواء 0.4 بار مقارنة بالمياه الغير معاملة، تأثير ارتفاع الأنبوب المثقب ومعدل ضخ الهواء عند مسافة بين الثقوب على معدل أداء ونمو الأسماك: وزن الجسم النهائي : أظهرت الدراسة تأثير كلا من عمق أنبوب التهوية والمسافة بين الثقوب كذلك ضغط الهواء المختلف تأثيراً معنوياً على وزن الجسم النهائي مقارنة بالأسماك المرباه في المياه الغير معامله، الطول الكلى لجسم الأسماك :تزايد الطول الكلى لجسم الأسماك المرباة تزايدا معنويا تدريجيا مع كل زيادة في ضغط الهواء عند نهاية التجربة مقارنة بالأسماك المرباه في المياه الغير معاملة، معامل الحالة (ك): تزايد معامل الحالة للأسماك الثلاثة المرباة معنوياً مع كل زيادة في عمق الأنبوب المثقب وضغط الهواء على مدار التجربة مقارنة بالأسماك المرباة في المياه الغير معاملة، معدل التحول الغذائي (FCR): أظهرت النتائج أن أفضل معدل تحويل غذائي للأسماك المرباة تحت ضغط 0.4 بار ومسافة 10 سم بين الثقوب أعلى من معدل التحويل الغذائي للأسماك المرباة في المياه الغير معاملة، معدل النمو النوعي (SGR): أوضحت النتائج التي تم الحصول عليها انه عند وضع الأنبوب المثقب على ارتفاع 100 سم من قاع التانك ومسافة 10 سم بين الثقوب عند ضغط 0.4 بار أعطت تفوقا معنويا في معدل النمو النسبي للأسماك المرباة فى المياه الغير معاملة، معدل البقاء:- أظهرت النتائج أن أعلى معدل بقاء للأسماك المرباة عند ضغط هواء 0.4 بار ومسافة 10 سم بين ثقوب التهوية مقارنة بالأسماك المرباه في المياه الغير معاملة، وبناء على النتائج السابقة يمكن التوصية باستخدام نظام التهوية بالأنابيب المثقبة حيث انه مناسب لتربية الأسماك عند تجهيز الحوض بالمواصفات السابقة للحصول على أعلى معدل نمو للسمك مقارنة بالحوض التقليدي كذلك استخدام العدد الأكثر من فتحات التهوية حيث أنها تتناسب طرديا مع زيادة الإنتاجية.

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