EFFECT OF DIFFERENT SIZES OF CIRCULAR CONCRETE TANKS ON GROWTH PERFORMANCE OF MONO SEXED NILE TILAPIA (*OREOCHROMS NILOTICUS*) REARED UNDER DIFFERENT STOCKING DENSITIES.

SHMAIS, N.M.

Department of Aquaculture Central Laboratory for Aquaculture at Abbassa, Sharkia Governorate, Egypt.

Abstract

The present study was carried out to evaluate mono sex Nile tilapia (*Oreochromis niloticus*) reared in different sizes of circular concrete tanks throughout 150 days growth period. Circular concrete tanks were used representing six treatments three, volumes (48.0, 98.1, and 141.3 m3) and two stocking densities (50 to 75 fish/m3) within each treatment was performed in duplicates. Results obtained can be summarized as follows: 1- regardless of stocking density increasing the size of tanks from (48.0 to 141.3m3) increased significantly ($P < 0.05$) growth rate during all experimental periods. On the other hand, increasing the stocking density from (50 to 75 fish/m3) decreased significantly ($P < 0.05$) growth rate. 2- Increasing the stocking density resulted in an increasing the total fish yield in all treatments tested. 3- Application of big size ponds (141.3 m3) improved water quality criteria of the experimental tanks. 4- The best size of tank and fish density achieved low feed cost and high profit index was for the 6th treatment (T3xSD2) followed by 5th treatment (T3xSD1). 5- Based on the obtained results from this study, it could be concluded that size of tank (141.3 m3) with stoking density of 75 Fish/m3 were the optimal size and stocking density to recommend to be used in monoculture intensive system for monosex Nile tilapia to give the best yield.

Key words: Concrete circular tanks, stocking densities, Mono sex Nile tilapia, Growth performance, Fish production, Economic efficiency.

INTRODUCTION

The growth of the human population has lead to an increased search for other methods of producing animal protein than those of animal livestock and capture fisheries as both fare limits in production performance. Therefore the potential of aquacultures as a supplementary producer of animal protein is attracting more interest the ever, and has led to an increased production and a rapid development of technologies (Stickney, 2005).

Total fish production from different resources in Egypt is 970,923 tone/year 2006, while fish consumption 1,174,442 tone / year 2006 (about 16.62 kg/Capita). Currently, about 61.0% of the fish in Egypt come from aquaculture while the remainders are supplied by domestic capture fisheries (GAFRD, 2007): Recent development in modern fish farming, however, is increasingly moving fish culture towards more industrialized market economics. This is characterized by one more of the following factors:

- Use of purpose-built rearing units for each stage in the production cycle.
- High stocking rates to achieve maximum yields per unit area.
- Use of nutritionally balanced diets, usually the form of protein rich compounded pellets.
- High water flow rates.
- Use of artificial aeration or oxygenation.
- A high degree of mechanization, e.g., feeding, grading and harvesting (Amin, 2005). Large circular tanks were successfully used in different parts of the world, e.g., in Japan for rearing shrimps (shigeno tanks), in Korea for rearing tilapias (Baobab tanks), and in Taiwan for the production of the latter species. They are usually constructed in concrete or fiber-glass. Circular tanks require less water, and keep fairly homogenous water quality inside tank, encouraging a more uniform distribution of food fish compared with raceways (Pillay and Kutly., 2005)

This study aims to evaluate the effect of different volumes of circular concrete tanks on growth performance of Nile tilapia (*O. niloticus*) mono six stocked by different stocking densities.

MATERIAL AND METHODS

The experiments was conducted during one growing season for 150 days at concrete tanks were located in private fish farm at Wady – El Natron, Behira, Government, Egypt. Twelve circular concrete tanks were used representing six treatments, three dimension (about 50, 100, 150 m^3) and two stocking rate (50 and 75 fish/m^3) within each dimension tested. Tanks were stocked with hormone treated mono sex Nile tilapia (*O. niloticus*) fingerlings in average 30 ± 0.20 g. Each treatment was performed in duplicates circular concrete tanks (T1, T_2 and $T_{3)}$ are identical in depth (1.25 m), but different in size and capacity, which were 48.0, 98.1 and 141.3 m^3 (7.0, 10.0 and 12 m diameter), respectively. Sex treatments were as follows:

Treatment (1) 50 fish/m^3 at 48.01 m^3 (T_1 x SD_1)

Treatment (2) 75 fish/m^3 at 48.01 m^3 (T_1 x SD_2)

Treatment (3) 50 fish/m^3 at 98.1 m^3 (T_2 x SD_1)

Treatment (4) 75 fish/m^3 at 98.1 m^3 (T_2 x SD_2)

Treatment (5) 50 fish/m^3 at 141.3 m^3 (T_3 x SD_1)

Treatment (6) 75 fish/m^3 at 141.3 m^3 (T_3 x SD_2)

Experimental tanks were supplied with ground water. Tank water was exchanged daily at 20%, 50 %, 70 % and 100 % rates during the first, second, third and fourth intervals of the study. The experimental tanks were prepared with water outlet pipes covered with screens to prevent escaping of the experimental fish.

The experimental fish of tanks were weighted at start and every four weeks during the experimental period individually to the nearest gram and body length was recorded to the nearest one millimeter. At the sampling periods the measurements cited above were taken for 150 fish/tank samples. The amount of diet was adjusted every four weeks, according to the last weight and the fish were fed for at 3 % rate of the total tanks fish biomass daily. The experimental fish were fed 7 days a week at three portions of the calculated amount of feed. At the experimental end, all tank fish were weighed and production was recorded. The determined chemical composition of the diet use was 94.10 dry matters, 30.27 % crude protein, 5.98 % crude fat, 9.56 crude fibers, 8.11 % ash and 46.08% nitrogen free extract according to A.O.A.C. (1990). This commercial diet was 3 mm (floating pelleted) size.

Air was supplied for fish tanks by using of the submerged air injectors machine (1m/hp) to improve oxygenation capacity. Temperature, dissolved oxygen, pH and unionized (free) ammonia were measured daily according to the method of Boyd (1990).

Assessed parameters

Body weight (BW) g, body length (BL cm), weight gain (WG), specific growth rate (SGR), condition factor (K), feed intake (FI), and feed conversion ratio (FCR) were calculated as follows:

Weight gain = fish weight g. period 2 – fish weight g period 1

SGR = 100X (Ln. W_2 - Ln $W_{1)}$ / T

Where W_2 is the final weight of fish (g)

W_1 is the initial weight of fish (g)

Ln is the natural log

T is the period in days

Condition Factor (K) :{ Final weight (g) / Final length $(cm)^3$ }X 100 Feed Conversion ratio (FCR) = Feed intake (g) / Weight gain (g).

Statistical analysis

The statistical analysis of the data was carried out by applying the computer program, SAS (1989). The least significant differences test (Duncan, 1955) was used to evaluate the significance among treatments means for all variables.

RESULTS AND DISSCUTIONS

Water quality criteria

Results of water quality parameters as affected by treatments as averages of the monthly samples are presented in Table (1). As shown in Table (1), the averages of temperature ranged between 29.4 and 30.8 °C. In general water temperature was adequate for tilapia growth. These are in agreement with results of Boyd (1992). Who reported that water species which are native to temperature climate and best semitropical conditions grow better at temperatures 30 °C.

An average of dissolved Oxygen (DO) had ranged between 5.3 and 6.6 mg/L. these values are beneficial to fish cultivation and indicate that water dissolved oxygen slight decreased in tanks with higher density and small tanks compared to the other ponds. This may be attributed to the increase in fish density of these tanks, which may lead to dissolved Oxygen decreases. In this connection Al-Zahaby *et al.* (2006) demonstrated that tanks culture system is characterized by high stocking and requires relatively more dissolved Oxygen concentration in water bodies. In this respect, aerators are used to increase the rate of Oxygenation in tank water.

An average of pH values for treatments T_1 x SD_1, T_1 x SD_2, T_2 x SD_1, T_2 x SD_2, T_3 x SD_1 and T_3 x SD_2 were 8.2, 8.0, 8.6, 8.1, 8.8 and 8.4, respectively. The lower values of pH in tanks with higher density and small tanks may be attributed to the increase in organic matter contents (fish feaces) of these tanks, which may lead to pH decrease. Un-ionized ammonia (NH_3) did not exceed 0.18 mg/l in different treatments. An average of phosphorus had ranged between 0.16 and 0.18 mg/L, which represented the normal range of phosphorus in fish tanks. The reported values of the tested water criteria were within the suitable range for rearing Nile tilapia according to Sadek *et al* (1992), Siddiqui *et al.* (1992) and Amin, (2005). Similar results were given too by krom *et al.* (1989), Lawson (1995), Timmons and Losordo (1994), Timmons *et al.* (1998) and Stickney, (2005).

Growth traits

Table (2) shows the effects of fish density and tanks size and their interactions on the different body measurements studies. Regardless of stocking density, the increasing of tanks size (from 48.01 to 141.3 m^3) increase the final body weight from 147.71 to 171.91 g, body length from 19.81 to 24.18 cm.

These results indicate that final body weight and length of mono sex Nile tilapia (*O. niloticus*) increased significantly ($p < 0.05$) with the increase in size of tanks from 48.01 to 141.3 m^3. These results are in agreements with those reported by Amin (2005). Also, Sadek *et al.* (1992), Siddiqu *et al.* (1992), Eid and El-Gamal.(1997) and Al-Zahaby *et al.* (2006) came to the conclusion that big stoking rate released negative effects on their body weight (BW) and Length (BL), where BW and BL decreased as the fish stoking rate increased.

It could be concluded that big size tank (141.3 m^3) used in this study gave the best growth performance of Nile tilapia in form of body weight and body length.

These growth parameters were increased significantly with increasing tank's size from 48.01 to 141.3 m^3, but concerning the two stocking densities used in the study, these growth parameters were lower with high stoking density than with lower stoking density and the differences among tank's size and stocking densities were significant (table 2). Table (2) presents some parameters of growth performance. There were significant ($P<0.05$) differences among the experimental treatments in daily weight gain, specific growth rate (SGR) and feed conversion ration (FCR). As described in this table, SGR value were 1.07, 1.05, 1.11,1.07,1.16 and 1.15 for the treatments (T_1 x SD_1, T_1 x SD_2, T_2 x SD_1, T_2 x SD_2, T_3 x SD_1, and T_3 x SD_2), respectively.

Data indicated that big tanks showed the highest SGR records compared with the small tanks. On the other hand, weight gains and daily weight gains recorded values indicating that big tanks showed the high weight gains and daily weight gains recorded compared with those of the small tanks. These results are in agreement with the findings of Krom *et al.* (1989), Timmons *et al.* (1998), Abdel-Maksoud *et al.* (2006), Ali *et al.* (2006) and Al-Zahaby *et al.* (2006) who study the effect of stocking rate on the growth performance of Nile tilapia and the interaction between tanks size and growth parameters. It was noticed that the best SGR was recorded by the big tanks but the weight gains were recorded by low stocking rates of Nile tilapia reared in tanks (table 2).

Total fish yield

Regardless of body weight and length were negatively correlated to the stocking density of fish (table 2), however total fish yield at harvest increased with increasing the stocking density (table 3). These results indicated that survival rate ranged between 97% and 99% which indicated that Nile tilapia fish density and tank's size had remarkable effects on tilapia survival. These results are in accordance with those reported by Zohar *et al.* (1984), Twarowska *et al.* (1997), Timmons *et al.* (1998) and Al-Zahaby *et al.* (2006), who found that the survival rate improved in fish tanks applied lower total biomass. The initial total biomasses of fish in all the experimental treatments were 1.50, 2.26, 1.49, 2.27, 1.49 and 2.25 Kg/m^3. for treatments (T_1 x SD_1, T_1 x SD_2, T_2 x SD_1, T_2 x SD_2, T_3 x SD_1, and T_3 x SD_2), respectively. Treatment T_3 x SD_2 followed by treatment T_2 x SD_2 produced the heaviest final total biomass as shown from Table (3), However tank's size and density is known with their effects on fish growth and total production as given by Abdel-Maksud *et al.* (2006) and Al-Zahaby *et al.* (2006). The FCR values declined as fish stocking rates increases, many studies confirmed these results, (Pillay and Kutly. (2005), Al-Zahaby *et al.,* 2006 and Bakeer *et al.,* 2007) with *O. niloticus,* they reported that FCR decreased with each increase stocking rates and this means that FCR improved significantly in Nile tilapia.

Cost benefit

Cost of feed and profit index per one Kg fish (in L.E) at different treatments are given in Table (4). Costs of feed intake per one kg fish gain (in L.E) at different treatments were 4.76, 4.70, 4.48, 4.36, 3.97 and 3.92 for treatments T_1 x SD_1, T_1 x SD_2, T_2 x SD_1, T_2 x SD_2, T_3 x SD_1, and T_3 x SD_2, respectively. These results indicated that lower fish density and size of tanks increased the feed cost. On the other hand, profit index was improved by decreasing cost of feed intake. The best size of tank and fish density achieved low feed cost and high profit index was for the 6^{th} treatment (T_3 x SD_2) followed by 5^{th} treatment (T_3 x SD_1).

These results are in partially agreement with Balarin, (1984), Ali, (1999), Amin, (2005) and Al-Zahby *et al.* (2006) who working on Nile tilapia were getting approach from these results.

CONCLUSIONS

Based on the obtained results from this study, it could be concluded that size of tank (141.3 m^3) with stoking density of 75 Fish/m^3 were the optimal size and stocking density to recommend to be used in monoculture intensive system for mono sex Nile tilapia to give the best and biggest yield at harvest, under similar condition to those of the present study.

ACKNOWLEDGEMENT

Appreciation is extended to Dr. M. N. Bakeer the head of Aquaculture Department, for providing help and assistance during the study.

Table 1. Mean variation of grand average values of some physico-chemical characteristics for water quality of the experimental tanks.

Parameters	Treatments					
	T_1 x SD_1	T_1 x SD_2	T_2 x SD_1	T_2 x SD_2	T_3 x SD_1	T_3 x SD_2
Temp. °C	29.4^a±0.09	30.8^a±0.09	30.0^a±0.09	29.7^a±0.09	30.11^a±0.09	29.8^a±0.09
DO. (mg/l)	6.0^b±0.6	5.8^b±0.6	6.4^a±0.6	5.3^b±0.6	6.6^a±0.6	6.5^a±0.6
pH value	8.2^b±0.2	8.0^b±0.2	8.6^a±0.2	8.1^b±0.2	8.8^a±0.2	8.4^a±0.2
NH_3 (mg/L)	0.18^a±0.1	0.18^a±0.1	0.17^a±0.1	0.10^b±0.1	0.12^b±0.1	0.13^b±0.1
Phosphorus (mg/L)	0.18^a±0.05	0.16^a±0.05	0.16^a±0.05	0.18^a±0.05	0.17^a±0.05	0.16^a±0.05

In each row, means followed by the same letter are not significantly different ($P \geq 0.05$).

T_1 x SD_1 = Small Tanks with stocking rate 50 fish/m^3. ,

T1 x SD_2= Small Tanks with stocking rate 75 fish/m^3.

T_2 x SD_1= Medium Tanks with stocking rate 50 fish/m^3.

T_2 x SD_2= Medium Tanks with stocking rate 75 fish/m^3.

T_3 x SD_1= Big Tanks with stocking rate 50 fish/m^3.

T_3 x SD_2= Big Tanks with stocking rate 75 fish/m^3.

Table 2. Growth performance and feed utilization of Nile tilapia (*O. niloticus*) as affected by the treatments.

Variable	Body weight (g)		Body length (cm)		Weight gain (g)/fish	Specific growth rate (%day)	Feed intake (g) fish	FCR
	initial	Final	initial	Final				
Stocking rate								
50 fish/m^3 (SD_1)	30.8^a	166.5^a	9.83^a	23.2^a	135.7^a	1.12^a	221.19	1.63^a
75 fish/m^3 (SD_1)	29.2^a	150.3^b	9.80^a	20.3^b	121.1^b	1.09^b	169.62	1.40^b
Tanks size treatment								
Small tank (T_1)	30.1^a	146.11^c	9.73^a	19.21^c	116.11^c	1.05^c	196.22	1.69^a
Medium tank (T_2)	30.2^a	158.13^b	9.80^a	20.31^b	127.93^b	1.10^b	198.25	1.55^{bc}
Big tank (T_3)	29.8^a	170.4^a	9.75^a	24.0^a	140.6^a	1.16^a	198.24	1.41^c
T_1 SD_1	30.11^a	150.29^c	9.90^a	20.11^c	120.18^c	1.07^c	204.30	1.70^a
T_1 SD_2	30.21^a	147.71^c	9.91^a	19.81^c	117.5^c	1.05^c	197.4	1.68^a
T_2 SD_1	29.8^a	155.78^b	9.85^a	21.11^b	125.98^b	1.11^b	201.56	1.60^b
T_2 SD_2	30.31^a	152.49^{bc}	9.80^a	22.31^{bc}	122.18^{bc}	1.07^c	190.60	1.56^b
T_3 SD_1	29.9^a	171.91^a	9.85^a	24.21^a	142.01^a	1.16^a	201.65	1.42^c
T_3 SD_2	30.11^a	169.91^a	9.8^a	24.18^a	139.8^a	1.15^a	195.75	1.40^c

Means with the same letter in each column are not significantly different ($P \geq 0.05$).

Table 3.Total fish production Kg/m3 of Nile tilapia (*O. niloticus*) as affected by the treatments.

Treatments	T_1xSD_1	T_1xSD_2	T_2xSD_1	T_2xSD_2	T_3xSD_1	T_3xSD_2
Average Initial weight, g.	30.11^a	30.21^a	29.80^a	30.31^a	29.90^a	30.11^a
Initial total biomass, Kg/m^3	1.50	2.26	1.49	2.27	1.49	2.25
Average final weight, g.	150.29^c	147.71^c	155.78^b	152.49^{bc}	171.91^a	169.71^a
Survival rate, %	99%	97%	99%	97%	99%	97%
Final total biomass, Kg/m^3	7.43^c	10.74^b	7.71^c	11.09^a	8.50^c	12.34^a
% from the best value	60.21%	87.03%	62.47%	89.87%	68.88%	100%

-Means in the same row having the same superscript letter are not significantly different ($P \geq 0.05$).

*Survival rate % = (Final No of fish/ Initial No of fish) x 100

Table 4. Costs of feed and profit index per one Kg fish (in L.E) at different treatments.

Items	Treatments					
	T_1 x SD_1	T_1 x SD_2	T_2 x SD_1	T_2 x SD_2	T_3 x SD_1	T_3 x SD_2
Feed intake per one Kg gain (Kg)*	1.70	1.68	1.60	1.56	1.42	1.40
Feed intake cost (L.E)**	4.76	4.70	4.48	4.36	3.97	3.92
% of the smallest value	121.42%	119.89%	114.28%	111.22%	101.27%	100%
Profit index***	1.57	1.59	1.67	1.72	1.88	1.91
% of the smallest value	100%	101.2%	106.3%	109.5%	119.7%	121.6%

* Price of one ton of feed equal 2800 L.E.

** L.E means Egyptian pond 0.18 US $.

*** Profit index = Income of Kg gain of fish/feed intake cost (price of fish was calculated as 7.5, L.E per 1 Kg fish.)

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تأثير أحجام مختلفة من الأحواض الخرسانية الدائرية على معدل أداء النمو لأسماك البلطى النيلي وحيد الجنس المرباة تحت كثافات تخزينية مختلفة

نعيم مصطفى السيد شميس

المعمل المركزي لبحوث الثروة السمكية بالعباسة – محافظة الشرقية – مصر

أجريت هذه الدراسة بهدف تقييم أستزرع البلطي النيلي وحيد الجنس في تنكات خرسانية دائرية مختلفة الأحجام في مدة تربية ١٥٠ يوم. تم إستخدام عدد ١٢ تنك خرساني دائرى الشكل تمثل ٦ معاملات و٣ أحجام مختلفة من الأحواض (٤٨ ، ٩٨,١ ، ١٤١,٣ م٣ تقريباً) داخل كل معاملة عدد ٢ معدل تسكين ٥٠ ، ٧٥ سمكة / م٣ تم تكرار كل معاملة مرتين.

وكانت النتائج التي تم التحصل عليها تتلخص في الآتي

١ – بغض النظر عن معدلات التسكين فإن زيادة أحجام التنكات الخرسانية الدائرية من ٤٨,٠ إلى ١٤١,٣ م٣ أدى إلى زيادة معنوية في معدلات النمو ومن الناحية الأخرى فإن زيادة كثافة الأسماك من ٥٠ إلى ٧٥ سمكة / م٣ أدى إلى نقص معنوي في معدلات النمو.

٢ – زيادة معدلات التسكين أدى إلى زيادة في الإنتاج الكلي في كل المعاملات المختبرة.

٣ – إستخدام التنكات الخرسانية الدائرية ذات الحجم الكبير ١٤١,٣ م٣ أدى إلى تحسين في جودة المياه من حيث زيادة معدل الأكسجين وإنخفاض نسبة الأمونيا بالأحواض.

٤– أفضل دليل ربحية مع أقل تكلفة للتغذية تم الحصول عليها من المعاملة السادسة (T_3xSD_2) ويليها المعاملة الخامسة (T_3xSD_1).

الخلاصة

بناء على النتائج التى تم التحصل عليها من الدراسة موضوع البحث نوصى باستخدام التنكات الدائرية التى يصل حجمها ١٤١,٣ م^3 مع كثافة ٧٥ سمكة/م^3 من أسماك البلطى النيلى وحيد الجنس لحصول على أفضل النتائج فى نفس ظروف التجربة.