Vet.Med.J.,Giza. Vol.46, No.4B. (1998): 895-904.

EFFECT OF DIETRY PROTEIN LEVELS ON WATER QUALITY OF TILAPIA (OREOCHROMIS NILOTICUS) PONDS

BY

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SUMMARY

The experimental work was conducted to study the effects of dietary protein levels on water quality. Fifteen floating circular cages were used as culture units throughout this work. Three cages per treatment were used and placed in each of the five concrete ponds. Nile tilapia (Oreochromis niloticus) fingerlings were stocked in each cage at a rate of 40 fish/cage. Averages body weight ranged from 55 to 60 g and 14 to 15 cm in length. Four commercial diets containing different protein levels being 12 (T1), 19 (T2), 26 (T3) and 32% crude protein (CP) (T4) were used in this study. A treament without supplemental feed (To) was included as a blank. The diets were fed at a rate of 3% of live body weight per day, 7 days a week, divided into two equal feedings per day during the 20 weeks experimental period.

Results showed that water temperature during the experimental period ranged between 29.12 and 29.52°C., while the dissolved oxygen content was ranged between 6.75 and 9.16mg/l These two parameter within the optimum level for growth of tilapia fish. Salinity values were highest for diets containing high protein levels the decreased to 0.2 and 0.18 ppt for no feed (To) and 12% CP (T1), respectively. The salinity values were in the range found suitable for growth of tilapia which lies between 8.62 to 9.55. The concentration of unionized ammonia (NH3) were ranged between 0.44 and 0.92 ppm for diets containing 12% CP and 32% CP, respectively. The values did not affect the growth of the fish in this experiment. The values of Secchi disk were ranged between 33.27 and 60.63 cm. The values of total phosphorus were ranged between 0,34 to 0.83. These values were related to the treatments of the diets. The available phosphorus were the highest for the high protein diet groups (26% and 32% CP). Nitrate NO3 (mg/l) values indicated that there were nitrate in the water in case of high protein level. The high concentration of phytoplankton and zooplankton was observed for the 32% CP and 26% CP treatments. It was

found that phytoplankton existed in the fish intestine.

INTRODUCTION

Tilapias are important food fish in many tropical and subtropical countries. More than 20 species of tilapia have been cultured in developing countries where animal protein is lacking. Nile tilapia (*Oreochromis niloticus*) are considered suitable for culture because of their high tolerance to adverse environmental condtions, their relatively fast growth and the ease with which they can be bred.

Feed represents a large part of production costs during intensive culture. As protein represents the most expensive component in a prepared feed, it is of considerable practical importance to determine the lowest level that will support optimal growth and survival.

Good water quality is the key to the successful of fish production. An abundant water supply will solve many problems associated with intensive fish culture by deluting out accumulated wastes and toxic products as well as maintaining optimal water condition. Halver (1972) found that the cold water fishes require a temperature between 5-15°C and large amounts of dissolved oxygen, while warm water fishes are able to survive in water temperature between 20-40°C, when the oxygen level is low. Mabaye (1971) observed that (*Oreochromis mossabicus*) stoped feeding when the dissolved oxygen level was below 1.5 mg/l at a temperature of 30oC Magid and Barbkier (1975) reported that the lowest dissolved oxygen limit for Oreochromis niloticus was 0,1 mg/l. Balarin and Hatton (1979) showed that tilapias began to metabolise anaerobically at 2-3 mg/l oxygen at 30oC. Ross and Ross (1983) indicated that above 3.0 mg/l dissolved oxygen was suitable for tilapia (Oreochromis niloticus). Degani et al., (1988) observed that optimum water temperature for Oreochromis aureus was ranged between 24 to 31°C. Requena et al., (1993) found that *Oreochromis niloticus* and *O. galilaeus* in Morra lakes of Egypt were capable of maintaining population at salinity of 13 ppt. They added that salinity provoked a lower deposition of liver glycogen and affected lipid mobilization in muscle. Mabaye (1971) found that the low pH reduced the appetite of Tilapia rendalli.

Un-ionized ammonia (NH_3) is toxic to fish but the ammonium ion (NH_4) is not toxic (Boyd, 1984). Turbidity refers to the amount of suspended materials in the water, so it is a measurement of the inhibition of light passing through a water sample which in turn reduce the phytoplankton productivity. The results of Lovell (1977) indicated that fed ponds produce more natural food than unfed ponds. But the amount and species of pond organisms consumed by fish from the fed and unfed ponds were almost the same. The same author added that fish fed in cages gained 9% less than those fed in the open ponds. This was attributed to the availabilty of pond food to the fish in open ponds. As the phosphorus concentration in feed pellets is commonly in the range of 0.7-1.6% of the dry weight, the uneaten pellets represented a major source of phosphorus to the sedimentary environment (Liam, 1992). Degani et al.,1988 found that optimum water temperature for (*Oreochromis aureus*) was ranged between24 to 31°C. They added that food conversion of fish maintained at higher temperature (27°C) was better than that in fish maintained at lower temperature (23 and 25°C). Requena et al. (1993) showed that the changes in water conditions (after 1 to 20 days acclimation period) were not stressful enough to stop growth, but organs indexes and compositions were affected. Degani and Levanon (1988) found that the concentration of ammonia in water of eels, fed different protein levels, increased with the increase in the protein level of the diet and also with body weight. This study was conducted to evaluated the effect of feeding nile tilapia different dietary protein level on water quality and body weight gain of *Oreochromis niloticus*.

MATERIALS AND METHODS

The present work was conducted at the Central Laboratory for Aquaculture at Abbassa, Agriculture Research Center. The experimental work was carried out for a period of 20 weeks between May to October 1994. Fifteen floating circular cages were used as culture units through this study. Each cage was made mainly of polyethylene net of 0.5 cm mesh and a capacity of 1 m3. Three cages per treatment were used and placed in each of the five concrete ponds. Each pond was 15X2X1.25 meter. The ponds were treated by potassium permenganate and formalin to avoid any infection. Each pond was provided with flow water from Ismailia canal to keep the pond clean and air stones were used to keep proper level of oxygen in the water. Tilapia (*Oreochromis niloticus*) fingerlings ranging between 55 to 60 g in weight and 14 to 15 cm in length were randomly distributed among the 15 cages at a rate of 40 fish/cage. During this time, they fed 3% of their body weight per day with the experimental diets. Body weight and body length at the beginning of the experiment and subsequently every 14 days during the 20-weeks experimental period. Four locally commercial diets containing 12, (T_1), 19 (T_2), 26 (T_3) and 32 % CP (T_4) were used in this experiment. A treatment without supplemental feed (T_0) was included as a blank. A water sample was taken biweekly using 90 cm water column sampler as described by Boyd (1984) to determine the total ammonia, total alkalinity, hydrogen ion, total phosphorus and available phosphorus. The temperature, dissolved oxygen and Secchi dusk visibility were measured daily during the experimental period. Water samples were taken monthly from each pond during the study for the identification of phytoplankton and zooplankton using the method of Lind (1979).

Data were analyzed using analysis of variance (SAS Program, 1987). Differences between means were tested by Duncan new multiple range test (Duncan, 1955). The following model analyze the obtained data.

$$Yij = M + Ti + eij$$

where:

$$Yij = observation$$

M = is the overall mean

Ti = is the effect of treatment (is i being from 1 to 5)

eij = is random error

RESULTS AND DISCUSSION

Effect of dietary protein levels on growth performance of *Oreochromis niloticus*:

As shown in table 1, the initial body weights of tilapia fingerlings at the beginning of the experiment for all treatments were very similar ranging from 55.8 to 59.5 g. The results clearly showed that all groups of fish gave satisfactory growth during the experimental period since the body weight (BW) values increased progressively with advancement of age. The average BW of fish fed on a diet containing 32% CP (T_4) significantly ($P<0.05$) surpassed all other treatments during the progress of the experimental period followed by those of fish fed the diets containing 26% CP (T_3), 19%CP (T_2) and 12 % CP (T_1), descendingly.

The fish fed on the lowest CP diet (T_1) during most of the fornight periods of the experiment exhibited statistically similar or significantly ($P<0.05$) higher BW than those of no feed treatment (T_0). This would indicate that T_4 was the best quality treatment to be utilized by Tilapia nilotica during the successive fornight periods while T_1 was the poorest quality treatment to utilize by fish which exhibited almost similar BW to those of (T_0). However, the final value of BW at the end of the 20-week experimental period (table 1 and fig 1) was the highest for T_4 (401.27 g) then progressively with decreasing the dietary CP level to give the lowest value with T_1 (104.64 g). The final BW of T_1 was significantly ($P<0.05$) higher than that of To (94.39 g). It is worthy to mention that fish of To group were mainly depended in their nutrition on the natural feed in pond.

Effect of dietrary protein levels on water quality of *Oreochromis niloticus*:

Table 2 showed the effect of different treatments on water temperature throughout the experimental period. Water temperature during the experimental period ranged between 29.12 and 29.52°C. In general, water temperature was in the optimum range for growth of tilapia which lies between 15 and 30°C as reported by Job (1969 a,b). At this temperature the best requirement of the protein for maximum body weight was 32% CP. In this respect, Hepher et al., (1983), found that the requirement of protein was affected by the environmental temperature. Their results indicated that the high protein diet (43.9%) was more efficient than the medium protein (28.7%) and low protein (13.1%) diets at the higher temperature of 24.3% °C rather than at the lower temperature of 10.2°C for red tilapia.

The concentrations of dissolved oxygen (DO)

CamScanner

mg/l are shown in table 2. The values ranged between 9.16 and 6.75 for no feed (T_0) and 26% CP (T_3), respectively. The average of dissolved oxygen for all treatments was in the optimum level for growth of tilapia. The level of DO was above 4 ppm which is considered a limiting level since below 4 ppm DO, fish may live but can not feed or grow well (Boyd, 1984). The higher levels of oxygen were noticed with no feed (T_0) and the low protein diets 12% CP (T_1), while the lowest values were recorded for groups fed on the high protein level diets T_3 (26%CP) and T_4 (32% CP). The lower values of oxygen may be due to the developing algae blooms at a high rate in rich ponds, 26% CP (T_3) and 32% CP (T_4) which consume some of oxygen at night and also the higher weights of fishes in both T3 and T4 than in the other treatments. In this respect, Degani and Levanon (1988) showed that oxygen concentration in water was inversely corrected to the weight of eels.

Salinity values were showed in table 2 for the experimental treatments. The highest values were recorded for diets containing high protein levels then decreased to 0.2 and 0.18 ppt for no feed (T_0) and 12% CP (T_1), respectively.

The average values of pH are presented in table 2. The values ranged between 8.62 to 9.55 for diets containing 19% CP (T_2) and 32% CP (T_4), respectively. The values were in the range found to be suitable for growth of tilapia which lies between 7 and 12 as reported by Huet (1972). The results indicated that the tilapia in cage culture can tolerate up to 9.55 pH without affecting their growth performance.

The average concentration of unionized ammonia (NH3) are presented in table 2. The values ranged between 0.44 and 0.92 ppm for diets containing 12% CP (T_1) and 32% CP (T_4), respectively. The concentration of ammonia was related to the protein levels and did not affect the growth of fish in this experiment. European Inland Fisheries Advisory Commission (1973) reported that the toxic level of ammonia to fish is 2 mg/l.

The depth of visibility of an under water object such as secchi disk affords a measure of transparency (Boyd, 1984). The average values of secchi disk are shown in table 2. The values were in the acceptable range as reported by Boyd (1984) who found that a secchi disk reading of 40 to 80 cm is desirable in ponds.

The averages concentrations of total phosphorus are presented in table 2. The values were increased on the following order, 0.34, 0.35, 0.51 and 0.83 for the no feed (T_0), 12% CP (T_1), 19% CP (T_2), 26% CP (T_3) and 32% CP (T_4), respectively. The values were related to treatments of the diets used in this experiment.

The average concentrations of availalble phosphorus are presented in table 2. The values were 0.02, 0.06, 0.05, 0.25 and 0.19 for no feed (T_0), 12% CP (T_1), 19% CP (T_2), 26% CP (T_3) and 32% CP (T_4), respectively. The values

Table (1): The effect of the different dietary Protein levels on body weight (g) of Oreochromis niloticus during the 20-week experimental period.

Dietary treatment	0 (Initial BW)	Experimental period (week) 2	4	6	8	10	12	14	16	18	20
T_1 (12% CP)	57.77± 0.11	60.00^{e} ± 0.12	66.06^{ca} ± 0.12	70.05^{d} ± 0.12	73.60^{d} ± 0.91	77.71^{e} ± 0.13	85.47^{d} ± 0.14	92.81^{d} ± 0.15	98.18^{d} ± 0.14	101.52^{d} ± 0.11	104.64^{d} ± 0.31
T_2 (19% CP)	56.32^{a}± 0.12	61.63^{e} ± 0.12	70.00^{c} ± 0.12	80.11^{e} ± 0.12	92.58^{c} ± 0.92	107.98^{e} ± 0.12	124.98^{c} ± 0.14	143.48^{c} ± 0.16	162.48^{e} ± 0.14	178.05^{e} ± 0.11	192.63^{c} ± 0.13
T_3 (26% CP)	59.50^{a}± 0.12	72.23^{b} ± 0.12	87.66^{b} ± 0.12	106.11^{b} ± 0.12	126.60^{b} ± 0.09	106.11^{b} ± 0.12	182.46^{b} ± 0.14	212.87^{b} ± 0.61	245.28^{b} ± 0.14	276.78^{a} ± 0.11	306.20^{b} ± 0.13
T_4 (32% CP)	58.77^{a}± 0.12	76.58^{a} ± 0.12	98.08^{a} ± 0.12	124.39^{a} ± 0.12	155.50^{a} ± 0.09	124.39^{a} ± 0.12	240.74^{a} ± 0.13	285.51^{a} ± 0.15	329.64^{a} ± 0.14	372.94^{a} ± 0.11	401.27^{a} ± 0.12
T_0 (no feed)	55.80^{a}± 0.12	61.51^{c} ± 0.12	63.50^{d} ± 0.12	65.20^{c} ± 0.12	72.94^{d} ± 0.09	65.20^{c} ± 0.12	86.06^{d} ± 0.14	88.07^{e} ± 0.16	90.16^{e} ± 0.14	92.39^{e} ± 0.11	94.39^{e} ± 0.13

a-e. Means ± SE within a column with no common superscript differ significantly ($P<0.05$).

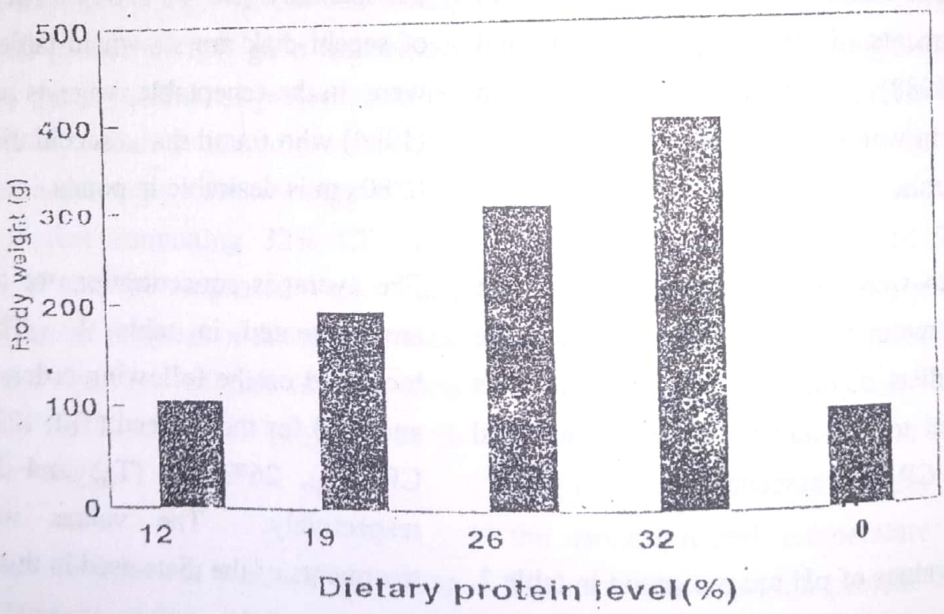

Fig.1. Effect of different dietary protein levels on body weight of *Oreochromis niloticus*

Dietary protein level (%)

Fig. 1: Effect of different dietary protein levels on body weight of *Oreochromis nilloticus*.

Table 2: Effect of different dietary protein levels on water quality in the ponds of *Oreochromis niloticus.*

Parameters	Untreated water	T_1 (12%CP)	T_2 (19%CP)	T_3 (26%CP)	T_4 (32%CP)	To (no lead)
Dissolved oxygan (mg/L)	5.5	9.13	7.57	6.75	6.61	9.16
Salinity (ppt)	0.10	0.18	0.22	0.23	0.23	0.20
pH	7.9	9.35	8.62	8.92	9.55	9.53
Ammonia (ppm)	0.02	0.44	0.61	0.63	0.92	0.65
Tubidity	35	60.63	41	50.9	33.27	51.18
Total phosphorus (mg/L)	0.20	0.35	0.51	0.59	0.83	0.34
Available phosphorus (mg/L)	0.01	0.06	0.05	0.25	0.19	0.02
NO3 (mg/L)	0.1	0.13	0.12	0.17	0.20	0.11
Total alkalinity (ppm)	260	148.54	155.45	168.18	190.90	171.36

Table 3: Effect of different dietary protein levels on identification of the phytoplankton (Numb/L) in the ponds of *Oreochromis niloticus.*

Treatment	Green algae	Blue green algae	Diatom	Euglina	Biomass
Untreated water	11000	10200	3450	2250	26900
T_1 (12%CP)	22905	17666	10058	4603	55832
T_2 (19%CP)	24273	22101	31185	4874	64433
T_3 (26%CP)	56148	46308	28918	12475	143894
T_4 (32%CP)	112170	91763	59210	24456	287599
To (no lead)	15040	10741	7143	2511	35435

Table 4: Effect of different dietary protein levels on identification of the zooplankton (Numb/L) in the ponds of *Oreochromis niloticus.*

Treatment	Copepoda	Rolefira	Clodesera	Ostracoda	Biomass
Untreated water	9	3	2	1	15
T_1 (12%CP)	52	8	5	2	67
T_2 (19%CP)	88	5	9	5	110
T_3 (26%CP)	138	26	16	5	185
T_4 (32%CP)	200	31	13	6	250
To (no lead)	54	11	7	2	74

followed the same trend as those for the total phosphorus. The highest value were for the high protein diet groups (26 % and 32% CP).

The values of the nitrate were 0.13, 0.12, 0.17, 0.20 and 0.11 mg/l for diets containing 12% CP (T_1), 19% CP (T_2), 26% CP (T_3), 32% CP (T_4) and no feed (T_0), respectively (Table 2). The values indicate that there are more nitrate in the water in case of the high protein levels 26% CP (T_3) and 32% CP (T_4) than the no feed or low protein diet groups (12%CP and 19% CP).

The average values of total alkalinity were 148.54, 155.45, 168.18, 190.90 and 171.36 for T_1, T_2, T_3, T_4 and T_0 , respectively (Table 2). Generally all parameters of water quality were suitable for well being of *Oreochromis niloticus*.

Biological analysis:

Phytoplankton:

Table 3 showed the effect of different protein levels on numbers and species of phytoplankton. In this experiment phytoplankton contained Green algae, Blue green algae, Diatom and Euglina. The pond in T4 (32% CP) contained the highest number of Green algae, Blue green algae, Diatom and Euglina. While no feed (T_0) treatment contained the leasr number of those organisms.

The total biomass of phytoplankton was 287599, 143849, 64433, 55832 and 35435 Org/L for the T_4, T_3, T_2, T_1 and T_0, respectively. The general conclusion is that the 32% (T_4) and 26% CP treatments, which gave maximum growth contained the maximum number of phytoplankton. Lin (1969) and Prowse (1969) supported these results by finding that when biomass of phytoplankton in the pond contained both of green algae and Diatoms, fish grew faster than that containing blue green algae only because blue green algae were not penetrated by digestive enzymes.

Zooplankton:

Table 4 showed the effect of different protein levels on numbers and species of zooplankton. Zooplankton contained Copepoda, Rotefira Clodesera and Ostracoda. It was obvious that Copepoda Rotefira species are abundant when compared to the other species of zooplankton. While, no big difference was observed between number of Clodesera and Ostracoda species. The minimum biomass was observed in case of 12% CP (T_1) and no feed (T_0). The biomass of zooplankton were 20, 185, 110, 74 and 67 No/L for the T_4, T_3, T_2, T_0 and T_1, respectively.

It is worthy to note that no feed treatment contained more zooplankton than 12% CP which supported the suggestion that no feed treatment is better than feeding on 12% CP.

The high numbers of both phytoplankton and zooplankton in T_4 and T_3 may be due to the availability of the nutrients of such treatments which contained 32% and 26% CP, respectively. Also, the amount of both feed consumed and feaces out put in those ponds could be involved as factors that may affect the number of phytoplankton and zooplankton ponds. Thus they acted as organic fertilizers in this case.

Gut content:

It was observed that all species of phytoplankton existed in the fisah intestine, except Euglina which existed only in pond water. This may be due to the feeding habits of *Oreochromis niloticus* as indicated by Chimist (1955) who obtained the same findings for adult *Sarothordom mossambicus* fed mainly on algae and zooplankton. Also, Gophen et al., (1983) found that Oreochromis aureus consume zooplankton. But regarding zooplankton, all species were found in the intestine of the fish.

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