EFFECT OF SOME ENGINEERING FACTORS (POND SHAPE AND DIMENSION) ON WATER QUALITY AND GROWTH PERFORMANCE OF NILE TILAPIA

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Abstract

This study was carried out to evaluate the effect of some engineering factors (pond shape and pond dimension) on water quality parameters and growth performance of *Oreochromis niloticus*. The experiment was included eight rectangular ponds, A- six ponds with water volume of 15 m^3 for each (3m width × 5m length × 1m depth), and two ponds with water volume of 9 m^3 for each (0.5m width × 18 m length × 1m depth). B- Two circular fiber glass pond with water volume of 3 m^3 for each (2m diameter × 1m depth). Both of the ponds were stocked with *O. niloticus* of average weight 3.34 g with the same stocking densities (30 fish/m^3). Both growth performance and water quality parameters were investigated. Circular ponds had better water quality and fish growth performance than that rectangular pond.

The short width rectangular ponds showed better water quality than the long width rectangular ponds. The growth performance parameters were significantly ($p < 0.05$) higher in long rib than short rib rectangular ponds.

INTRODUCTION

The increased fish production intensity, using modern technology, afford high fish production and results in both high feed input rates, chemical substances and waste products (Bergheim and Aasgard, 1994).

Intensive culture requires less space, has a higher degree of control, can easily mechanize and automate feeding (Ali, 1999).

Aquaculture engineering is concerned with the pond shapes, pond dimensions, aeration, mechanical feeding and stocking density which consequently affect fish production,

The objectives of the present study were to evaluate the effect of some engineering factors on water quality and growth performance of *O. niloticus*.

MATERIALS AND METHODS

The study was conducted in the Central Laboratory for Aquaculture Research and accomplished in the World Fish Center, Abbassa, Abu-Hammad, Sharkia Governorate.

The work was carried out for six months from 15 April to 15 October 2003 fish stocked at 30 fish/m^3.

Eight concrete ponds were irrigated with fresh water and stocked with Nile tilapia (*Oreochromis niloticus)* with an individual weight of 3.34 g. Fish fed commercial pelleted feed 25% crude protein, presented in demand feeder. Two different shapes of ponds (rectangular concrete and circular fiber glass) were used. Two rectangular groups of concrete ponds: the first was long arm 0.5m X 18 X 1 m and the second was short arm 3 X 5 X 1 m. Circular ponds had 2 m diameter X 1 m depth). Aeration was used in this experiment using agitators.

Growth parameters were registered monthly, body weight gain, daily weight gain, specific growth rate, condition factor, and feed conversion ratio were calculated according to the following equations:

Body weight gain = Final weight (g) - Initial weight (g).

Daily weight gain = Body weight gain (g)/ time (day).

SGR = (Ln wf - Ln wi) / (Tf - Ti) X 100 (Allen and Wootton, 1982).

Where: Wf = final weight of fish (g), Wi = initial weight of fish (g), (Tf-Ti) = time between the final and the initial weight (days) and Ln = Logarithm to the base.

$K = (W / L^3) X 100$ (Lagler, 1959).

Where: W = weight (g) L = length (cm)

FCR = Feed consumed during the period / gain in live weight during the same period.

Statistical analysis was done using the SAS program (SAS, 2000).

RESULTS AND DISCUSSION

1-**Water quality**:

Data in Table (1) shows the effect of pond shapes on water quality parameters. 24.98 ± 0.21 and 24.64 ± 0.22 °C for temperature, 4.57 ± 0.28 and 4.04 ± 0.25 mg/l dissolved oxygen, 0.064 ± 0.007 and 0.033 ± 0.006 mg/l ammonia (NH_3) and the pH 8.13 ± 0.04 and 7.79 ± 0.08 for rectangular short rib shape and circular shape, respectively.

The results showed insignificant differences in temperature or dissolved oxygen and significant in ammonia concentration and pH values between rectangular short rib shape and circular shape respectively.

The obtained results may due to the shape of the two ponds short rib (3x5m), circular are nearly the same. So, the aeration machine should be oriented at the middle of each pond which leads to a good mixing and distribution of water waves by using the aerators that affect directly the distribution of temperature and dissolved oxygen. The high pH value increases un-ionized ammonia concentration that related to the metabolic functions and feeding activity.

Data presented in table (2) showed that there were significant differences in temperature, dissolved oxygen or un-ionized ammonia between long rib rectangular shape and circular shape pond, respectively. These may be due to the good distribution of dissolved oxygen aerator in the circular shape compared with long rib rectangular one.

Table 1. Effect of pond shape (rectangular and circular) reared with *O. niloticus* on some water quality parameters.

Item	Pond shape	
	rectangular short rib	circular
T (°C)	24.986 ± 0.208 a	24.639 ± 0.221 a
DO (mg/l)	4.573 ± 0.277 a	4.043 ± 0.247 a
NH_3 (mg/l)	0.064 ± 0.007 a	0.033 ± 0.006 b
pH	8.128 ± 0.040 a	7.792 ± 0.077 b

Means followed by the same litters in the same row are not significantly different (P<0.05). Using Duncan.

Table 2. Effect of pond shapes (rectangular and circular) on water quality parameters of *O. niloticus* rearing concrete pond.

Item	Pond shape	
	rectangular long rib	circular
T (°C)	25.002 ± 0.180 a	24.639 ± 0.221 a
DO (mg/l)	3.227 ± 0.191 b	4.043 ± 0.247 a
NH_3 (mg/l)	0.062 ± 0.005 a	0.033 ± 0.006 b
pH	8.024 ± 0.062 a	7.792 ± 0.077 b

Means followed by the same litters in the same row are not significantly different (P<0.05). Using Duncan.

Table 3. Effect of the rectangular pond dimensions ratio on water quality parameters.

Item	Rectangular shape pond	
	short rib *	long rib **
T (°C)	24.986 ± 0.208 a	25.016 ± 0.183 a
DO (mg/l)	4.573 ± 0.277 a	3.223 ± 0.195 b
NH_3 (mg/l)	0.064 ± 0.007 a	0.062 ± 0.005 a
pH	8.128 ± 0.040 a	7.979 ± 0.090 a

Means followed by the same litters in the same row are not significantly different (P<0.05). Using Duncan.

* 1:2 width: length. ** 1:36 width: length.

Effect of rectangular pond dimensions (ribs-ratio) on the water quality of rearing pond aerated by agitators and the stocked with 30 fish/m^3 showed in table (3).

Temperature, un-ionized ammonia concentration and pH value in short rib rectangular pond had insignificant difference compared to long rib one.

Dissolved oxygen concentration decreased significantly in long rib rectangular ponds this may be the result of ribs-ratio of rectangular ponds that leads to the best distribution and mixing of water from corner to other.

2-**Production**:

Data in table (4) represent the growth performance of *O. niloticus* reared in both of rectangular and circular ponds stocked with 30 fish/m^3 and aerated by agitator machines that were, 3.51 ± 0.25 and 3.13 ± 0.13 g/fish initial average weight, 60.79 ± 4.40 and 77.77 ± 6.15 g/fish final average weight. The percentage of body weight gain/fish were 1632 and 2384.7 %, percentage of daily weight gain /fish were 17.1 and 25.2 %, the values of (SGR) were 3.07 ± 0.12 and 3.32 ± 0.13, condition factor (K) were 2.03 ± 0.03 and 2.18 ± 0.05, survival rate 92 and 95%, feed conversion ratio 1.9 and 1.7 for fish reared in rectangular shape (long rib) and circular shape, respectively.

Table (5) showed the effect of pond shape on the growth performance of *O. niloticus*. Average initial body weight was 3.44 ± 0.13 and 3.13 ± 0.39 g/fish, average final body weight was 44.63 ± 2.76 and 77.77 ± 6.15 g/fish. Percentage of body weight gain/fish was 1197 and 2384.7%, percentage of daily weight gain/fish was 12.5 and 25.2 %. Specific growth rate (SGR), 2.65 ± 0.09 and 3.33 ± 0.13, condition factor (K), 1.90 ± 0.20 and 2.18 ± 0.05. Survival rate was 75 and 95 %. Feed conversion ratio (FCR) was 2 and 1.7 (kg feed/kg fish gain) for the fish reared in short rib rectangular shape and circular shape, respectively.

Percentage of body weight gain and daily weight gain per fish were higher in the circular pond than in the short rib rectangular pond. This may due to the pond shape, whereas that the circular shape pond was protracted and un-ended, so that fish move without stunting and behaving as they are in open environment, beside the regular distribution of dissolved oxygen that leads to improve the feeding intake and other biological activities than the rectangular shape ponds in both dimensions.

Specific growth rate showed a significant ($p<0.05$) difference for fish reared in short rib rectangular pond and both of long rib rectangular and circular ponds, this may be due to the pond shape. Both of circular and the longest rib rectangular pond were nearest to the natural habitats.

Condition Factor (K) values increased significantly ($p<0.05$) in ascending order for fish reared in short rib rectangular pond, circular ponds These results in agreement with data presented by Boyd, 1990, and Siddiqui *et al.*, 1992.

Table 4. Effect of pond shapes (rectangular and circular) on growth performance of *O. niloticus* aerated with agitator machine.

Growth parameter	Treatments	
	L. R. rectangular*	circular
initial wt (g/fish)	3.51 ± 0.25 a	3.13 ± 0.13a
final wt (g/fish)	60.79 ± 4.40 b	77.77 ± 6.15a
BWG (%)	1632	2384.7
DWG (%)	17.1	25.2
SGR	3.07 ± 0.12 a	3.32 ± 0.13 a
K	2.03 ± 0.03 b	2.18 ± 0.05a
Survival (%)	92	95
FCR	1.9	1.7

Means followed by the same litters in the same row are not significantly different (P<0.05). Using Duncan.

* Long rib rectangular pond.

Table 5. Effect of pond shapes (rectangular and circular) on growth performance of *O. niloticus* aerated with agitator machine.

Growth parameter	Pond shape	
	S. R. rectangular*	circular
initial wt (g/fish)	3.44 ± 0.13 a	3.13 ± 0.13a
final wt (g/fish)	44.63 ± 2.76b	77.77 ± 6.15a
BWG (%)	1197	2384.7
DWG (%)	12.5	25.2
SGR	2.65 ± 0.09 b	3.32 ± 0.13 a
K	1.90 ± 0.02 b	2.18 ± 0.05a
Survival (%)	90	95
FCR	2	1.7

Means followed by the same litters in the same row are not significantly different (P<0.05). Using Duncan.

* Short rib rectangular tanks.

Table 6. Effect of the rectangular concrete pond dimensions on performance of *O. niloticus* aerated by agitator machine.

Growth parameter	Rectangular shape pond	
	short rib*	long rib**
initial wt (g/fish)	3.44 ± 0.13 a	3.51 ± 0.25 a
final wt (g/fish)	44.63 ± 2.76 b	60.79 ± 4.40 a
BWG (%)	1197	1632
DWG (%)	12.5	17.1
SGR	2.65 ± 0.09 b	3.07 ± 0.12 a
K	1.90 ± 0.02 b	2.03 ± 0.03 a
Survival (%)	91.6	89.3
FCR	2	1.9

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

* 1:2 width: length. ** 1:36 width: length.

2-2- **Effect of pond dimensions**:

Data in table (6) showed the effect of different dimensions of the rectangular pond (long rib and short one) on the growth rate of *O. niloticus* that were 3.44 ± 0.13 and 3.51 ± 0.25 g/fish for initial average weight, 44.63 ± 2.26 and 60.79 ± 4.40 g/fish for final average weight, the percentage of body weight gain/fish were 1197 and 1632 %, percentage of daily weight gain/fish 12.5 and 17.1 %, the values of specific growth rate were 2.65 ± 0.09 and 3.07 ± 0.12, the condition factors were 1.90 ± 0.02 and 2.03 ± 0.03, survival rate, 91.3 and 89.3 %, FCR, 2 and 1.9 for short rib rectangular pond (1 : 2 width: length) and long rib rectangular pond (1 : 36 width: length), respectively.

Statistical evaluation represented a significant increase ($P<0.05$) in the fish reared in long rib rectangular pond than those in short rib rectangular ones. This may be due to the fish moving in the longest rib rectangular pond without stunting which affect positively in feeding activities that lead to improve the growth performance parameters. Long rib rectangular pond like circular pond in this protracted ripe.

The study suggests constructing fish ponds in circular shape or in long rip rectangular shape.

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تأثير بعض العوامل الهندسية (شكل وأبعاد الحوض) على جودة المياه ومعدل نمو سمك البلطى النيلى

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أجريت هذة الدراسة فى المعمل المركزى لبحوث الأسماك بالعباسة وذلك لتقييم تأثير شكل الحوض وأبعادة على جودة المياه ومعدل أداء البلطى النيلى.

إستمرت الدراسة ستة شهور ومتوسط وزن الأسماك المزروعة ٣جرام وبكثافة ٣٠سمكة /م^{٣}.

وتم إجراء هذة التجربة فى عدد ٨ أحواض خرسانية مستطيلة الشكل منها ٦ أحواض الحوض(٣م عرض × ٥م طول × ١م عمق) و٢حوض أبعاد الحوض (٠,٥م عرض × ١٨م طول × ١م عمق) و٢حوض من الفيبر جلاس أبعاد الحوض (٢م قطر × ١م عمق).

– أثر شكل الحوض على جودة المياه بالأحواض ومعدل أداء نمو البلطى النيلى ، كان الشكل الدائرى أفضل من الشكل المستطيل بنوعيه من حيث زيادة تركيز الأكسجين الذائب وإنخفاض نسبة الأمونيا بالأحواض حيث سجل ٤,٠٤٣ مجم/لتر و ٠,٠٣٣مجم/لتر، على التوالى وأيضاً من خيث إرتفاع معدل نمو السمك بالحوض.

– كانت الأحواض ذات الضلع القصير والأبعاد المتقاربة فى الطول أفضل من حيث إنتظام توزيع الإكسجين وإنخفاض مستوى الأمونيا عن الأحواض ذات الضلع الطويل والأبعاد المتباعدة فى الأطوال.

– أعلى نمو للأسماك المرباه كان بالأحواض ذو الشكل الدائرى و سجل ٧٧,٧٧ جم ثم المرباه بالأحواض المستطيلة ذات الضلع الطويل والأبعاد المتباعدة وسجل ٦٠,٧٩ جم وكان نمو السمك بالأحواض المستطيلة ذات الضلع القصير فى المرتبة الأخيرة وسجل ٤٤,٦٣ جم.

خلصت الدراسة إلى أن :

١– الأحواض الدائرية الشكل هى الأفضل فى تربية البلطى النيلى نظراً لسهولة تنظيفها وإنتظام توزيع الأكسجين الذائب بها.

٢– زيادة النسبة بين الطول والعرض فى الأحواض الخرسانية يزيد معدل نمو أسماك البلطى النيلى والعكس صحيح ، نظراً لطول المشوار الذى يقطعه السمك بدون حواجزممايجعله مشابها لطبيعة الأسماك الغذائية والبيولوجية.وتقترح الدراسة مراعاة نسب الأبعاد عند تصميم وإنشاء الأحواض الخرسانية المستطيلة الشكل.