Egyptian J. Nutrition and Feeds (2004) 7 (2) : 243-252

GROWTH PERFORMANCE OF NILE TILAPIA (*Oreochromis niloticus*) CULTURED IN EARTHEN PONDS AFFECTED BY VARYING FEEDING AND FERTILIZATION INPUTS

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(Received 23/1/2004, accepted 31/8/2004)

SUMMARY

This study has been carried out to investigate the growth performance of Nile tilapia (*Oreochromis niloticus*) reared in monoculture earthen ponds as well as pond productivity affected by different feeding inputs. Nile tilapia (*Oreochromis niloticus*) fingerlings averaging 2.21± 0.28 to 2.51± 0.49 g in weight were assigned randomly to three tested different feeding inputs. Three treatments were applied in the earthen ponds. These were (T_1) fertilization plus artificial diet; (T_2) blue green algae plus fertilization and artificial diet; (T_3) artificial diet only. Six earthen ponds each measuring 20x50 m^2 were used in the experiment. Each treatment was performed in duplicate. All the ponds were stocked with 1000 fish / pond. The study extended 90 days. Results obtained can be summarized in the following: 1- The highest final body weight, specific growth rate (SGR), final length, protein retention efficiency and energy retention efficiency were recorded for fish group fed blue green algae plus fertilization and artificial diet (T_2); followed by (T_1) and (T_3) treatments respectively. 2- The highest net production was recorded on group of fish on (T_2) blue green algae plus fertilization and artificial diet; followed by (T_1) and (T_3) treatments, respectively. In conclusion feeding, blue green algae at a rate of 5% of fish body weight plus artificial diet (20% protein) at rate 2% daily can be applied with the fertilization system for Nile tilapia (*Oreochromis niloticus*) reared in earthen ponds in order to achieve best growth performance results.

Keywords: *Growth performance, Nile tilapia, varying feeding inputs; earthen ponds.*

INTRODUCTOIN

A feeding system for grass carp ponds, which includes dried blue green algae plus fresh *Medicago sativa* at a rate of 5% of body weight with 2000 fish / feddan, seems to be the best production system for the grass carp (Bakeer, *et al* 2003). The use of dried blue green algae (5% of fish body weight every week) in rice fish field was recommended for Nile tilapia weighing 30g. (Salama, 2003)

The manure can be used from a direct or indirect integration of fish and livestock. In the direct integration system, fresh manure is added continuously to the ponds, while in the indirect integration system the manure is transported to the ponds and used in fresh or dried forms in different manuring regime (Peker, 1994).

Starling and Rocha (1990), examined the impacts of three facultative planktivorous fishes, Congo tilapia (*Tilapia rendalli*), bluegill (*Lepomis macrochirus*) and tambaqui (*Colossoma* *macropomum*), and an obligate planktivorous fish, silvar carp (*Hypophthalmichthys molitrix*) on plankton community and water quality of a tropical eutrophic reservoir. Silver carp suppressed Copepod nauplii, Cladocerans and rotifers while the presence of tilapia and bluegill were associated with increased rotifers density. The dominant blue- green algae, Cylindrospermopsis raciborkii (98% of phytoplankton biomass) was enhanced in the presence of bluegill, tilapia and tambaqui, but reduced in the presence of silver carp. Stewart *et al*., (1969) found that the blue green algae is active in nitrogen fixation.

The present study was performed to study the effect of chicken manure fertilization, artificial diet and blue green algae on water quality, plankton communities, growth performance, total production, and economic efficiency of growing of Nile tilapia (*Oreochromis niloticus*).

MATERIALS AND METHODS

The present study was carried out in Central Laboratory for Aquaculture Research at Abassa, Sharkia Governorate, Egypt. Plant material and blue green algae, including (the genera Anabaena, Nostoc and others) were obtained as dry plant material from Ministry of Agriculture Biofertilizer Unit (G.O.A.E.F) - Cairo - Egypt. The dried blue green algae was applied by prod casting it at the water inlets in amounts of 5% of fish body weight/week pond (4 g /m^3). Before the experimental start all ponds were drained completely and then were exposed to sunrays for 2 weeks till complete dryness. Ponds were then refilled with fresh water coming from Ismailia Nile branch through a canal to the experimental station. Nile tilapia (*Oreochromis niloticus*) fish with average initial weights ranging between 2.21± 0.28 to 2.51±0.49 g / fish were obtained from El-Abbassa governmental fish hatchery, Sharkia Governorate. Fish were transported in plastic bags and after arrival to the experimental station, fish were adapted to the new conditions for one hour, then distributed randomly into six ponds each measuring 20x50 m^2 (0.25 feddan). Total water area of each pond was 1000 m^2, water level was maintained at one-meter level throughout the whole experimental period (90 days). Three treatments were applied in the experimental earthen ponds. These were (T_1) fertilization with chicken manure 25 kg / 2 weeks per pond plus artificial diet (20% protein) at rate 2% of fish biomass daily; (T_2) blue green algae at rate of 5% of fish body weight / week per pond plus fertilization at 25kg every two weeks and artificial diet; (T_3) artificial diet only. at the same rate mentioned before. Each treatment was performed in duplicate. All ponds were stocked with 1000 fish / pond (4000/feddan). Experimental artificial diet (20% protein) at rate 2% of fish biomass was offered in two equal portions twice daily at 10 a.m. and at 2 p.m. for 5 days a week.

Water temperature, dissolved oxygen and pH were measured daily at 6 a.m. and 12 p.m. using thermometer, dissolved oxygen meter (YSI model 57) and pH meter (model Corning 345), respectively. Determinations of water quality parameters (alkalinity, phosphorus and ammonia were carried out every two weeks according to the methods of Boyd (1979). Phytoplankton and zooplankton communities in pond water were determined every month according to the methods described by Boyd (1990) and A.P.H.A (1985). Samples were collected from different sites of the experimental ponds randomly to represent the water of the whole pond.

The experimental diet was formulated to contain 20% crude protein. The composition of the experimental diet is illustrated in Table (1). The tested diet was analyzed for dry matter, crude protein; ether extract (EE) and ash contents according to A.O.A.C. (1990) Gross energy (GE) content of the experimental diet was calculated according to Jobling, (1983). The chemical analysis of blue green algae and chicken manure on basis of dry matter are illustrated in Table (2).

Live body weight and length of 150 fish at start and monthly thereafter were recorded till the termination of the experiment. Specific growth rate (SGR) was calculated using the following equation:-

$$\mathbf{SGR\% = 100\ (Ln\ W_2 - Ln W_1) / T_2 - T_1}$$

Where W_2 is the weight at the end and W_1 is the weight at the start and Ln is the natural log. As described by Bagenal and Tesch, (1978).

At the experimental end 6 fish were taken randomly from each treatment, and were exposed to chemical analysis for the whole fish composition according to the methods of A.O.A.C. (1990).

Statistical analysis:

The statistical analysis of the data was carried out by applying the computer program Harvey, (1990) by adopting the following fixed model.

$$Y_{ijk} = \mu + P_i + S_j + (PS)_{ij} + e_{ijk}$$

Where: Y_{ijk} = observation of the ijk- th fish, μ = overall mean, P_i = fixed effect of the i-th protein level, S_j = fixed effect of the j-th stocking density, $(PS)_{ij}$ =interaction between the effect of i-th protein level and j-th stocking density, e_{ijk} = random error assumed to be independently randomly distributed (0, δ^2e). Differences between means were tested for significance according to Duncan's multiple range tests (1955).

RESULTS AND DISCUSSION

Water quality parameters

Results of water quality parameters of the experimental ponds as affected by varying feeding inputs during the experimental period (90 days) as averages of the monthly samples are summarized in Table (3). In general, averages water temperature of the different treatments were 28.55, 28.18, and 26.33 °C. for T_1, T_2, and T_3, respectively. The least value 26.33 °C was for T_3 (artificial diet only) and the highest (28.55 and 28.18C) was for T_1 (fertilization plus artificial diet) and T_2 (blue green algae plus fertilization and artificial diet), respectively. The higher records of water temperature in fertilized fields may be attributed to the increased organic matter contents of these ponds that may lead to temperature increases. These results are in agreement with those of Boyd, (1983) and Abdel -Hakim *et al.*, (2000[a]), who found slight increase in water temperature with increasing manure.

The concentration of dissolved oxygen (mg/L) (Table 3) for T_1,T_2 and T_3 ranged between 6.16 and 7.34 mg/L. These values are beneficial to fish cultivation. These results are in agreement with Boyd, (1992), who reported that levels of dissolved oxygen above 4 ppm is considered as a limiting value, below which, fish may live but can not feed or grow well. Averages of available phosphorus ranged between 0.24 and 1.10 mg /L which represent the normal range of phosphorus in fish ponds. This range was found to be suitable for growth of fish as reported by Fortes *et al.*, (1986) and Boyd *et al.*, (1981). Nitrite (No_2) concentrations were higher in T_1 (fertilizer) than the other treatments, which may be due to the accumulation of nitrogen from the fertilizer in the pond (Boyd, 1990).

Table (1) : The composition and chemical analysis of experimental diet for Nile tilapia used in the study.

Composition of the artificial	diet 20% protein
Ingredients	Diet %
Yellow corn	36
Wheat bran	20
Fish meal (72.3%C.P)	5
Soybean meal (44%C.P)	6
Rice bran	14
Decorticated Cotton Seed Meal	11
Poultry Slaughter by- Products	5
Vitamin premix*	1.5
Mineral mixture**	1.5
Total	100
Chemical analysis (as fed)	
Protein%	20
Gross energy k cal/kg Diet***	3198
Analyzed % on dry mater basis	
Moisture	10.20
Crude protein(C.P)	20.10
Ether extract (E.E)	6.54
Crude fibers	6.72
Ash	6.06

*Each gram of vitamin premix contains: 20.000IU vit. A 2000IU vit. D3, 400 vit. E, 20 mg Niacin, 4.5 mg riboflavin, 3 mg pyridoxine, o.o13 mg vit. B12, 100 mg chorine chloride and 2 mg. vit. K.
** Each gram contains: 0.83 Ca, 0.63P, 0.78 Na, 0.018 Mn, 0.011 Zn and 0.001 Cu. The Mixture was prepared by mixing 35 parts of dicalcium phosphate, 3 parts of mineral premix and 2 parts of common salt.
*** According to Jobling, (1983).

Table (2) : The chemical analysis of blue green algae and chicken manure used in the experiment on dry matter basis .

Analysis % of Blue green algae									
Crude protein	Ash	CF	Fat	NFE	Total	Vitamin C mg/100g	K		P
49.5	18.1	11.3	2.8	18.3	100	3.5	0.27		0.89
Analysis % of Chicken manure									
C P %	Ash	CF	EE	NFE	Total	N%	P %	C:N Ratio	N:P Ratio
18.9	32.5	12.57	1.92	34.11	100	1.64	0.29	23.41	5.66

Table (3) : Average water quality parameters during the experimental period (90 days).

Items	T_1	T_2	T_3	Averages
Temperature °C	28.55 ±1.57	28.18± 0.56	26±0.33	27.6± 0.82
Dissolved oxygen (mg / l)	6.42 ±0.44	7.34± 0.19	6.16±0.46	6.64± 0.36
Total phosphor (mg/L)	0.73± 0.04	1.51± 0.16	0.87± 0.09	1.03 ± 0.09
Available phosphorus (mg/L)	0.24± 0.08	1.10± 0.01	0.24± 0.01	0.52±0.03
No_2 (mg/L)	0.49 ± 0.06	0.34 ±0.03	0.38±0.06	0.40±0.05
NH_3 (mg/L)	0.68±0.12	0.47±0.02	0.57±0.14	0.57±0.09
pH	8.5± 0.13	8.0± 0.02	8.3 ± 0.23	8.2±0.12
Alkalinity	356±55.4	300±43.2	335±40.5	330.3±46.36

Table (4) : Least square means and standard errors for plankton communities in all experimental groups.

Phytoplankton (Organisms) / L					
Trt.	Chlorophyta	Cyanophyta	Bacillarophyta	Total. phytoplankton	% of the smallest value.
T_1	$3133±24.4^b$	$2390±23.3^b$	$2031±24.3^b$	$7554±103.6^b$	110.7%
T_2	$3493±24.4^a$	$2575±23.3^a$	$2220±24.3^a$	$8288±103.6^a$	121.5%
T_3	$2808±24.4^c$	$2322±23.3^c$	$1690±24.3^c$	$6820±103.6^c$	100%
Zooplankton (Organisms) / L					
Trt.	Rotifer	Copepod	Cladocera	Total zooplankton	% of the smallest value.
T_1	$2452±15.3^b$	$914±28.8^b$	$898±24.2^b$	$4264±105.4^b$	111.3%
T_2	$3616±15.3^a$	$994±28.8^a$	$986±24.2^a$	$5596±105.4^a$	146.18%
T_3	$2239±15.3^c$	$875±28.8^c$	$714±24.2^c$	$3828±105.4^c$	100%

Trt. = Treatments

a,b,c: Means in the same column with different superscripts are significantly different (P<0.01).

The average concentration of unionized ammonia (NH_3) (Table 3) ranged between 0.47 and 0.68 ppm for T_2 and T_1, respectively. The decrease in the total ammonia observed in T_2 (blue green algae plus fertilization and artificial diet) may be due to the consumption of ammonia by blue green algae (Rhyne *et al.* 1985) . The European Inland Fisheries Advisory Commission, (1993) reported that the toxic level of NH_4 to fish is 2 mg/L.

Averages of pH (Table 3) values for the treatments T_1, T_2 and T_3 were 8.0, 8.3 and 8.5, respectively. The lower values of pH in fertilized ponds may be attributed to the increase in organic matter contents of these ponds, which may lead to lower pH levels. The acid and alkaline death points were found at pH 4 and 14 (Swingle 1961 and Calabrese 1969).

The values of the total alkalinity ranged between 300 and 356 ppm for T_2 and T_1. The above results showed that all parameters of water quality were in the suitable range.

Phytoplankton

As shown in table (4) the total phytoplankton counts for treatments T_1, T_2 and T_3 were on the average, 7554, 8288, and 6820 organisms ml., respectively. The phytoplankton total counts increased in water samples collected from T_2 and T_1 and the differences were highly significant ($P<0.01$) and ($P<0.001$) for the abundance of phytoplankton groups (Chlorophyta, Cyanophyta and the total phytoplankton organisms). These results could be explained by the fact that chicken manure and decomposed blue green algae have more fertilization potential compared with other treatments. Table (4) revealed that chicken manure contains 1.64% nitrogen and 0.29% phosphorus and also the decomposed Blue green algae contain 0.27 % (K) and 0.89% phosphorus which may reflect the better fertilization potential of blue green algae and chicken manure, respectively.

Results of the present study indicated that Chlorophyta was the dominant group followed by Cyanophyta and Bacillarophyta in the all treatment ponds. The community composition of phytoplankton reported in this study is in accordance with the findings of EL-Serafy and EL- Zahaby (1991) and Abdel-Hakime *et al* (2000 [a and b]) who pointed out that Chlorophyta predominated all the other groups followed by Cyanophyta and Bacillariophyta.

Table (4) also showed that the averages number of zooplankton organisms per liter were higher in water samples of T_2 and T_1 and the differences were significant ($P<0.01$) for Rotifer, Cladocera and total zooplankton organisms per liter. The present study indicates that Rotifera is the dominating group followed by Copepoda and Cladocera in all ponds. This community composition of zooplankton is in conformity with observations of Abdel-Hakim *et al.*, (2000 [a and b]).

In general of table (4) indicate that the community composition of phytoplankton and zooplankton in all treatment ponds fluctuated greatly with temperature, fertilization and feeding habits of fish. In this concern, Riely (1947), reported that statistically no strict relationship between the total zooplankton and the total phytoplankton numbers.

Growth performance

As described in Table (5), the average body weight of Nile tilapia increased from 2.22, 2.48 and 2.51g to 98.60, 119.54 and 81.23 g for T_1, T_2 and T_3 , respectively. It is obvious that T_2 (blue green algae plus fertilization and artificial diet) recorded the highest ($P> 0.05$) final body weight followed by T_1 (fertilization with 25 kg chicken manure / 2 week per pond plus artificial diet (20%

Table (5) : Growth performance of Nile tilapia (*Oreochromis niloticus*) in pond culture.

Treatments	T_1	T_2	T_3
Initial Body Weight (g)	2.22^{a} ±1.18	2.48^{a} ±1.18	2.51^{a} ±1.18
Final Body weight (g)	98.60^{b} ±4.37	119.54^{a} ±4.32	81.23^{c} ±2.61
Weight gain (g)	96.38^{b}	117.6^{a}	87.72^{c}
Average daily gain (g)	1.09^{b}	1.30^{a}	0.97^{c}
S.G.R(% 1 day)	4.2^{a}	4.3^{a}	3.8^{b}

a,b,c: Means in the same row with different superscripts are significantly different (P<0.05).

Table (6) : Economic efficiency (%) of Nile tilapia (*Oreochromis niloticus*) as affected by the applied treatments during the experimental period for 90 days in L.E/ feddan.

Item	T_1	T_2	T_3
Stocking data			
Stocking rate (fish / feddan)	4000	4000	4000
Average size at stoking (g)	2.22	2.48	2.51
Average size at harvesting (g)	98.60	119.54	81.23
Survival rate %	96%	99.0%	94.0%
Production Kg/feddan	378.62	473.37	305.4
A- Operating costs (L.E)			
Fish fingerlings	135	135	135
Feed	638.3	823.07	489
Fertilization(manure)	75	75	-
Blue green algae	-	20	-
Labor (one feddan)	300	300	300
Taxes (one feddan)	100	100	100
Total costs/feddan (L.E)	1248.3	1453.07	1024
% of the smallest value of total costs	121.90%	141.90%	100%
B- Returns			
Total Returns (L.E)	1893.1	2366.85	1374.3
Net returns (L.E)	644.8	913.85	350.3
C- % Net return to total cost	51.65%	62.89%	34.2%

The economical evaluation of results was carried out according to market prices in L.E. where: 1 kg fish (80- 120g each) = 5 L.E.

protein) at a rate 2% of fish biomass) and T_3 (artificial diet only), respectively. The same trend was obtained with regard to weight gain, ADG and SGR (table 5). Treatment 2 (blue green algae plus fertilization and artificial diet) recorded the highest (P> 0.05) value of weight gain, ADG and SGR followed by T_1 (fertilization with 25 kg chicken manure /2 week per pond plus artificial diet (20% protein) at a rate 2% of fish biomass) and T_3 (artificial diet only), respectively. These results are in agreement with McDonald (1987) who found that Tilapia fish (*Oreochromis aureus*) fed blue green algae (Anabaena spp.) gained more weight than the control.

The high value of daily gain and the other growth traits found in this study may be attributed to the presence of the natural food organisms enhanced by the fertilization of the pond environment which served as a direct source of food for Nile tilapia (Chapman and Fernando, 1994).

As illustrated in Table (6) the fish yields were 378.62; 473.37 and 305.4 Kg per pond for T_1; T_2 and T_3, respectively. Abdel-Hakim *et al* (2000[a]) reported that fish yields vary from 50 kg/ha to 2.25 tons/ha, depending on systematically on country, fish species, density, fish diets and other factors.

Economic efficiency

Table (6) shows the results of economical evaluation including the costs and returns for treatments applied in kg / feddan and income in (L.E) for 90 days. Total costs were 1248.3; 1453.07 and 1024 L.E / feddan for the T_1, T_2 and T_3, respectively. These results revealed that the total cost of T_2 (blue green algae plus fertilization and artificial diet) was higher than the other groups. On the other hand, the total cost of T_3 (artificial diet only) was the lowest. Net returns in L.E per feddan were 644.8; 913.85 and 350.3 for T_1, T_2 and T_3, respectively.

Percentages of net return to total cost for treatments cited above were 51.65, 62.89 and 34.2 % for T_1, T_2 and T_3, respectively, indicating that the highest returns were obtained with the group T_2 ((blue green algae plus fertilization and artificial diet) and the lowest return were obtained with the group T_1 (fertilization with 25 kg chicken manure / 2 weeks per pond plus artificial diet (20% protein) at a rate 2% of fish biomass).

CONCLUSION

Based on the obtained results, the use of dried Blue green algae in fish pond culture could be recommended for Nile tilapia at rate of 5% of fish body weight every week ($4g/m^2$) plus fertilization with chicken manure 25 kg every two weeks per pond plus artificial diet (20% protein) at a rate 2% of fish biomass.

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أداء النمو لأسماك البلطي النيلي المستزرعة في الأحواض الترابية تحت تأثير معاملات غذائية مختلفة

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قسم الاستزراع السمكي – المعمل المركزي لبحوث الثروة السمكية بالعباسة – محافظة الشرقية.

أجريت هذه الدراسة بالمعمل المركزي لبحوث الأسماك بالعباسة مدينة أبو حماد– محافظة الشرقية –مصر. وكان الهدف من الدراسة التعرف على أداء النمو وإنتاجية أسماك البلطي النيلي المرباة في أحواض ترابية فى نظام الاستزراع السمكي وحيد النوع تحت تأثير معاملات غذائية مختلفة وكان متوسط وزن الإصبعيات من أسماك البلطى النيلى يتراوح بين ٢،٢ و ٥،٢ جرام وتم إجراء ٣ معاملات مختلفة وهى كالآتي (ت١) التسميد مع العلف الصناعي (ت٢) التسميد مع العلف الصناعي و الطحالب الخضراء المزرقة (ت٣) العلف الصناعي فقط وتم استخدام ٦ أحواض مساحة الحوض الواحد ٢٠×٥٠ متر و تم تخزين الأسماك في الأحواض بمعدل ١٠٠٠ سمكة/ للحوض. وتم تكرار كل معاملة مرتين والدراسة استمرت ٩٠ يوم. و كانت النتائج المتحصل عليها على النحو التالى:-

١- أعلى متوسط جسم نهائي و معدل النمو النوعي و طول الجسم النهائي ونسبة الاستفادة من البروتين والطاقة تم تسجلها لأسماك المعاملة (ت٢) التسميد مع العلف الصناعي بالإضافة إلى الطحالب الخضراء المزرقة، يليها أسماك المعاملات (ت١) التسميد مع العلف الصناعي ثم (ت٣) العلف الصناعي فقط على التوالي.

٢- افضل إنتاجية كلية تم الحصول عليها من المعاملة (ت٢) التسميد مع العلف الصناعي و الطحالب الخضراء المزرقة.

وتوصى الدراسة باستخدام الطحالب الخضراء المزرقة بمعدل ٥% من وزن الجسم اسبوعيا مع العلف الصناعي ٢٠ % بروتين بمعدل (٢%) من وزن الجسم يوميا مع التسميد (١٠٠كجم زرق دواجن/فدان) كل أسبوعين بكثافة تخزيني ٤٠٠٠ إصبعية/فدان من اسماك البلطي النيلي المرباة في الأحواض الترابية وذلك للحصول على أعلى إنتاجية للفدان.