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EFFECT OF DIFFERENT AERATORS MACHINE ON WATER QUALITY AND GROWTH PERFORMANCE OF *OREOCHROMIS NILOTICUS*

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ABSTRACT: This study was carried out in the Central Laboratory of Aquaculture Research (CLAR). The experimental studies were accomplished in The World Fish Center – Abbassa Abu-Hammad, Sharkia Governorate Egypt. The research aimed to study the effect of engineering factors on the optimum growth of *O. niloticus*. The selected engineering factors were Aerators machines Fountain (Splasher), Vertical aspirator for (3 hour/day) and Agitators for (6 hour/day). The aerators were evaluated in respect to their effect on keeping the dissolved oxygen and other water quality parameters within the required range. The investigations were conducted through six concrete ponds having the volume of 15 m^3/ each. All ponds were stocked with the same number of Nile tilapia fry (100 fish/m^3) with average body weight (0.3 g/fish). The obtained results reveal to that the concentration percents of dissolved oxygen were through the allowable level for fish culture in all ponds. As to except the control pond which was the least level of 1.7 mg/L. The temperature decreased significantly in ponds aerated by Vertical and Fountain machines than ponds aerated by Agitators and control treatment. Highest growth rate was remarked with Agitator aerator. Meanwhile the lowest growth rate was found under vertical aspirator machine.

***Key words*: water quality, growth rate, aerators, Vertical spirator, Fountain, Agitator.**

INTRODUCTION

Intensive culture generally required less space than extensive culture methods. Greater degree of control over the rearing systems is required. The trend in fish culture worldwide has been toward intensive conditions (Ali, 1999). The fish culturist and engineer must work together to explore ways to improve the biological, environmental (water quality) and facility design factors which lead to increase intensity without added cost (Timmons and Losordo, 1994).

Aquacultural engineering is concerned with the pond shape, pond dimensions, aeration, mechanical feeding and stocking density. Air-contact aeration systems transfer all gases present in atmospheric air into water. These systems can increase dissolved oxygen concentration to saturation, and the efficiency of oxygen transfer declines and dissolved oxygen concentration in water increases (Boyd, 1982).

The aim of this study was to evaluate the effect of different types of aerators machine on water quality parameters (temperature, dissolved oxygen, ammonia and pH) and growth rate of *Oreochromis niloticus*.

MATERIAL AND METHODS

The experimental work was carried out for 6 months, 15 Apr. 2003 to 15 Oct. 2003.

Six concrete ponds (15 m^3) for each, irrigated with freshwater and stocked with different stocking densities of Nile tilapia *Oreochromis niloticus* were used to evaluate three types of aeration machines on water quality and fish production under the local conditions.

Fries of *O. niloticus* was introduced from the Tilapia hatchery of Arab Fisheries Company (A.F.C), Abbassa, Abu-Hammad, Sharkia

The fish were acclimated to pond conditions for two weeks prior to the experiment by holding 150 fish fry/m^3 in each pond to acclimate them to the intensive conditions of the same pond in which the experimental work was to be carried out. Fish were observed to select the more viable and healthy fishes were restocked in the same pond prior to each next experiment at stocking rate of 100 fish/m^3 with initial average weight (0.3 g/fish) under different types of aerators. The Final average weight, total weight gain, total weight gain per day, feed conversion ratio and survival ratio were calculated for the reared fish.

Commercial pelleted fish feed 25 crude protein introduced by using demand feeder (plate 1) which will greatly decrease hand feeding labor and increase growth rate, as well as other savings may be realized in improved feed conversion ratios and by switch to less expansive sinking pellets. No power is required during operating this type of feeder.

Aerators:

Aerators have been used to restore adequate oxygen, reduce water temperature, dislodge obnoxious gases and dissolve organic wastes

Aeration and air supply was conducted by using three types of aerators:

Fountain (Splasher):

Ideal using for small ponds, ponds and raceways. It produce a spray 1- 0.5 m high and 3 m in diameter, pumping about 540 liters of water per min. Oil-filled motor, Cast aluminum motor housing, high-density foam float. This reliable aerator comes equipped with 50 m power cord. 1/3 HP, 115-230 volt single phase, 50 Hz; draws 2.1 amps; SAE rating is 2.4. R.P.M.987 (plate 2).

Operating theory:

An Electric motor with an impeller attached to its shaft, The motor suspended by floats, the impeller jets water into the air to enhance the aeration by mixing dissolved oxygen supersaturated surface waters with deeper water of lower dissolved oxygen concentration.

Agitator :

Agitators used for pond aeration for small fish and fish transport. It is normally suspended above the water surface by its hanging ring, it's a heavy duty motor unit, with automatic thermal overload protection and an 8-foot power cord, continuos heavy duty and shock proof motor, 220-volt DC, 1650 R.P.M., 1/20 HP., 50 Hz., fan coiled and proven very satisfactory. Basket included that an epoxy-coated quarter-inch screen 4" dia. X 10.5"long. Agitator draws only 1.2 amps while providing enough oxygen for 1000 minnow by agitating 327.6 l/m (plate 3).

Operating theory:

Heavy duty motor with on impeller attaches to the end of the rotating shaft, which rotate at 1650 R. P. M. inside the epoxy coated quarter-inch screen basket that leads to strong agitating of the water outside the basket in bubbles so, providing enough oxygen on the superficial layer of water though fish ponds.

Vertical aspirator :

Fresh- FLO water aerator with centrifugal action will operate on either 115 or 230 volt, single phase motor 50 Hz, AC 1/2 HP, R.P.M.1425, Draws 2.9 amps, pumping capacity 1012.5 gallons/min, vinylized tube with dimensions 4.5 " diameter, 24" length, high speed aluminum impeller inside aerator tube. Stainless steel impeller shaft, impeller shaft bearing stainless steel and self lubricated, strainer with vinylized steel rod to prevent corrosion. All bearings are long life type, grease sealed and self-lubricated (plate 4).

Operating theory:

The impeller within the aerator draws water within the aerator and initiates tremendous centrifugal force. The water is passed, under high pressure, through slots of the aerator, which stand above the water line. Sheets of water are sandwiched with open air - the air is sucked between the sheets - the oxygen is added and the obnoxious gases and waste materials eliminated. The newly aerated surface water is pushed toward shores as the aerator creates a continuous circulation process.

Water Quality:

Water was tested five days a week in each pond to determine temperature (°C) and concentrations of dissolved oxygen (DO), and at biweekly intervals to estimate pH and ammonia (NH_3). All determinations were carried out in the World Fish Center (ICLARM) according to the standard methods of the American Public Health Association (APHA, 1985) and Boyd (1990).

Statistical analysis:

Analysis of variance was considered (ANOVA) and Duncan's (1955) Multiple Range Test to determine differences between treatment mean at significance level of $p < 0.05$. Standard errors were also estimated. All statistics were run on the computer using the SAS program (SAS, 2000). All curves were fitted with the computer program Office (1997).

RESULT AND DISCUSSION

Water quality:

Regarding to the data included in Table (1) and Figures (1, 2, 3 and 4) that clarifying the quality of water under the use of different aerators on concrete ponds and cultured with O. niloticus at the stocking densities of 100 fish/m3. The values ranged between 22.25 ± 0.37, 21.92 ± 0.35, 20.76 ± 0.37 and 20.52 ± 0.34 °C for temperature; 1.65 ± 0.15, 4.24 ± 0.21, 4.42 ± 0.26 and 4.83 ± 0.26 mg/L for dissolved oxygen; 0.083 ± 0.009, 0.060 ± 0.009, 0.062 ± 0.005 and 0.060 ± 0.007 mg/L for ammonia (NH_3); 8.62 ± 0.06, 8.50 ± 0.06, 8.24 ± 0.08 and 8.03 ± 0.08 for the pH values for the treatments of control, agitators, fountain and vertical aerators respectively.

The value of temperature was decreased significantly than control treatment of and agitator in both fountain and vertical aerators. Due to the strong mixing of water which resulting from the operation of fountain and vertical aerators. Whereas, strong mixing consider the main operational feature of vertical aerators and fountain.

Concerning to dissolved oxygen concentration representing significant difference ($P<0.05$) between aerated ponds and treatments control (un-aerated pond) which gave good indication on the effect of different types of aerators machine for serving the dissolved oxygen concentration around optimal levels that required or aquaculture activities.

Concentration ammonia and pH showed a highly significant difference ($P<0.05$), where the highest values were for the control treatment and the lowest values was for the treatment of Vertical aerators resulting from the aspiratory function that depends on lifting the water from the bottom of the ponds to the open air under high pressure of centrifugation action of impeller which leads to oxygen added and elimination of ammonia and obnoxious gases according to (Mitchell and Kirby, 1976).

Growth Rate:

Data compiled in Table (2) and Figures (5, 6, 7 and 8) showed the effect of different types of aerators on the growth performance parameters of *O. niloticus* reared in concrete ponds and stocked by the rate of 100 fish/m^3 the average of initial weight was 0.255 g/fish, while the average final weight ranged from 2.42 ± 0.11 to 4.58 ± 0.38 g/fish, gained body weight ranged from 2.17 ± 0.09 to 4.32 ± 0.26, gained daily weight ranged from 0.036 ± 0.002 to 0.052 ± 0.004 g/fish/day; specific growth rate ranged from 5.29 ± 0.30 to 5.96 ± 0.34 and condition factor were 1.35 ± 0.17 to 2.327 ± 0.12 in ascending order for treatments of vertical aerator and treatment of agitators respectively. While the survival ratio were 30, 86, 71 and 75%; feed conversion ratio were 13.33, 2.88, 2.98 and 3.41 (g feed consumed /weight gain) for control treatment, agitator, fountain and vertical aerators respectively.

Insignificant difference was found between averages of initial weights that indicate the random distribution of initial stocking size.

However growth parameters within the treatment of agitators were significantly higher ($p<0.05$) than both of control and fountain over the vertical aerators respectively which indicated that the agitators machine may be the most efficient machine for the aeration of concrete ponds under this experimental condition. Although, vertical aerators and fountain aerators stronger than the agitators in the aeration efficiency which may be leads to disturbance (districted) or decrease the growth performance as a result of many reasons. A- sizes of experimental ponds were too small to use these types of machines. B- high operational efficiencies of vertical and fountain machine may create the unfavorable conditions for rearing fish. The both reasons may be play the important role in growth performance disturbances. Concerning to survival ratio was significantly higher ($p<0.05$) in treatment of agitator than other treatments (Refstie, 1977; Brett, 1979; Alabaster et al., 1979; Colt and Armstrong, 1981; Chervinski, 1982; Meade 1985; Boyd, 1990; and Siddiqui *et al.*, 1992).

CONCLUSION

Type of Aerators machine affect directly on the water temperature, ammonia (HN_3) and pH of rearing ponds, whereas dissolved oxygen concentration of all aerated ponds still within the allowable level for fish culture. Also, higher growth rate of reared fish were in the treatment aerated with Agitators, and the lowest growth rate was in the treatment of Fountain followed by the Vertical aerators, indicating that the suitability of agitators machine for the experimental condition.

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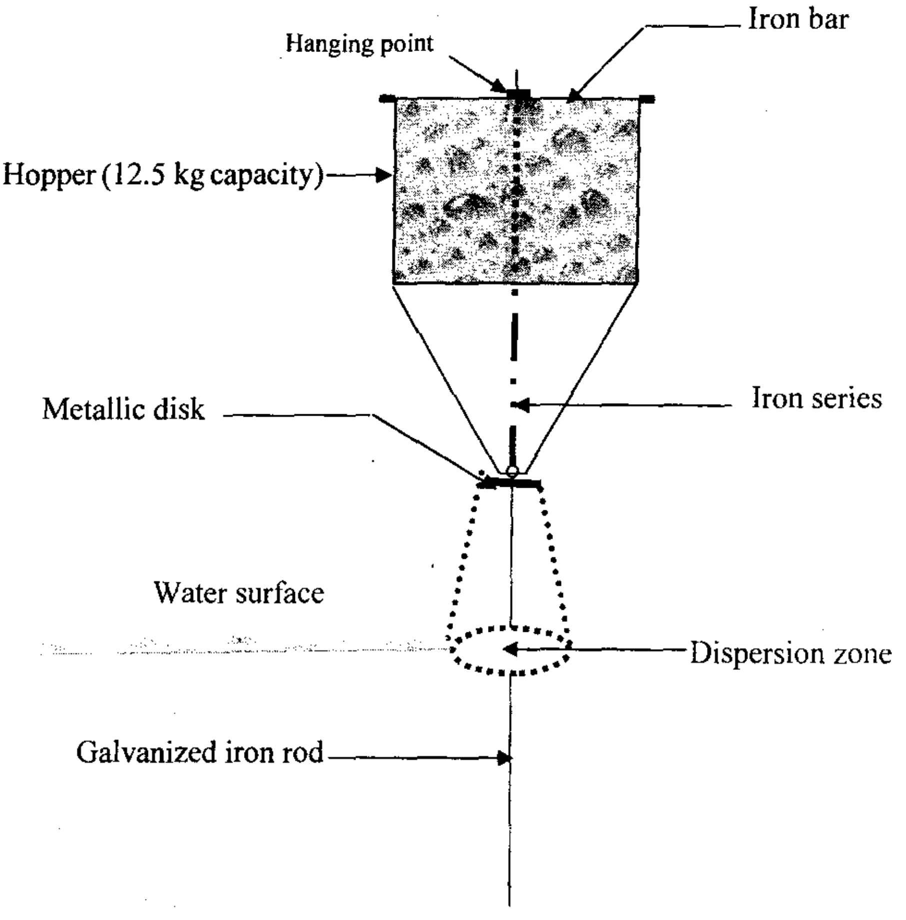


Plate (1): Schematic diagram of the used demand feeder.

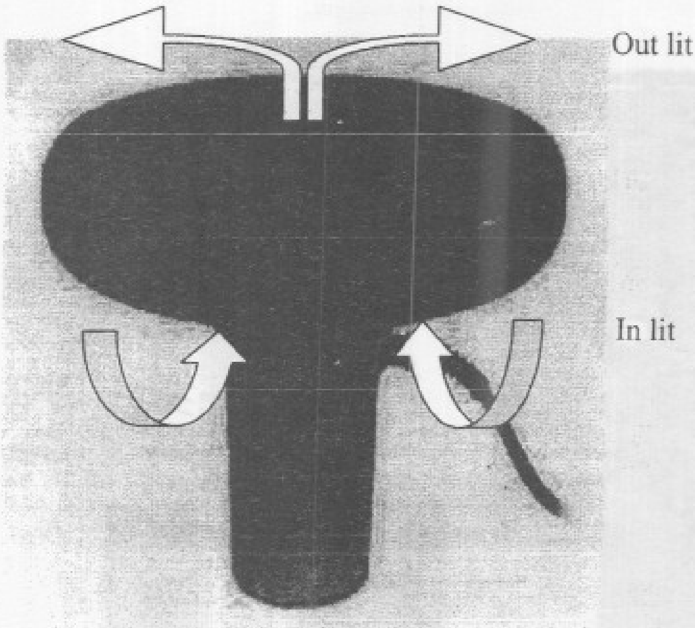


Plate (2): Fountain (Splasher).

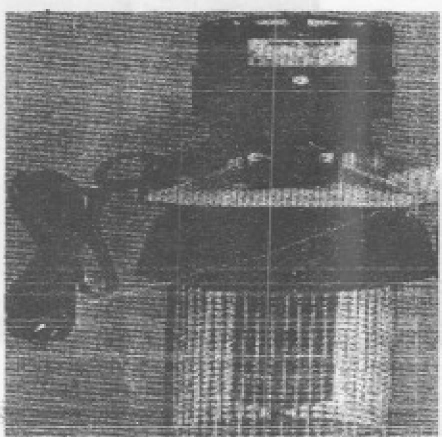


Plate (3): Agitator.

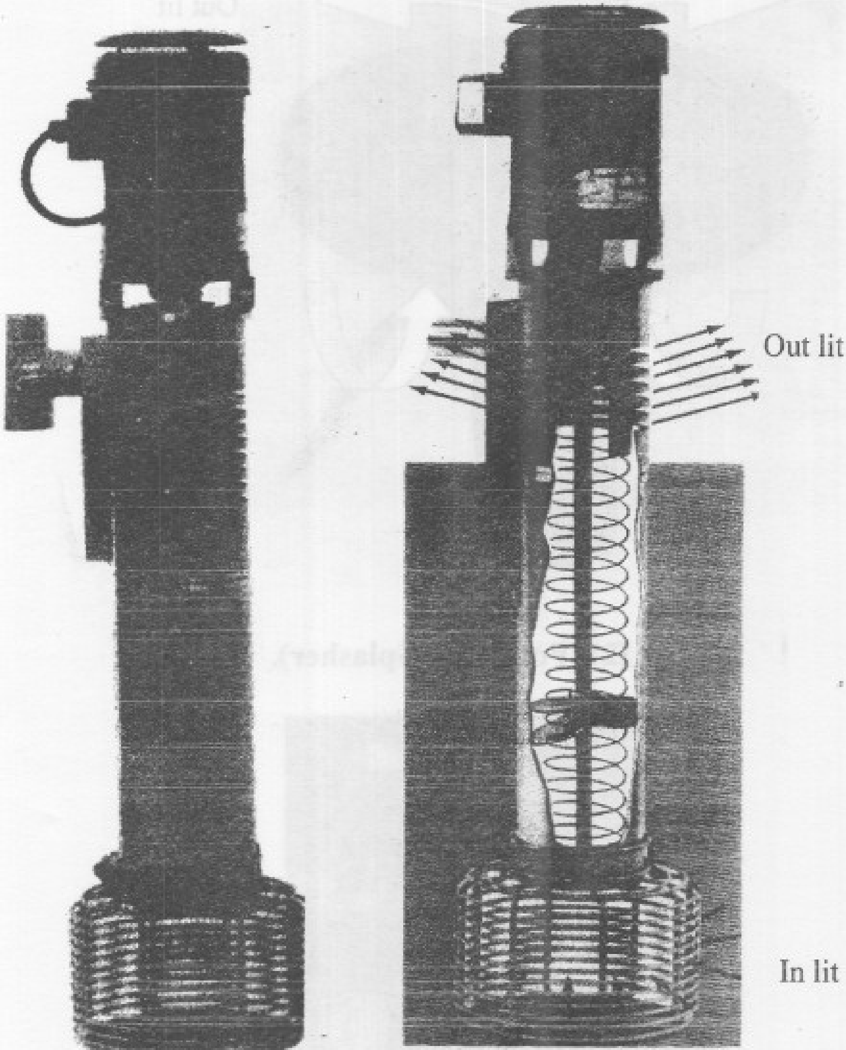


Plate (4): Vertical aspirator.

Table (1): Effect of different aerators machine on the water quality parameters within rectangular concrete ponds stocked with *O. niloticus* during the experimental stage.

Water quality parameter	Treatments			
	control	Agitator	Fountain	Vertical
Temperature C	22.250 ± 0.37a	21.921 ± 0.346a	20.760 ± 0.374b	20.522 ± 0.339b
Dissolved Oxygen (mg/l)	1.652 ± 0.15 b	4.238 ± 0.210a	4.419 ± 0.256a	4.829 ± 0.263a
Ammonia - NH_3 (mg/l)	0.083 ± 0.009a	0.060 ± 0.009b	0.062 ± 0.005b	0.047 ± 0.007c
pH	8.624 ± 0.056a	8.296 ± 0.057b	8.238 ± 0.082b	8.032 ± 0.083c

Means with the same litters in the same row are not significantly different ($P<0.05$). Using ANOVA.

Table (2): Effect of different aerators machine on the growth performance of *O. niloticus* reared in concrete ponds and stocked by the rate of 100 fish/m^3 during the experimental stage.

Growth parameter	Treatments			
	control	Agitator	Fountain	Vertical
initial wt(g/fish)	0.255 ± 0.020 a	0.255 ± 0.020 a	0.255 ± 0.020 a	0.255 ± 0.020 a
final wt (g/fish)	3.346 ± 0.283 b	4.577 ± 0.381 a	3.615 ± 0.441 b	2.423 ± 0.113 c
BWG (g/fish)	3.091± 0.263 b	4.322 ± 0.261 a	3.360 ± 0.421 b	2.168 ± 0.093 c
DWG (g/fish)	0.052 ± 0.004 b	0.072 ± 0.004 a	0.056 ± 0.007 b	0.036 ± 0.002 c
SGR	5.913 ± 0.312 b	6.582 ± 0.291 a	5.959 ± 0.341 b	5.287 ± 0.302 c
K	1.655 ± 0.055 b	1.738 ± 0.064 a	2.057 ± 0.118 b	1.358 ± 0.166 c
Survival (%)	30	86	71	75
FCR	3.1	2.88	2.98	3.41

Means with the same litters in the same row are not significantly different ($P<0.05$). Using ANOVA.

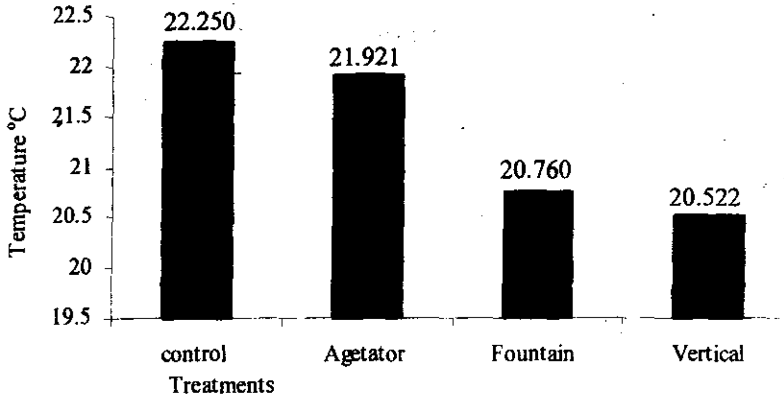


Figure (1): Effect of different aerators on the temperature of water within rectangular concrete ponds of *O. niloticus* at stocking rate 100 fish/m^3 during the experiment.

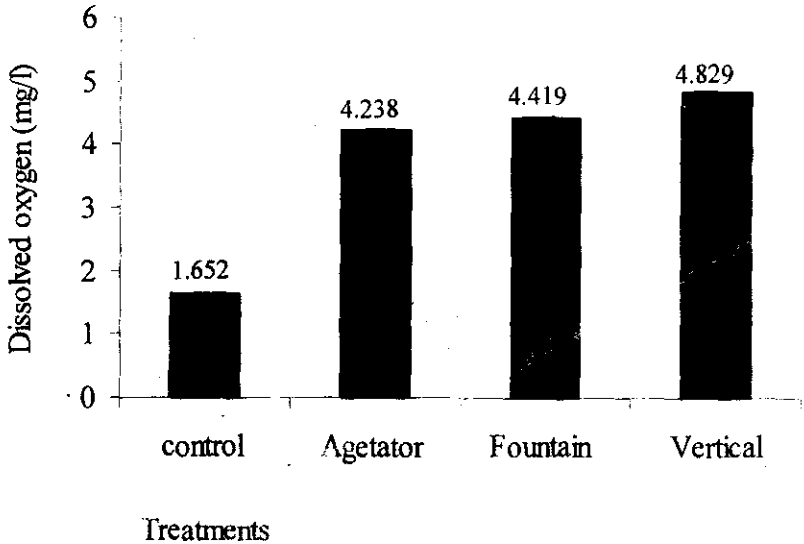


Figure (2): Effect of different aerators on dissolved oxygen (mg/l) of water within rectangular concrete ponds of *O. niloticus* at stocking rate 100 fish/m^3 during the experiment.

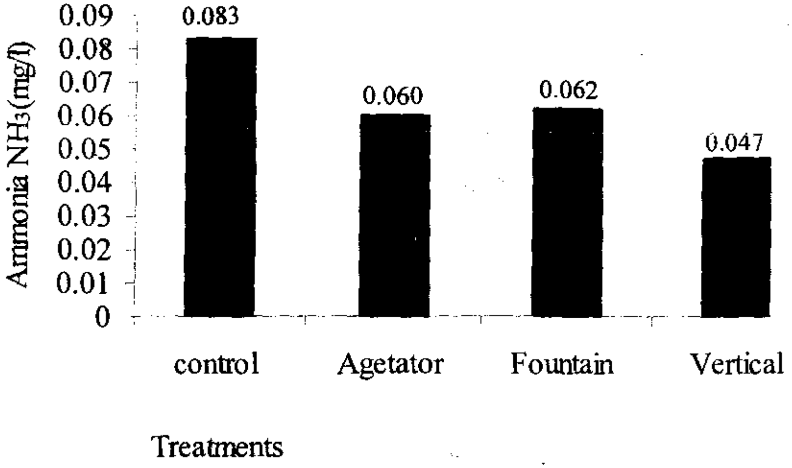


Figure (3): Effect of different aerators on ammonia concentration (mg/l) of water within rectangular concrete ponds of *O. niloticus* at stocking rate 100 fish/m^3 during the experiment.

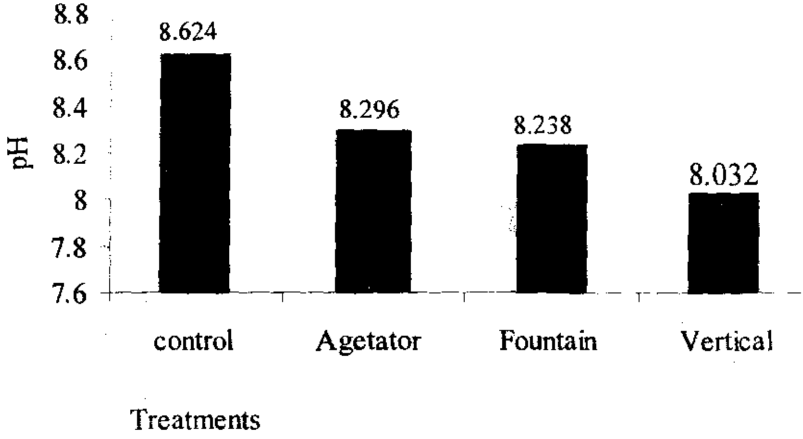
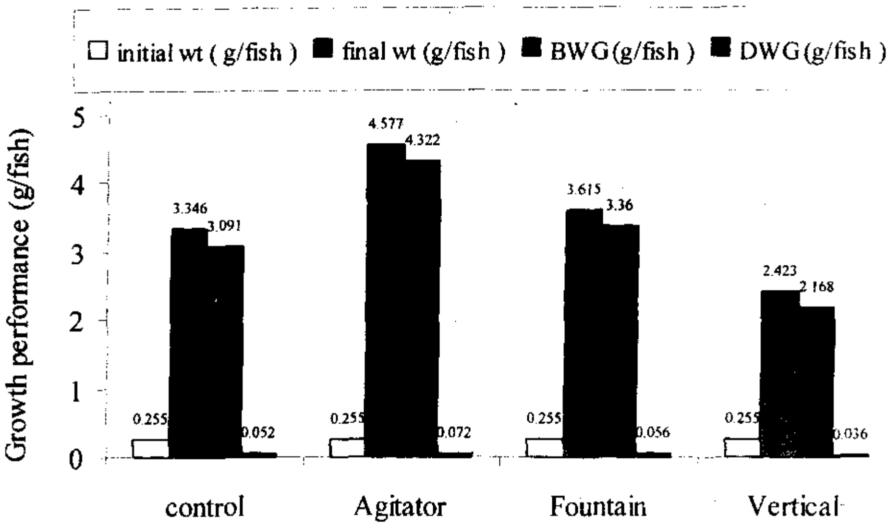


Figure (4): Effect of different aerators on pH concentration of water within rectangular concrete ponds of *O. niloticus* at stocking rate 100 fish/m^3 during the experiment.



Figure(5): Effect of different aerators on the growth performance of *O. niloticus* reared in concrete tanks and stocked by the rate of 100 fish/m³ during the experiment.

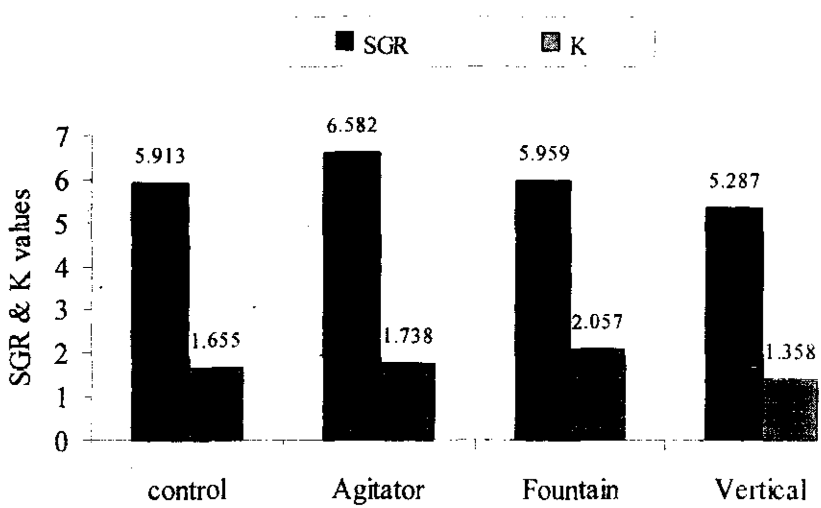


Figure (6): Effect of different aerators on SGR and K factor of *O. niloticus* reared in concrete tanks and stocked by the rate of 100 fish/m³ during the experiment.

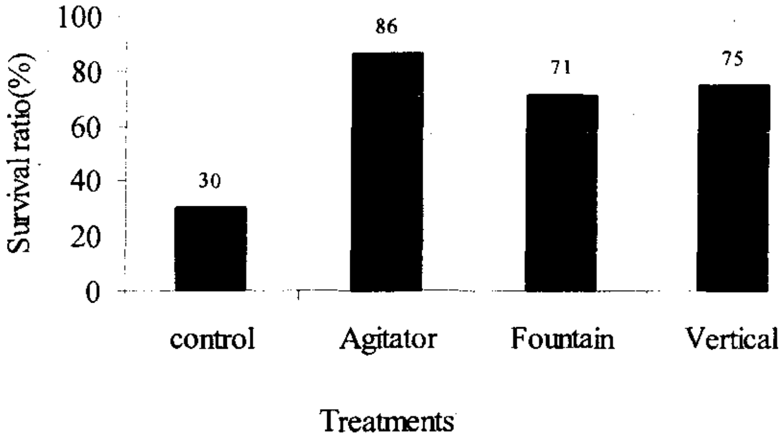


Figure (7): Effect of different aerators on survival ratio (%) of *O. niloticus* reared in concrete tanks and stocked by the rate of 100 fish/m^3 during the experiment.

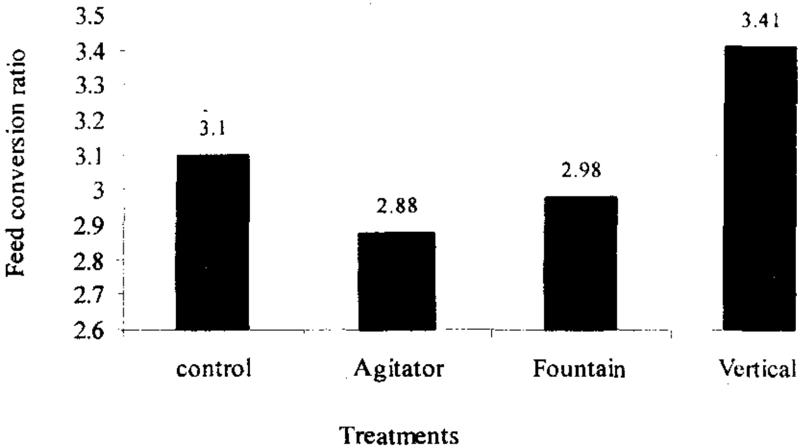


Figure (8): Effect of different aerators on feed conversion ratio (FCR) of *O. niloticus* reared in concrete tanks and stocked by the rate of 100 fish/m^3 during the experimente.

تأثير استخدام أنواع مختلفة من أجهزة التهوية على جودة المياه و معدل نمو أسماك البلطي النيلي

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**** المعمل المركزى لبحوث الأسماك-مركز البحوث الزراعية-العباسة-أبو حماد- شرقية.**

لقد أجريت هذه الدراسة في المعمل المركزي لبحوث الأسماك بالعباسة وتم إجراء التجارب العملية بالمركز الدولي للأسماك (إكلارم) وذلك لتقييم قدرة آلات التهوية المختلفة على جودة المياه ومعدل أداء النمو لزريعة أسماك البلطي النيلي تحت كثافة ثابتة وهى ١٠٠ اسمكة في المتر المكعب.

– لقد أثرت الأنواع المختلفة من أجهزة التهوية تأثيرا مباشرا على درجة حرارة المياه في أحواض التربية حيث انخفضت درجة الحرارة معنويا داخل الأحواض المستخدم فيها آلات التهوية ذات القدرات العالية (آلة التهوية الرأسية – وآلة التهوية النافورة) عنها في الأحواض المستخدم فيها آلات التهوية ذات القدرات الصغيرة وحوض الكنترول.

– لقد ظل تركيز الأكسجين الذائب في حدود المستويات المسموح بها للاستزراع السمكي في جميع الأحواض(١٥م^{3} / حوض) المستخدم فيها آلات التهوية المختلفة فيما عدا حوض الكنترول (بدون تهوية) حيث وصل مستوى الأكسجين إلى أقل مستوى له وهو (١،٧ملجم/لتر).

– كما أظهرت النتائج أن أقل مستوى لتركيز الأمونيا والأس الهيدروجيني في معاملة الأحواض التي بها أجهزة التهوية الرأسية وكانت أعلى تركيزات في حوض الكنترول.

– لقد أظهرت النتائج أن أعلى معدل لنمو الأسماك كان في الأحواض المستخدم بها أجهزة التهوية ذات القدرة الصغيرة بينما كان أقل معدل للنمو في معاملة الأجهزة الرأسية ذات القدرة الكبيرة مما يوضح ملائمة قدرة أجهزة التهوية ذات القدرة الصغيرة لظروف التجربة ومساحة الأحواض المستخدمة وحجم المياه.

من النتائج المتحصل عليها يمكن التوصية بضرورة استخدام أجهزة التهوية المناسبة في الاستزراع السمكي تحت الكثافات المرتفعة مع مراعاة مدى ملائمة أحجام وقدرات أجهزة التهوية لمساحة الأحواض المستزرعة وحجم المياه بها