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EFFECT OF PROTEIN LEVELS ON GROWTH PERFORMANCE AND ECONOMICAL EVALUATION OF NILE TILAPIA (*Oreochromis niloticus*)

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ABSTRACT

Six approximately isoenergetic diets were formulated with protein levels from 20% to 45% in increments of 5%. The effects of varying dietary protein level on growth performance and economic efficiency were studied. The best growth rate was obtained with 30% dietary protein, followed by the diets containing 35, 40, 45, 25 and 20% protein, respectively. Feed conversion ratio was improved with increasing dietary protein levels up to 30%. Protein efficiency ratio was decreased with increasing dietary protein levels.

Body protein was increased with increasing dietary protein levels up to 45%. There was an inverse relationship between the body moisture and lipid contents. Dietary protein levels did not affect the body ash content. From the economical point of view, the highest net return percentage of the total costs was 110.3% as recorded by the 30% Protein; followed by 102.4 % (25%. Protein) 99.4% (20%. Protein); 94.1 % (35%. Protein); 59.0 % (40%. Protein) and finally 48.6 % for (45%. Protein). The optimum dietary protein level for Nile tilapia (weighing 20g) was 30% and the feeding rate was 3% of body weight.

INTRODUCTION

In recent years an increased interest in aquaculture has revealed the lack of knowledge concerning nutritional requirements of fish, although they have many of the dietary requirements as warm blooded species. The dietary protein requirements of several species of young

fish have been reviewed (NRC, 1983 Cowey *et al.*, 1985). In general, the values ranged from about 30 to 55% crude protein for maximum growth. Some studies have attempted to determine the exact dietary protein requirements of tilapia to maximize growth (Lunney, 1982; Santiago *et al.*, 1982; De Silva and Perera 1985; Wang *et al.*, 1985 and Siddiqui *et al.*, 1988). Others have been directed towards identifying low cost, readily available raw materials as protein sources for tilapia diets (Jackson *et al.*, 1982 and Viola and Arieli, 1983;). In spite of these studies, the picture is still not clear and the dietary protein requirements of Nile tilapia still remain inadequate, so, more studies are required.

The aim of the present study was to determine the effects of varying dietary protein levels on growth performance and economical evaluation of Nile tilapia.

MATERIALS and METHODS

Culture condition:

Two hundred and forty fish, weighing 20.10 grams on average were used. The fish were divided into 6 groups, each of 20 fish in duplicates. The experiment was conducted in glass aquaria (80 × 50 ×40 cm) supplied with de chlorinated tap water. Water temperature was maintained at 25 °C through the experiment by an electric heater. Fish were acclimatized to experimental condition for two weeks prior to the experiment. The experimental period lasted for 60 days. All fish in each aquarium were weighed every 10 days.

Diet and feeding regime:

The experiment was undertaken at the Fish Research Center, Suez Canal University. Six isocaloric diets containing 20, 25, 30, 35, 40 or 45% protein were formulated (Table 1). The experimental diets were analyzed for moisture, protein, ether extract, crude fiber and ash by standard methods (AOAC. 1980). The composition and proximate analysis of the diets are given in table1. The parameters chosen for the evaluation of the experimental diets were weight gains, relative growth rate (RGR), protein efficiency ratio (PER), feed conversion ratio (FCR), specific growth rate (SGR) and feed efficiency (FE).

Experimental diets were fed at 3% feeding rate of body weight per day. The daily amount of food was offered two times at 9.00 a.m and 3.00 p.m. for six days a week.

Statistical analysis was carried out, using analysis of variance and Duncan's multiple range tests according to Snedecor and Cochran (1980).

RESULTS and DISCUSSION

The growth performance of Nile tilapia fed different protein levels is shown in table 2. Diet 3 which contained 30% crude protein gave significantly ($P < 0.05$) the best weight gain. RGR, SGR then diets 4, 5, 6, 2 and 1 having 35, 40, 45 25 and 20 crude protein respectively. However, no significant differences were found between the weight gain of groups of fish fed diets 4.5 and 6 respectively.

It appears from the results of the present study that the level of dietary protein producing maximum growth of Nile tilapia is 30%, as indicated by the growth parameters data presented in Table 2. In this connection, De Silva and Perera (1985) found that best growth was achieved when ration contained 28-30% protein. Siddiqui *et al.*, (1988) found also that the protein requirement of young Nile tilapia (weighing 40 g) was 30% protein. Wang *et al.*, (1985) reported better growth with 30% protein diet than diet containing 40% protein and the maximum growth was obtained with a diet containing 25% protein fed at the rate of 3.5% body weight per day.

Based on various studies, Balarin and Haller (1982) summarized the protein requirements of various size groups of tilapia as:

Group	Weight (g)	% protein requirement
1	Up to 1	35 – 50
2	1 – 5	30 – 40
3	5 –25	25 – 30
4	25 and more	20 – 25

Diets 3, 4, 2, and 5 (containing 30, 35, 25 and 40% crude protein) gave significantly better feed conversion ratios (Table 2) than diets 1 and 6 (having 20 and 45% crude protein). The best-feed conversion ratio was found with 30% protein diet. Similar results were obtained by Jauncey (1982), De Silva and Perera (1985) and Siddiqui *et al.*, (1988).

Average protein efficiency ratios (PER) values for the experimental diets are presented in table 2. generally PER decreased with increasing dietary crude protein level gradually up to 45% as has been noted in *O. mossmbicus* (Jauncey, 1982); *O.niloticus* (Siddiqui *et al.*, (1988) and other fish species (Ogino and Saito, 1970 ; Dabrowski, 1997 and Jauncey, 1982).

Diets 3 and 4 (having 30 and 35% crude protein) gave significant ($P< 0.05$) better-feed efficiency than diets 2, 5, 1 and 6 (25, 40, 20 and 45% crude protein) respectively.

The gross body composition presented in Table 3 shows that fish fed the lowest dietary protein level (20%) tend to have lower moisture and protein contents, and significantly higher lipid content. There was an inverse relationship between body moisture and lipid contents. Similar results were obtained by other authors (Atack *et al.*, 1979 and Jauncey, 1982). The lowest protein content was that of fish fed low protein diets. Similar results were reported by Jauncey, (1982) and Siddiqui *et al.*, 1988). The ash content was unaffected by different dietary protein levels, as has been reported with other fish species (Dabrowski and Wojno, 1977; Atack *et al.*, 1979; Jauncey. 1982; Sidiqui *et al.*, 1988).

Economic efficiency:

Table (4), shows the results of economical evaluation including the costs, total fish production Kg. per / m^3 for180 days and net returns for treatments applied in L.E. Total costs were found to be 79.86; 79.61; 80.45; 83.9; 94.69 and 109.0 L.E/ m^3 for the T1 (20% Protein); T_2 (25% Protein); T_3 (30% Protein); T_4 (35% Protein); T_5 (40% Protein) and T_6 (45% Protein); groups, respectively. These results revealed that the total costs of T_3 (45% Protein) were the highest (109 L.E/ m^3) than other groups. On the other hand, the total costs of T_2 (25% Protein) were the lowest (79.61 L.E/ m^3) due to the costs of feed. Net returns in L.E per m^3. were 79.42; 81.51; 88.75; 78.98; 55.87 and 53.0 for T_1 (20% Protein); T_2 (25% Protein); T_3 (30% Protein); T_4 (35% Protein); T_5 (40% Protein) and T_6 (45% Protein); groups, respectively. Percentages of net return to total costs for treatments cited above were 99.4%; 102.4%; 110.3%; 94.1%; 59%and 68.6%, respectively indicating that the highest net returns were obtained with the group T_3 (30% Protein). From the economical point of view, results suggest that the protein level of 30 % for Nile tilapia

(weighing 20g) is recommended to achieve the highest percentages of net returns to total costs.

In conclusion, the optimum dietary protein level for Nile tilapia (weighing 20g) was 30% and the feeding rate was 3% of body weight.

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Table (1): composition and proximate analysis of experimental diets.

Ingredient	Diet No.					
	1	2	3	4	5	6
Fish meal (58%)	34.50	43.50	52.00	60.40	69.00	77.60
Starch	49.50	41.50	32.50	26.60	18.00	10.40
Fish oil	5.00	4.00	4.50	2.00	2.00	1.00
Mineral Mix.	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin mix.	2.00	2.00	2.00	2.00	2.00	2.00
Cellulose	5.00	5.00	5.00	5.00	5.00	5.00
CNC (1)	1.00	1.00	1.00	1.00	1.00	1.00
Proximate analysis						
Moisture %	8.30	8.70	9.50	8.60	10.40	9.50
Crude protein %	20.10	25.20	30.10	35.00	40.10	45.00
Ether extract %	9.50	9.70	11.20	10.00	11.20	11.30
Crude fiber %	5.00	5.20	5.70	5.90	5.90	5.90
Ash %	10.10	11.10	13.50	14.60	16.30	19.30
NFE (2)	47.00	40.10	30.00	25.90	16.10	9.00
GE (3) Kcal / 100 g.	396.04	398.45	398.90	398.44	398.40	397.93
ME (4) Kcal / 100 g.	349.80	348.20	344.65	340.92	336.83	332.75

1- Carboxymethyl cellulose.

2- Nitrogen free extract.

3- Based on 5.65 kcal/g protein, 9.45 kcal/g fats & 4.1 Kcal /g carbohydrate (Pantha, 1982).

4- Metabolizable energy based on 4.5 kcal/ g. protein, 8.5 Kcal / g fat and 3.8 kcal / g digestible carbohydrate (Jauncey and Ross, 1982).

Table (2): The performance of Nile tilapia as affected by dietary protein level.

CP 1	Diet No.					
	1 20%	2 25%	3 30%	4 35%	5 40%	6 45%
Initial weight (g)	20.10	20.10	20.10	20.10	20.10	20.10
Final weight (g)	53.10	53.70	56.40	54.30	50.20	54.00
weight gain (g)	33.0a	33.6a	36.30c	34.20 b	34.10b	33.9 b
Feed intake	97.2a	70.56a	65.34d	64.98a	75.02b	88.14c
RGR 2	164.18a	167.16a	180.60c	170.14b	169.65b	168.66b
SGR 3	1.01a	1.67a	1.71c	1.66b	1.52b	1.65b
FCR 4	2.40b	2.10a	1.80a	1.90a	2.20ab	2.60c
PER 5	2.08e	1.90d	1.85d	1.50c	1.13b	0.85a
FE 6	0.42b	0.48b	0.55c	0.53c	0.45b	0.38a

1- Crude protein (%).

2- Relative Growth Rate $= \frac{\text{Final wt} - \text{Initial wt}}{\text{Initial}} \times 100$

(Winberg, 1960)

2- Specific Growth Rate (% day) =

$$\frac{\text{Log}_e W1 - \log_e Wo}{T1 - To} \times 100$$

(Brown, 1957)

Where W1 and Wo = final and initial weights (g) respectively.

T1 and To = final and initial time (days)

Log_e = Natural logarithm to base e

4- Feed Conversion Ratio = Feed intake (g) / wet weight gain

5- Protein Efficiency Ratio = wet weight gain / protein intake.

6- Feed Efficiency = wet weight gain / dry wt feed offered.

Table (3): Gross body composition of experimental fish fed different dietary protein levels at the beginning and end of the experiment (values are expressed as %, wet weight basis).

Diet	Body composition			
	Moisture	Protein	Fat	Ash
Initial	73.10	14.55	6.80	5.55
20% Crude protein	72.60a	14.10a	7.70c	5.60a
25% Crude protein	73.30a	14.60a	7.10ab	5.00a
30% Crude protein	73.79a	15.56a	6.55a	4.10a
35% Crude protein	73.00a	15.78a	6.50a	4.72a
40% Crude protein	73.30a	16.00a	6.55a	4.15a
45% Crude protein	72.40a	16.30a	6.80a	4.50a

Figures in the same column having the same superscript are not significantly different ($P < 0.50$).

Table (4) Economic efficiency (%) for Nile tilapia (*O. niloticus*) as affected by dietary protein levels Kg./M³ (L.E.) for 180 days.

Treatments / Costs and Returns		1 20%	2 25%	3 30%	4 35%	5 40%	6 45%
Costs	Fingerlings	41.25	41. 25	41.25	41.25	41.25	41.25
	Feed	38.61	38.36	39.20	42.65	53.44	67.75
	Total	79.86	79.61	80.45	83.9	94.69	109.0
Returns	Production	19.91	20.14	21.15	20.36	18.82	20.25
	Fish sales	159.28	161.12	169.2	162.88	150.56	162.0
	Net returns	79.42	81.51	88.75	78.98	55.87	53.0
	% smallest value of total costs	150%	154%	167%	149%	105 %	100%
Economic Efficiency	% Net return to total costs	99.4%	102.4 %	110.3 %	94.1%	59%	48.6%

The economical evaluation of results was carried out according to market prices in 2003 in L. E.