

ECONOMICAL EVALUATION OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) CULTURE IN RICE FIELDS RECEIVING VARYING FEEDING INPUTS

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ABSTRACT

This study aimed to evaluate the nutritive value, growth parameters, productivity and economical efficiency of dried blue green algae for feeding Nile tilapia (*Oreochromis niloticus*) cultured in rice fields. Eight rice fields (one fed. each) were cultivated by rice and divided into four groups, the first group (T₁) of two fields with dried blue green algae at a rate of 5% of body weight per week, and the second (T₂) one was fed on artificial diet containing 20% crude protein. The third group (T₃) was fed on natural food resulting from fertilization only (30 Kg. chicken manure/week) and the fourth group (T₄) has served as a control (without any treatment). All fields were stocked with Nile tilapia (1000 fingerlings/fed.) with an average weight of 30 g. The growing season for tilapia fish was 90 days. Results obtained can be summarized in the following:

- Treatments applied had significant effect on final body weight, specific growth rate, body length and condition factor of Nile tilapia.
- The highest survival rate was obtained with group of fish on T₂ followed by T₁, T₃, T₄ treatments respectively
- The highest net production was recorded with group of fish on T₂ followed by T₁, T₃ and T₄ treatments respectively.
- The highest net return was recorded with group of fish on T₁ followed by T₃, T₂ and T₄ treatments respectively.

INTRODUCTION

In 1998, only 12440 tons of fish were produced from 23360 feddan (rice fish integrated system) and this contributed only 2.28% of the total Egyptian fish production (Abdel-Hakim *et al.* 2000a).

In aquaculture, feed is the most expensive cost item, commonly contributing between 40-70% of total variable expenses. Protein is the principal and most expensive component of the diet, where the protein sources in tilapia feeds comprising 55-75% of the dietary material cost. Consequently protein cost is usually given the first priority in formulating fish feeds (Hanley, 2000).

Average body weight of Nile tilapia (*Oreochromis niloticus*) culture in rice fields has been increased from 4.08 to 81.97g. and the rice yield increased by 148 Kg/feddan, beside 77.9 Kg. fish/feddan (Abdel-Hakim *et al.* 2000). Mohamed Bakeer *et al.* (2003) reported that the grass carp(25 g.) which fed on blue - green algae plus Lucerne (5% of body weight/5days a week for 150 days) cultured in earthen pond recorded the highest final body weight and specific growth rate (SGR). The total fish production in rice fields is about 20,000 tons as reported by GAFRD(2001).

The objective of the present study is to evaluate the technical and economic feasibility of cultivating Nile tilapia in rice fields under varying feeding systems.

MATERIALS AND METHODS

Location

The present study was carried out in a private rice farm, at Abbassa village, Abu-Hammad, Sharkyia Governorate, Egypt.

Facilities and fish

Eight rice fields (one fed. each) were cultivated by rice and divided into four groups, the first group of two fields was fed with dried blue - green algae at a rate of 5% of body weight per week, and the second one was fed on artificial diet (20% crud protein). The third group was fertilized on only with 30 Kg. chicken manure/weekly and the fourth group served as control (without any treatment). Rice fields were prepared with ditches in the middle of the pond with a depth and width of 0.75 x 0.50 m, respectively. Screens were fixed at the end of the canals to prevent fish from escaping or the entrance of foreign fishes into rice fields. Rice was cultivated in the field at first 30 days, and then transplanted in the permanent rice fields. After 7 days of rice transplantation all ponds were stocked with Nile tilapia fingerlings at a density of 1000 fingerlings/feddan with an average initial weight of 30 g. The growing period for tilapia fish was 90 days.

Experimental diet

Application of chicken manure at a rate of 300 kg/ feddan was carried out before rice transplantation. During the growing period, the

third group received 30 Kg. chicken manure/week. The second group was fed on pellets containing 20% crude protein at a rate of 2% daily of fish biomass. Feeding rate of artificial diet was recalculated and adjusted biweekly according to the change in fish biomass as assessed by fish sample. The food pellets were applied once a day for 5 days a week by broadcasting the pond surface near the supply gate. No pesticides were used during the entire experiment. The experimental diet was chemically analyzed according to the methods of AOAC (1990). The chemical compositions of experimental diets are shown in (Table 1 a, b, c.)

Growth performance parameters

Live body weight and length of a random sample of 150 fish from each pond were taken at start and every 15 days and were recorded till the termination of the experiment. The fish were netted from the water and weighed to the nearest gram. Standard length of fish was measured at the beginning and at the end of the experimental period to the nearest mm. Then the fish were returned immediately to their ponds.

Samples and measurements

Water temperature, dissolved oxygen and pH were measured daily at 6⁰⁰a.m. and 12⁰⁰ p.m. using temperature and dissolved oxygen meter (YSI model 57) and pH meter (model Corning 345). 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 two weeks according to the methods described by Boyd (1990) and A.P.H.A (1985). Samples were collected from different sites of the trench center randomly to represent the water of the whole rice fields. Parameters of specific growth rate (SGR) and condition factor (K) were calculated according to the following equations: Specific growth rate (SGR) $SGR\% = 100(\ln W_2 - \ln W_1) / T_2 - T_1$ (Bagenal and Tesch, 1978) where W_1 and W_2 are the first and following fish weight in grams, \ln is the natural logarithm and T is the growing period in days.

Condition factor (K): $K = \text{weight } g \times 100 / \text{length } cm^3$ (Hopkins, 1992)

Where W and L are the individual weight and length of the fish.

After 90 days of fish culture, tilapia was harvested from each field and a sample of 30 fish was randomly taken for body weight and

body length measures. The rice was harvested after 120 days of sowing.

Statistical analysis:

The statistical analysis of data was carried out by applying the computer program of Harvey (1990).

RESULTS AND DISCUSSION

Water quality parameters:

Results of water quality parameters of paddies as affected by receiving varying feeding inputs during the experimental period (90 days) as averages of the monthly samples are summarized in table (2). In general, water temperature of the different treatments were 26.55; 26.16; 28.00 and 25.00 °C. for T₁; T₂; T₃ and T₄, respectively. The least value 25.00 °C was for T₄ (control) and the highest (28.00°C) was for T₃ (fertilization). The higher difference in water temperatures in fertilized fields may be attributed to the increased organic matter contents of these fields that may lead to temperature increases. These results are in agreement with those of Boyd, (1983); Jobling, (1983) and Abdel -HaKim *et al.* (2000), who found a slight increase in water temperature with increasing manure and the optimum temperature ranged between 15 and 30°C for Nile tilapia (*Oreochromis niloticus*).

The concentration of dissolved oxygen (mg/L) for T₃ and T₄ ranges between 6.12 and 7.00 mg/L. These values are beneficial to fish culture and indicate that water dissolved oxygen was slightly lower in fertilized fields compared to the other fields. These results are in agreement with Boyd (1992), who reported that levels of dissolved oxygen above 4 ppm is considered a limiting factor, below which, fish may live but can not feed or grow well. Averages of available phosphorus ranged between 0.10 and 0.13 mg /L, which represent the normal range of phosphorus in rice fish fields. This range was found to be suitable for growth of fish as reported by Fortes *et al.* (1986) and Boyd *et al.* (1981). Nitrite (No₂) concentrations were higher in T₃ (fertilizer) than the other treatments, which may be due to the accumulation of nitrogen from the fertilizer in the ditch (Boyd, 1990).

The average concentration of unionized ammonia (NH₃) (Table 2) ranged between 0.53 and 0.68 ppm for T₄ and T₃. The increase in the total ammonia observed in fertilized treatment may be due to decomposition of the heavy organic load of the unexploited blue green algae which fall to the bottom of the ditches after death.

The European Inland Fisheries Advisory Commission (1993) reported that the toxic level of NH_4 to fish is 2 mg/L.

Averages of pH values for the treatments T_1 ; T_2 ; T_3 and T_4 were 9.2, 9.0, 8.1 and 9.41, respectively. The lower values of pH in fertilized paddies may be attributed to the increase in organic matter contents of these paddies, which may lead to lower pH levels. The acid and alkaline points were found between pH 4 and 14 (Swingle 1961 and Calabrese, 1969).

The values of the total alkalinity, were ranged between 301 and 335 ppm for T_4 and T_3 . The above results showed that all parameters of water quality were in the suitable range, however fish with T_4 (control) recorded minimum levels of NO_2 ; NH_3 and alkalinity and the highest levels of DO and pH.

The average values of most water quality parameters were very close for T_1 ; T_2 and T_3 .

Phytoplankton

As shown in Table (3) the total phytoplankton counts for treatments T_1 ; T_2 ; T_3 and T_4 were 5094, 3673, 4926 and 4532 organisms ML., respectively on the average. The phytoplankton total counts increased in water samples collected from T_1 , T_3 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 (1) 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.

The present study indicates that Chlorophyta was the dominant group followed by Cyanophyta and Bacillarophyta in the all treatment paddies. 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 (3) also shows that the average number of zooplankton organisms per liter were higher in water samples of T_1 and T_3 and the differences were significant for Copepoda, Cladocera and total

zooplankton organisms per liter. The present study indicates that Rotifera is the dominate group followed by Copepoda and Cladocera in all fields. This community composition of zooplankton is in conformity with observations of Abdel-Hakim *et al.* (2000 a and b).

The present study also indicates 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 statistically that no strict relationship between the total zooplankton and the total phytoplankton numbers.

Growth performance

As described in Table (4), the average body weight of Nile tilapia increased from 30.12 to 108.10; 120.70; 91.71 and 78.13 g. for T₁; T₂ T₃ and T₄, respectively. Daily gain (g) was between 6.53 and 1.00g. These values were higher than obtained by Mang-Umphun and Arce (1988); who found that, under the integrated rice fish system, the body weight of Nile tilapia increased from 8.3-8.59 to 33.78-36.69 g. during 75 days rice fish culture period, where fields were supplied with inorganic fertilizers. Table (4) also shows that the body length of Nile tilapia increased from 6.24 to 13.70; 14.95; 12.96 and 10.96 cm. for T₁, T₂, T₃ and T₄. After 90 days of culture in rice fields and the values of fish condition factor recorded 4.20; 3.61; 4.2 and 5.91 for T₁, T₂, and T₃ and T₄ respectively.

Specific growth rate (SGR) recorded were 1.4; 1.5; 1.2 and 1.05 for T₁; T₂; T₃ and T₄ respectively. These values are in agreement with that reported by Sadek (1986), Haroon & Pittman (1997) and Sadek, (1998), who found that SGR of Nile tilapia was 1.8 when cultured in paddies. 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 paddy environment which served as a direct source of food for Nile tilapia (Chapman & Fernando, 1994).

Table (5) shows that rice yields in the present study were 2640; 2560; 2544 and 2440Kg./feddan for T₁; T₂; T₃ and T₄, respectively. So approximately about 5-10% increase in rice yield was achieved as a result of the integration of fish in rice paddies. The increase in rice yield is in agreement with that obtained by EL-Bolok and Labib (1967), who found that the rice yield increased, by 5-7% in rice fields. As illustrated in Table (5) the fish yields were 102.69; 115.87; 85.29 and 75.66 Kg. for T₁; T₂; T₃ and T₄, respectively. The fish yield in the present study was higher than that obtained by

Haroon & Pittman (1997) and Abdel-Hakim *et al.* (2000)b who found that the total fish yields of Nile tilapia were 59.4 and 158.2 kg/ha when their initial weights were 3.1 and 30.7, respectively (Li, 1992), they reported that fish yields vary from 50 kg/ha to 2.25 tons/ha, depending unsystematically on country, fish species, density, fish diets and other factors.

Survival Rate

As shown in Table (5) survival rate were 95; 96; 93 and 92%, for T₁; T₂; T₃ and T₄, respectively. These results are in agreement with Perez- Athanasiadis and Bellido- de Cedeno (1989), who obtained 90% survival rate for Nile tilapia in rice culture fields, while Haroon & Pittman (1997) found a survival rate from 66.4 to 65.6% for Nile tilapia in paddies for 78 days.

Economic Efficiency.

Table (5) 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 1293; 1675; 1350 and 1275 L.E /feddan for the T₁; T₂; T₃ and T₄, respectively. These results revealed that the total cost of T₂ (diet with 20% protein) was the highest than other groups. On the other hand, the total cost of T₄ (without treatment) was the lowest due to the absence of input costs. Net returns in L.E per feddan were 1860.45; 1463.35; 1620.45 and 1524.3 for T₁, T₂, T₃ and T₄, respectively.

Percentages of net return to total cost for treatments cited above were 143.8; 87.36; 120.03 and 119.55% for T₁, T₂, T₃, and T₄ respectively, indicating that the highest returns were obtained with the group T₁(blue green algae at a rate of 5% of body weight per week) and T₃(fertilized with 30 kg. chicken manure/weekly).

RECOMMENDATION

Based on the obtained results, the use of dried blue green algae in rice fish culture could be recommended for Nile tilapia (weighing 30g) and the feeding rate was 5% of fish body weight every week.

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Table (1): The chemical analyses of experimental diets for Nile tilapia in rice fish culture.

(A): Analyzed % of Blue green algae					
Crude protein	Ash	Vitamin C mg/100g	k	P	
9.62	48.17	3.5	0.27	0.89	
(B): Analyzed % of Chicken manure					
Crude protein %	Carbon %	Nitrogen %	Phosphorus %	C:N Ratio	N:P Ratio
9.83	38.39	1.64	0.29	23.41	5.66
(C): 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
Calculated diet composition as fed					
Protein%					20
Gross energy k cal/kg Diet***					3198
Analyzed % on dry mater basis					
Moisture					10.20
Crude protein(C.P)					20.08
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, 0.013 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).

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Table (2): Average water quality parameters at paddies during the experimental Period (90 days).

samples	No of samples	T ₁ Blue green algae	T ₂ Diet (20% C.P)	T ₃ Fertilization	T ₄ (control)	Averages
Temp C	15	26.55 G±1.57	26.16± 0.88	28± 0.33	25± 1.20	26.42 ± 0.99
Dissolved oxygen (mg / l)	15	6.42 ±0.44	6.15± 0.76	6.12± 0.44	7.00± .57	6.42± 0.55
Total phosphor (mg/(L)	15	0.73 ± 0.24	0.51± 0.16	0.81± 0.06	0.43± 0.01	0.62 ± 0.11
Available phosphorus (mg/L)	15	0.21± 0.08	0.10± 0.01	0.24± 0.01	0.31± 0.05	0.21± 0.03
No (mg/L)	15	0.39 ± 0.06	0.34± 0.02	0.58± 0.04	0.28± 0.03	0.39± 0.03
NH ₄ (mg/L)	15	0.58 ±0.12	0.67± 0.02	0.78± 0.4	0.53± 0.1	0.64± 0.16
PH	15	9.2 ± 0.13	9.0± .02	8.1 ± 0.23	9.41± 0.12	8.9± 0.12
Alkalinity	15	323 ±50.8	308± 50.2	335± 40.8	301± 50.7	316.75± 48.12

Table (3): Least square means and standard errors for plankton abundance in all experimental groups.

Phytoplankton (Organisms) L				
Treatments	Chloro phyta	Cyan ophyta	Bacill arophyta	Total. phyto plankton
	***	**	**	***
Tr ₁	2493±60.3	1380±30.5	1221±31.0	5094±105.3
Tr ₂	1850± 60.3	1013±30.5	810±31.0	3673±105.3
Tr ₃	2481±60.3	1335±30.5	1110±31.0	4926±105.3
Tr ₄	2431±60.3	1211±30.5	890±31.0	4532±105.3
Zooplankton (Organisms)L				
Treatment	Rotifer	Copepod	Cladocera	Total zooplankton
	**		**	***
Tr ₁	1452±	898±35.5	672±29.1	3022±107.3
Tr ₂	1350±29.3	818±33.5	515±29.1	2683±107.3
Tr ₃	1412±29.5	891±33.3	650±29.1	2953±107.3
Tr ₄	1352±29.5	898±33.3	672±29.1	2839±107.3

± Mean of 12 samples (2 replicates and 6 samples for each replicate)

** P<0.01 *** P<0.001

Table (4): Growth performance of Nile tilapia (*Oreochromis niloticus*) as affected by varying feeding inputs.

Treatments	T ₁	T ₂	T ₃	T ₄
Initial Body Weight (g)	30.12	30.12	30.12	30.12
Final Body weight (g)	108.10±1.38	120.70±1.48	91.71±1.50	78.13±1.35
Weight gain (g)	77.98	90.58	61.59	48.01
Daily gain (g)	0.86	1.00	0.68	0.53
Initial Body length	6.24	6.24	6.24	6.24
Final Body length cm	13.70±0.71	14.95±0.71	12.97±0.71	10.97±0.70
Condition factor (K)	4.20 ±0.23	3.61±0.12	4.2±0.20	5.91±0.36
S.G.R	1.4	1.5	1.2	1.05

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Table (5): Economic efficiency (%) for Nile tilapia (*Oreochromis niloticus*) as affected by varying feeding inputs.

Item	T ₁	T ₂	T ₃	T ₄
Stocking data				
Stocking rate (No / fed)	1000	1000	1000	1000
Average size at stoking (g)	30	30	30	30
Average size at harvesting	108.10	120.70	91.71	78.13
Survival rate %	95.0	96.0	93.0	92.0
Production Kg. /fed.				
Rice	3300	3200	3180	3050
Fish	102.69	115.87	85.29	75.66
A- Operating costs				
Fish fingerlings	100	100	100	100
Rice seeds	75	75	75	75
Food	-	400	-	-
fertilization	-	-	75	-
Labor	500	500	500	500
Blue green algae	18	-	-	-
Land renting	600	600	600	600
Total costs/feddan	1293	1675	1350	1275
B- Returns				
Rice	2640	2560	2544	2440
Fish	513.45	578.35	426.45	359.35
Total Returns / Fed	3153.45	3138.35	2970.45	2799.35
Net returns	1860.45	1463.35	1620.45	1524.3
C-% Net returns to operating cost	143.8	87.36	120.03	119.55

The economical evaluation of results was carried out according to market prices in 2002 in L.E.