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EFFECT OF DIFFERENT PROTEIN/ENERGY RATIOS ON GROWTH PERFORMANCE OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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Abstract

This study was carried out at the Central Laboratory for Aquaculture at Abbassa, Abou-Hammad, Sharkia, Agricultural Research Centre. This experiment aimed to investigate the influence of dietary energy and protein levels (different P/E ratios) with different percentages of fish meal protein to soybean meal protein (FM:SM ratios) on growth performance of Nile tilapia, *Oreochromis niloticus*, fingerlings. The experiment started on 29/3/1995 and lasted for 98 days. Sixteen concrete ponds (each pond had a total area of 24 m^2) were kept dried for about one month in order to remove all aquatic weeds. After this period, all ponds were divided into 3 pens (total area 8 m^2) representing 3 replicates. All ponds were filled with fresh water for about one week before stocking the fish. Each pond was provided with flow water from Ismailia canal to keep the pond clean and air stones used to keep proper level of aeration in the water. A total of 768 Nile tilapia, *Oreochromis niloticus*, fingerlings were obtained from Abbassa hatchery. The experimental fish were healthy, free of any parasites and had an average weight 35.50g ± 0.20 with average total length 13.00 cm ± 0.02 at collection time. Tilapia fingerlings were taken randomly and transferred with special care after weighing, and distributed into the experimental sixteen ponds to represent 16 nutritional treatments (3 replicates for each nutritional treatment). Tilapia were stocked in pond using the optimum stocking rate of tilapia (2 fish/m^2) (16 fingerlings per each pen).

Two metabolizable energy levels (3000 and 3500 Kcal/Kg diet) and two protein levels (30 and 35%) were used to prepare four protein/energy ratios (CP/E ratio, mg/Kcal/Kg diet) (100, 110, 90 and 100). Four replacements were done between dietary soybean meal protein and fish meal protein (30% : 60%; $0% : 50%; 50% : 40% and 60% : 30%) as fish meal: soybean meal, respectively, from the percentage of protein in each diet in a 4 X 4 factorial manner.

Improvement of tilapia body weight gain, specific growth rate and feed conversion ratio were achieved when dietary P/E increased, while, decreased dietary P/E ratio reduced feed consumption and increased

condition factor. The results for the above parameters of tilapia performance increased significantly ($P<<0.05$) with increasing fish meal protein on the expenses of soybean meal protein in all experimental diets, and highest values were obtained for fish fed diets containing 60:30 fish meal protein : soybean protein.

INTRODUCTION

Animal protein shortage for human consumption in Egypt faces a great problem, fish meat is considered one of the best animal protein source for human nutrition. Raising fish is a main subject in the map of nutritional security strategy in Egypt.

Tilapia is an important food fish in many tropical and subtropical countries. Tilapia are somewhat easy cultured due to their high tolerance to adverse environmental condition, their relatively fast growth and ease with which they can be bred. The success of intensive and semi-intensive fish culture depends to a large extent on supplemental feeding, especially the dietary protein which is the most expensive component. Protein is responsible for large part of the cost of most prepared feeds. Excess dietary protein will be used for energy and lead to an increase in ammonia excretion. El-Dahhar and Lovell (1995) have demonstrated that over an adequate range of dietary protein energy, the diet with optimum P/E ratio produced the best growth and feed utilization of tilapia (*O. mossambbicus*) fingerlings. The optimum PIE ratio is economically important for fish producers to produce maximum amount of fish at minimal cost. Fish nutritionists have tried to use less expensive plant protein sources to partially or totally replace fish meal.

The present study is designed to investigate the influence of different protein to energy (mg protein/Kcal ME) ratios with various ratios of fish meal protein to soybean meal protein (FM: SM ratios) on the performance of Nile tilapia, *Oreochromis niloticus*, fingerlings.

MATERIALS AND METHODS

This study was carried out in the Central Laboratory for Aquacultural Research at Abbassa, Abou-Hammad, Sharkia Governorate.

Sixteen concrete ponds (each pond had a total area of 24 m^2 and water depth 1m) were kept dried for about one month in order to remove all aquatic weeds. After this period, all ponds were divided into 3 pens (total area 8 m^2) representing 3 replicates. All ponds were filled with fresh water provided from Ismailia canal. Air stones used to keep proper level of aeration in the water. The experimental fish had an aver-

age weight 35.50g ± 0.20 with average total length 13.00cm ± 0.20. Tilapia fingerlings were taken randomly and stocked in ponds at a rate of 2 fish/m^2 (16 fish per each pen).

Two metabolizable energy levels (3000 and 3500 Kcal/Kg diet) and two protein levels (30and 35%) were used to prepare four protein/energy ratios (CP/E ratio, mg/Kcal/Kg diet) (100,110, 90, and 100). Four replacements were done between dietary soybean meal protein and fish meal protein (30%:60%; 40%:50%; 50%:40%; and 60%:30%) as fish meal: soybean meal, respectively, from the percentage of protein in each diet in a 4x4 factorial manner. Table 1 illustrated a summary of the experimental design and the chemical composition of the ingredients, and experimental diets are shown in Tables 2 and 3, respectively, while, the amino acids composition of ingredients were shown in Table 4.

For the experiment, fish were offered their diets at a rate of 3% of total biomass of fish per day. The amount of all the experimental diets were divided into two equal portions and fed in pelleting form (2mm) two times at 10 a.m. and 3 p.m. for 7 days weekly. Every fourteen days, the fish in each pond were weighed and the amount of feed was adjusted according to the change in body weight throughout the experimental period.

Physiochemical characteristics of pond's water, during the experimental periods were obtained biweekly at 6:00 a.m. Water temperature and dissolved oxygen (D.O.) were measured daily using a temperature oxygen meter model (Model YSI 57). pH was measured weekly by electrode pH meter model (Jackson, 1973). Ammonia was analyzed by a comparison apparatus No. 1854 (APHA, 1980).

Feed conversion ratio was calculated from the following equation:

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Total feed consumption (g)}}{\text{Final body weight - Initial body weight}}$$

$$\text{Average daily gain (ADG)} = \frac{\text{Final body weight (g) - Initial body weight}}{\text{Time (days)}}$$

Specific growth rate (SGRR%) = [(Ln wt1 - Ln wt0/T)] x 100

Where: Ln = Natural Log

wt0 = Initial body weight (g)

wt1 = Final weight (g)

T = Time in days between the two weighing

Condition factor (K) = 100 [weight g/total length^{3}cm]

To determine amino acids content ingredients, one sample of each ingredient was hydrolyzed with 6N HCL for 20 hours at 110°C according to the method of Moor *et al.*, (1958). Amino acid pattern of the acid hydrolysates was determined by amino acid analyzer (Beckman model 121).

The statistical evaluation of results was carried out by SAS program (1988). Duncan's new multiple range test was conducted to determine the significant differences between means (Duncan, 1955).

The profitability of pond tilapia culture was calculated according to Green (1992).

RESULTS AND DISCUSSION

Water Quality

Average water quality measurements obtained from different experimental ponds were shown in Table 5. The average of water ammonia content (mg/l) among ponds during the experimental periods ranged from 0.04 at the end of March to 0.34 (mg/l) at the beginning of July. Inversely, dissolved oxygen ranged from, as low as 4.73 (July) to, as high as 6.27 mg/l (March). However, pH value ranged with a little bit increment from 7.23 to 7.68, and the average water temperature during the experimental period increased gradually from 21.80 to 27.25 through the experimental period.

The average water content of ammonia, dissolved oxygen, pH and temperature were suitable for growth of Nile tilapia, *Oreochromis niloticus*. Shepherd and Bromage (1992) showed that the dissociation of ammonia (NH_3) in water was heavily dependent on both pH and temperature. At water temperature, 15°C, to achieve the 0.02 mg/l NH_3 maximum level would require a total ammonia level of 22.2 mg/l at pH 6.5, whereas, at pH 8.5, only 0.3 mg/l total ammonia level would yield the same quality of toxic free ammonia. Practically, below pH 7, ammonia is unlikely to represent a health problem in fish farms, but relatively low levels of total ammonia at higher pH levels are dangerous. Shepherd and Bromage (1992) found that, carp, catfish and tilapia can withstand dissolved oxygen level of below 2 mg/l, for short period (e.g. over night). In this connection, Reite *et al.*, (1974) indicated that tilapia tolerated a range of pH between 5-11 which had no ill effect in 24 hour test period, while, at pH lower than 3-4 or

above 12 caused 100% mortality in 2-6 hours for brackish water. Maske (1985) reported that the water temperature must be kept above 24°C for optimum growth of tilapia.

The data indicated that dissolved oxygen, temperature, ammonia and pH values of water had no negative impact in tilapia performance, and none of the values for the above mentioned parameters during the experimental period were found to be outside the normal range of tolerance for Nile tilapia.

Tilapia Performance

The performance of tilapia fed diets containing different protein/energy (P/E) ratios at different replacement ratios between dietary fish meal protein: dietary soybean meal protein are presented in Tables 6 and 7. Averages of initial live body weight of tilapia ranged between 35.22 and 35.90 g±0.12. No significant difference in initial weight among the experimental treatments was observed indicating the accuracy of randomization process between and within the experimental treatments.

Analysis of variance of final live body weight, average body weight gain, specific growth rate and feed conversion ratio indicated that the differences between treatments were significant ($P<0.05$) (Table 6). Influence of protein/energy (P/E) ratio, regardless of different replacement ratios between dietary fish meal protein: soybean meal protein (FM: SM) ratios on tilapia final body weight, average body weight gain, specific growth rate and feed conversion ratio, (Table 7), showed a significant differences ($P<0.05$) among the experimental treatments. The fish fed diets of 100 P/E ratio was more significant ($P<0.05$) than other P/E ratios for all previous performance parameters, while, condition factor had higher significant differences ($P<0.05$) for fish fed diets of 90 P/E ratio than other P/E ratios. In this connection, El-Dahhar and Lovell (1995) found that optimum ratio for, *O. mossambicus,* fish required for rapid growth was obtained with a diet containing 99.61 P/E ratio at an initial weight 5..19 and fed a 25% protein.

Regardless of P/E ratio, statistical analysis revealed that the final live body weight, average body weight gain, specific growth rate and feed conversion ratio of tilapia increased significantly ($P<0.05$) with increasing fish meal protein than soybean meal protein in all experimental diets. The highest values were obtained for fish fed diets containing 60: 30 fish meal protein: soybean meal protein (FM: SM) ratio, Table 7.

Soybean meal has one of the best amino acid profiles among plant protein feedstuffs and its composition meet the essential amino acid requirements of many fishes. Replacement of fish meal with soybean meal showed variable success. The balance of available essential amino acids in the experimental diets containing different combinations of fish meal and soybean meal met the essential amino acid requirements of Nile tilapia, *O. niloticus*, according to NRC (1993) except for marginal deficient in methionine content (Tables 5 and 6).

The diet containing 110 (P/E) ratio and 60:30 (FM:SM) ratio seemed to be sufficient for growth of tilapia *O. niloticus*, fingerlings under commercial culture condition. These results are in agreement with the findings of Winfree and Sickney (1981) who found that the optimum protein to energy (P/E) ratio for rapid and efficient gain of tilapia, *O. niloticus*, being, 108 mg protein/Kcal of diet.

Significant differences ($P<0.05$) were observed for the average daily gain (ADG) and specific growth rate (SGR) during the whole experimental period. The higher ADG and SGR were recorded for fish fed diet containing 110P/E ratio at 60:30 FM: SM ratio.

Regardless of the FM:SM ratio, protein to energy (P/E) ratios have an influence on ADG and SGR. Analysis of variance revealed that, the differences between P/E ratios were significant ($P<0.05$). Fish fed diets containing 110 P/E ratio have ADG and SGR more significant ($P<0.05$) than fish fed diets containing other P/E ratios. The results agreed with those findings of Jauncey (1982) who found that the maximum growth of *O. mossambicus* was obtained when fed diet containing 40% CP and 116.6 mg crude protein/Kcal. He added that the SGR increased almost linearly with increasing dietary P/E ratios (up to 40% dietary protein), and then, reached a plateau, decreasing only slightly at higher dietary protein levels (48% and 56%). In this connection, Tacon and Cowey (1985) concluded that SGR was positively correlated to the dietary protein.

Regardless of dietary P/E ratio, FM:SM ratio has a significant ($P<0.05$) effect on ADG and SGR. Fish fed diets containing 60:30 FM:SM ratio have ADG and SGR significantly ($P<0.05$) higher than fish fed diets containing other FM:SM ratios. These results agreed with the findings of Shiau *et al.*,(1987) who found that feeding the optimal dietary protein level (32%), partial replacement of fish meal protein with protein from soybean meal (70% FM+30 SM) depresses weight gain in tilapia (*O. niloticus X O aureus*).

Concerning feed conversion ratio (FCR), data of Table 6 showed significant differences ($P<0.05$) between experimental treatments, the better values of FCR (lower ratio) were recorded for treatments B4, B3, B2 and B1, respectively, in a decreasing

order. Regardless of FM:SM ratios, dietary P/E ratios have a significant ($P<0.05$) effect on the means of averages FCR for different experimental treatments (Table 7). The worst ratio of FCR was recorded for fish fed diets containing 90 P/E ratio than 110 P/E ratio (better ratio). The results indicated that tilapia fed 110 P/E ratio had significantly ($P<0.05$) the highest body weight with significantly ($P<0.05$) the least feed conversion ratio. It means that fish utilized feed more efficiently when the dietary P/E ratio was raised up to 110 mg protein/Kcal metabolizable energy. The results agreed with the findings of El-Dahhar and Lovell (1995) for *O. mossambicus* at 107.2 mg protein/Kcal.

Concerning FM:SM ratio, regardless P/E ratio, fish fed diet containing FM:SM ratio at 60:30 had the highest final body weight with the least feed conversion ratio (Table 7). The tabulated result agreed with those reported by Jackson *et al.*, (1982) who observed the best feed conversion ratio (1.97) when *O. mossambicus* fed diet containing 25% replacement of fish meal protein by soybean meal protein. They added that, with increasing level of soybean meal in diets, the feed conversion ratio increased.

Generally, the optimum growth performance and feed conversion ratio for tilapia, *O. niloticus* were obtained with a diet containing 110 mg protein/Kcal metabolizable energy (P/E) ratio at 60:30 fish meal protein: soybean meal protein (FM: SM) ratio.

Economic Evaluation

The enterprise budgets for production pond stocked with tilapia, *O. niloticus*, fed different protein to energy (P/E) ratios fish meal protein to soybean protein (FM:SM) ratios for 98 days grow-out are shown in Table 8. The results indicated that the highest fish production (Kg/pond) and profits (L.E./pond) were observed for fish fed diets containing 110 (P/E) ratio (35% CP with 3000 Kcal ME) followed by 100 (P/E) ratio (35% CP with 3500 Kcal ME) and 110 (P/E) ratio (30% CP with 3000 Kcal ME), while, the lowest values were obtained for 90 (P/E) ratio (30% CP with 3500 Kcal ME).

Concerning, the cost of feed consumption (L.E./pond) and the cost of production fish (L.E./pond), the highest values were observed for fish fed diets containing 100 (P/E) ratio (35% CP with 3500 Kcal ME) followed by 110 (P/E) ratio (35% CP with 300 Kcal ME) and 90 (P/E) ratio (30% CP with 3500 Kcal ME), while, the lowest values were observed for fish fed diets containing 100 (P/E) ratio (30% CP with 3000 Kcal ME).

Irrespective P/E ratios, the FM:SM ratios have an influence on fish production (Kg/pond), cost of feed consumption (L.E./pond), cost of fish production (L.E./pond)

60:30 followed by 50:40 (FM:SM) ratio, while, the lowest values were recorded for fish fed diets containing 30:60 and 40:50 (FM:SM) ratios, respectively.

It could be concluded that the diets containing 110 (P/E) ratio with 60:30 (FM:SM) ratio seemed to be sufficient for optimal growth of *O.niloticus* fingerlings under commercial culture condition in this experiment.

Table 1. Chemical Composition of the Experimental Diets.

Experimental Treatments																
Dietary energy (Kcal ME/Kg)	3000								3500							
Crude protein (%)	30				35				30				35			
P/E ratio (mg CP/Kcal ME)	100				110				90				100			
Fish meal: Soybean meal ratio	30:60	40:50	50:40	60:30	30:60	40:50	50:40	60:30	30:60	40:50	50:40	60:30	30:60	40:50	50:40	60:30
Treatment assighne	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
Ingredients %																
Yellow corn	40.00	43.00	46.00	48.50	31.50	35.00	38.50	41.50	31.50	35.50	38.00	40.50	23.50	26.50	30.00	33.50
Soybean meal	41.00	34.00	27.00	20.50	48.00	39.50	31.50	23.50	42.00	34.00	27.50	21.00	48.00	40.00	31.50	24.00
Fish meal	13.00	17.00	21.00	25.00	14.50	19.50	24.00	29.00	13.00	17.00	21.00	25.00	15.00	20.00	25.00	29.00
Linseed oil	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50
Vit. + Min. primex. (1)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Nutrient Composition Determined																
Dry matter %	90.30	90.35	90.76	90.08	90.10	90.36	90.62	91.01	91.85	91.42	91.35	91.06	91.86	91.50	91.57	91.63
Crude protein %	30.85	31.00	31.10	31.16	34.28	34.43	34.54	34.75	30.67	30.44	30.61	30.69	34.10	34.25	34.41	34.45
Ether extract %	7.92	8.13	8.32	8.54	7.48	7.85	8.01	8.49	13.45	13.66	13.82	14.10	13.51	13.91	14.20	14.37
Total carbohydrate %	45.97	45.36	45.41	44.28	42.34	41.70	41.57	41.11	42.13	41.18	40.13	39.35	37.30	36.46	35.76	35.31
NFE %	42.98	42.54	42.68	41.64	38.92	38.42	38.74	38.39	38.77	38.35	37.46	36.80	33.20	32.56	31.95	31.71
Crude fiber %	2.99	2.82	2.73	2.64	3.42	3.28	2.83	2.72	3.36	2.83	2.67	2.55	4.10	3.90	3.81	3.60
Ash %	5.56	5.86	5.93	6.10	6.00	6.38	6.50	6.66	5.60	6.14	6.79	6.92	6.95	6.88	7.20	7.50
Cross energy	4412	4425	4438	4454	4450	4468	4482	4501	4864	4833	4848	4864	4863	4882	4899	4911
Metabolizable energy (2)	3088	3097	3107	3118	3115	3128	3137	3151	3405	3383	3394	3405	3404	3417	3429	3438

(1) vitamins and mineral mixture each 1 Kg. of mixture content:

4.8 m.I.U. vit. A, 0.8 m.I.U. vit. D_3, 4.0g. vit. E, 0.8g. K., 0.4g. vit. B_1, 1.6g. vit. B_6, 4mg. Vit. B_{12}, 4mg. Vit. Pantothenic acid, 8g. Niacin, 400mg. Folic acid, 20mg, Biotin, 200mg. Choline choride, 12g. Iron, 16g. Manganese, 1.2g. Copper, 120mg. Iodine, 80mg. Cobalt, 40mg. Selenium, 18g. Zinc.

(2) ME was calculated from gross energy as 70% as reported by Hepher *et al.*, (1983).

Table 2. Amino Acids Composition of Ingredients.

Amino acids (EA, A, S)	Ingredients					
	Yellow Corn		Soybean meal		Fish meal	
	g / 169 N	%	g / 169 N	%	g / 169 N	%
Arginine	4.94	0.43	7.53	3.32	6.44	4.64
Histidine	2.99	0.26	2.83	1.25	2.34	1069
Isoleucine	4.02	0.35	4.54	2	4.2	3.03
Leucine	13.91	1.21	7.53	3.32	6.96	5.02
Lysine	2.87	0.25	6.3	2.78	7.78	5.61
Methionine	1.95	0.17	1.43	0.63	2.86	2.06
Methionine + Cystine[1]	4.71	0.41	2.97	1.31	3.58	2.58
Phenylalanine	5.52	0.48	5.03	2.22	3.66	2.64
Phenylalanine + Tyrosine[2]	9.08	0.79	8.79	3.88	6.5	4.69
Threonine	3.22	0.28	3.88	1.71	3.97	2.86
Tryptophan[3]	0.92	0.08	1.45	0.64	1.07	0.77
Valine	5.06	0.44	4.6	2.03	5.65	4.07
Crude protein (%)	8.7		44.1		72.1	

(1) Cystine included as 2.76, 1.54 and 0.72 % from protein and 0.24, 0.68 and 0.52 % from ingredients of yellow corn, soybean meal and fish meal, respectively.

(2) Tyrosine included as 3.65, 3.76 and 2.84 % from protein and 0.31, 1.66 and 2.05 % from ingredients of yellow corn, soybean meal and fish meal, respectively.

(3) Tryptophan (Not determined) values obtained from Table of NRC (1993).

Table 3. Water Quality Measurements During the Experimental Period.

Criterion:	Experimental Ponds																Average
	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	
March, 29, 1995																	
Ammonia (mg/l)	0.04	0.02	0.03	0.04	0.05	0.04	0.06	0.04	0.03	0.05	0.04	0.03	0.06	0.04	0.03	0.05	0.04
D. O. (mg/l)	6.30	6.40	6.35	6.50	6.45	6.61	6.25	6.40	6.30	6.45	6.55	6.60	6.33	6.30	6.35	6.34	6.35
pH	7.20	7.25	7.25	7.30	7.15	7.35	7.30	7.25	7.30	7.28	7.20	7.35	7.23	7.20	7.25	7.18	7.25
T 8C	21.70	21.80	21.70	22.00	21.90	21.70	21.80	21.80	21.65	21.90	21.70	22.00	21.80	21.80	21.79	21.80	21.80
April, 12, 1995																	
Ammonia (mg/l)	0.25	0.23	0.23	0.22	0.28	0.26	0.25	0.24	0.32	0.22	0.20	0.19	0.26	0.24	0.24	0.21	0.22
D. O. (mg/l)	6.10	6.10	6.08	6.07	6.06	6.06	6.05	6.04	6.12	6.11	6.11	6.09	6.08	6.08	6.06	6.05	6.08
pH	7.30	7.35	7.35	7.45	7.40	7.45	7.45	7.40	7.35	7.35	7.40	7.40	7.43	7.45	7.46	7.45	7.40
T 8C	22.10	22.10	22.20	22.20	22.30	22.30	22.30	22.30	22.20	22.20	22.30	22.30	22.30	22.30	22.30	23.30	22.25
April, 26, 1995																	
Ammonia (mg/l)	0.28	0.28	0.26	0.28	0.30	0.30	0.29	0.29	0.29	0.29	0.28	0.28	0.31	0.31	0.30	0.29	0.29
D. O. (mg/l)	6.00	6.00	5.95	5.90	5.85	5.80	5.70	5.70	6.01	6.00	6.00	5.95	5.90	5.85	5.85	5.80	5.89
pH	7.35	7.30	7.40	7.35	7.45	7.40	7.45	7.45	7.40	7.35	7.35	7.40	7.45	7.42	7.44	7.43	7.41
T 8C	23.50	23.50	24.60	23.60	23.70	23.60	23.70	23.70	23.60	23.60	23.50	23.60	23.70	23.60	23.60	23.70	23.68
May, 10, 1995																	
Ammonia (mg/l)	0.30	0.30	0.29	0.29	0.31	0.31	0.30	0.30	0.32	0.32	0.30	0.29	0.31	0.31	0.29	0.30	0.30
D. O. (mg/l)	5.50	5.50	5.40	5.40	5.30	5.30	5.20	5.20	5.60	5.50	5.50	5.40	5.40	5.30	5.40	5.30	5.39
pH	7.50	7.50	7.60	7.70	7.60	7.70	7.70	7.70	7.80	7.70	7.80	7.80	7.70	7.80	7.70	7.70	7.69
T 8C	24.00	24.00	24.10	24.10	24.10	24.20	24.20	24.20	24.20	24.20	24.20	24.10	24.20	24.00	24.20	24.20	24.14
May, 24, 1995																	
Ammonia (mg/l)	0.30	0.30	0.30	0.29	0.31	0.30	0.31	0.31	0.31	0.31	0.31	0.31	0.30	0.31	0.32	0.31	0.31
D. O. (mg/l)	5.50	5.50	5.40	5.30	5.30	5.20	5.20	5.10	5.60	5.50	5.40	5.30	5.30	5.20	5.20	5.20	5.33
pH	7.60	7.60	7.50	7.50	7.50	7.40	7.60	7.50	7.60	7.60	7.50	7.50	7.80	7.40	7.50	7.60	7.53
T 8C	24.80	24.80	24.90	24.90	25.00	25.00	24.90	24.90	24.90	25.00	25.00	24.80	24.90	24.90	25.00	25.00	24.92
June, 7, 1995																	
Ammonia (mg/l)	0.32	0.32	0.31	0.31	0.34	0.34	0.33	0.32	0.33	0.33	0.32	0.32	0.35	0.35	0.34	0.33	0.33
D. O. (mg/l)	4.90	4.90	4.80	4.90	4.70	4.70	4.70	4.60	5.00	4.90	4.90	4.80	4.80	4.80	4.70	4.70	4.80
pH	7.30	7.30	7.20	7.30	7.20	7.20	7.20	7.20	7.16	7.20	7.15	7.14	7.17	7.13	7.14	7.15	7.20
T 8C	25.30	25.30	25.30	25.30	25.40	25.30	25.20	25.30	25.40	25.30	25.20	25.30	25.40	25.40	25.30	25.20	25.31
June, 21, 1995																	
Ammonia (mg/l)	0.30	0.30	0.31	0.31	0.33	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.34	0.34	0.30	0.30	0.32
D. O. (mg/l)	4.80	4.80	4.70	4.60	4.50	4.50	4.40	4.40	4.90	4.90	4.80	4.70	4.80	4.50	4.50	4.40	4.63
pH	7.40	7.40	7.30	7.30	7.50	7.30	7.20	7.40	7.40	7.30	7.30	7.30	7.40	7.40	7.40	7.40	7.36
T 8C	26.90	26.90	26.80	26.80	27.00	27.00	26.80	26.80	26.90	26.90	26.90	26.90	26.80	26.70	26.80	26.90	26.90
July, 5, 1995																	
Ammonia (mg/l)	0.33	0.33	0.32	0.32	0.36	0.36	0.35	0.35	0.34	0.34	0.33	0.33	0.35	0.35	0.34	0.33	0.34
D. O. (mg/l)	4.50	4.50	4.50	4.40	4.40	4.40	4.30	4.30	4.60	4.60	4.50	4.40	4.40	4.40	4.40	4.30	4.43
pH	7.40	7.50	7.60	7.50	7.50	7.60	7.40	7.60	7.40	7.50	7.50	7.50	7.50	7.40	7.50	7.60	7.50
T 8C	27.30	27.20	27.20	27.30	27.30	27.30	27.30	27.30	27.20	27.20	27.20	27.30	27.30	27.20	27.30	27.30	27.0

Table 4. The Response of P/E Ratios and FM: SM Ratios on Tilapia Performance.

Criterion	Experimental treatments									
	P / E ratio				SE ±	Fish meal : Soybean meal ratio				SE ±
	100	110	90	100		30:60	40:50	50:40	60:30	
Initial body weight, (g)	35.52^{a}	35.43^{a}	35.45^{a}	35.62^{a}	0.07	35.48^{a}	35.61^{a}	35.56^{a}	35.47^{a}	0.07
Final body weight, (g)	129.08^{c}	147.01^{a}	121.07^{d}	143.02^{b}	1.36	127.83^{d}	133.04^{c}	137.64^{b}	141.66^{a}	2.92
Average body weight gain per fish, (g/day)	0.96^{c}	1.14^{a}	0.87^{d}	1.10^{b}	0.02	0.94^{d}	0.99^{c}	1.04^{b}	1.08^{a}	0.03
Specific growth rate, (%/day)	1.32^{c}	1.45^{a}	1.25^{d}	1.42^{b}	0.01	1.31^{d}	1.34^{c}	1.38^{b}	1.41^{a}	0.03
Conditional factor	2.07^{b}	2.01^{c}	2.20^{a}	2.11^{b}	0.01	2.11^{a}	2.10^{a}	2.10^{a}	2.09^{a}	0.02
Feed consumption per fish, (g/day)	2.11^{b}	2.29^{a}	2.03^{c}	2.28^{a}	0.02	2.08^{d}	2.16^{c}	2.21^{b}	2.26^{a}	0.03
Feed conversion ratio per fish	2.21^{b}	2.01^{d}	2.33^{a}	2.08^{c}	0.02	2.22^{a}	2.18^{b}	2.13^{c}	2.10^{d}	0.04

SE ± Standard error. Calculated from residual mean square in the analysis of variance.
a, b, ... etc. mean in same row with different superscript are significantly different ($P \leq 0.05$).

Table 5. Amino Acids Composition As % of Experimental Diets Containing Different P/E Ratios Irrespective of Different FM: SM Ratios.

Amino Acid	NRC (1993) requirement as % of diets	P/E Ratio				FM : SM Ratio			
		100	110	90	100	30:60	40:50	50:40	60:30
Arginine	1.18	1.78	2.03	1.64	1.90	1.90	1.85	1.82	1.79
Histidine	0.48	0.82	0.90	0.74	0.82	0.83	0.82	0.82	0.82
Isoleucine	0.87	1.23	1.38	1.12	1.27	1.31	1.25	1.25	1.24
Leucine	0.95	3.04	3.21	2.67	2.81	2.83	2.90	2.97	3.03
Lysine	1.43	1.45	1.72	1.37	1.65	1.56	1.55	1.54	1.54
Methionine	0.75	0.57	0.64	0.52	0.59	0.54	0.57	0.60	0.62
Methionine + Cystine	0.90	1.14	0.23	1.02	1.10	1.08	1.11	1.14	1.17
Phenylalanine	1.05	1.46	1.59	1.31	1.44	1.46	1.45	1.44	1.43
Phenylalanine + Tyrosine	1.55	2.47	2.72	2.23	2.47	2.50	2.48	2.45	2.44
Threonine	1.05	1.05	1.18	0.96	1.09	1.08	1.07	1.07	1.07
Tryptophan	0.28	0.33	0.38	0.30	0.35	0.36	0.34	0.34	0.33
Valine	0.78	1.47	1.63	1.33	1.49	1.44	1.47	1.49	1.52
Crude protein (%)	28.00	31.00	34.50	30.60	34.30	32.50	32.53	32.67	32.76

Table 6. Amino Acids Composition As % From Protein of Experimental Diets Containing Different P/E Ratios Irrespective of Different FM: SM Ratios.

Amino Acid	NRC (1993) requirement as % from dietary protein	P/E Ratio				FM : SM Ratio			
		100	110	90	100	30:60	40:50	50:40	60:30
Arginine	2.40	5.72	5.96	5.36	5.54	5.83	5.69	5.56	5.51
Histidine	1.72	2.64	2.62	2.41	2.39	2.54	2.52	2.51	2.49
Isoleucine	3.11	3.97	4.01	3.68	3.71	3.89	3.85	3.83	3.80
Leucine	3.39	9.80	9.29	8.72	8.20	8.73	8.92	9.10	9.26
Lysine	5.12	4.68	4.99	4.48	4.81	4.80	4.76	4.71	4.68
Methionine	2.68	1.85	1.85	1.70	1.71	1.66	1.74	1.82	1.89
Methionine + Cystine	3.21	3.68	3.56	3.32	3.21	3.32	3.41	3.49	3.56
Phenylalanine	3.75	4.69	4.61	4.27	4.19	4.51	4.46	4.42	4.38
Phenylalanine + Tyrosine	5.54	7.96	7.88	7.28	7.18	7.71	7.62	7.53	7.44
Threonine	3.75	3.37	3.42	3.13	3.19	3.31	3.28	3.27	3.25
Tryptophan	1.00	1.06	1.09	0.99	1.02	1.09	1.05	1.03	0.99
Valine	2.80	4.73	4.72	4.35	4.35	4.44	4.51	4.57	4.62
Crude protein (%)	28.00	31.00	34.50	30.60	34.30	32.50	32.53	32.67	32.76

Table 7. Economic Evaluation of tilapia Fed Different P/E Ratios And FM: SM Ratios.

Criterion	Experimental treatments							
	P/E Ratio				Fish Meal : Soybean Meal Ratio			
	100	110	90	100	30:60	40:50	50:40	60:30
Mean initial weight, (g)	35.52	35.43	35.45	35.62	35.48	35.61	35.56	35.47
Mean final weight, (g)	129.08	147.01	121.07	143.02	127.83	133.04	137.64	141.66
Mean harvest weight, (Kg/pond)	6.19	7.06	5.81	6.87	6.14	6.39	6.61	6.80
Adult, (%)	78.92	93.80	72.50	91.92	79.75	80.67	88.00	88.72
Unmarketable size (%)	21.08	6.20	27.50	8.08	20.25	19.33	12.00	11.28
Grade N_1 (250-150g), Kg/pond	0.21	1.07	0.15	0.58	0.17	0.56	0.47	0.82
Grade N_2 (150-100g), Kg/pond	4.69	5.56	4.08	5.74	4.79	4.65	5.38	5.26
Grade N_3 (<100g - fingerlings), Kg/pond	1.29	0.43	1.58	0.55	1.19	1.18	0.76	0.72
Cost of Kg diet, L.E.	1.41	1.50	1.68	1.77	1.48	1.55	1.62	1.69
Cost of feed/pond/98 days, L.E.	13.99	16.10	16.03	18.95	14.48	15.76	16.82	18.02
Cost of fingerlings stocking in initial period/pond, L.E.	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80
Cost of production fish/pond/98 days, L.E.	18.79	20.90	20.83	23.75	19.28	20.56	21.62	22.82
Adult	32.28	45.25	27.79	42.21	32.51	34.96	38.92	41.15
Unmarketable size	3.24	1.07	3.96	1.38	2.97	2.96	1.91	1.81
Total	35.52	46.32	31.75	43.59	35.48	37.92	40.83	42.96
Profits, L.E.	16.73	25.41	10.92	19.85	16.20	17.36	14.21	20.14

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تأثير استخدام نسب مختلفة من الطاقة والبروتين ومعدلات إحلال بروتين مسحوق السمك ببروتين كسب فول الصويا على الأداء الإنتاجى لأسماك البلطى النيلى

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أجريت هذه الدراسة بالمعمل المركزى لبحوث الأسماك بالعباسة - مركز أبو حماد - محافظة الشرقية - التابع لمركز البحوث الزراعية. أجريت هذه التجربة بهدف تحديد مستوى الإستجابة للتغذية على أربع معدلات من البروتين إلى الطاقة (١٠٠ - ١١٠ - ٩٠ - ١٠٠ ملليجرام بروتين خام/كيلو كالورى طاقة ممثلة) باستخدام معدلات احلال بروتين مسحوق السمك ببروتين كسب فول الصويا (٣٠ : ٦٠ - ٤٠ : ٥٠ - ٥٠ : ٤٠ - ٦٠ : ٣٠) وذلك على الأداء الإنتاجى لأسماك البلطى النيلى باستخدام تصميم التجارب المعملية المتشعبة.

استخدم فى هذه الدراسة عدد ٧٦٨ من إصبعيات اسماك البلطى النيلى باستخدام بمتوسط وزن ٣٥,٥ جم والتى تم تقسيمها وتسكينها عشوائياً فى بداية التجربة فى ١٦ حوض أسمنتى بحيث قسم كل حوض (مساحة ٢٤ متر مربع) إلى ٣ أقسام متساوية (٨ متر مربع). ووضع فى كل قسم من الأقسام ١٦ أصبعية بمعدل ٢ سمكة فى المتر المربع. واختبرت على مدار فترة التجربة التى امتدت ٩٨ يوماً بيانات الأداء الإنتاجى.

أسفرت النتائج المتحصل عليها على الآتى:

- كان أعلى وزن جسم على مستوى المعنوية ٠,٠٥ للأسماك التى غذيت على عليقة تحتوى على ١١٠ ملليجرام بروتين/كيلو كالورى طاقة ممثلة ومعدل بروتين مسحوق سمك إلى بروتين كسب فول الصويا (٣٠ : ٦٠) عن باقى المعاملات. وكما كان متوسط الزيادة المكتسبة للجسم يومياً (ADG) ومعدل النمو النوعى (SGR%) أكبر معنوياً للأسماك التى غذيت على علائق تحتوى على نفس المعدلات السابقة.
- لوحظ أن أفضل نسبة تحويلية للغذاء (FCR) للأسماك التى تغذت على علائق تحتوى على معدل بروتين مسحوق السمك إلى بروتين كسب فول الصويا (٦٠ : ٣٠). بينما كانت أقل نسبة تحويلية للغذاء للعلائق التى تحتوى على ٩٠ ملليجرام بروتين/كيلو كالورى طاقة ممثلة مع (٣٠ : ٦٠) بروتين مسحوق السمك إلى بروتين كسب فول الصويا.
- النتائج المتحصل عليها للأداء الإنتاجى لأسماك البلطى النيلى فى هذه الدراسة تؤكد أن العليقة المحتوية على ١١٠ بروتين/كيلو كالورى طاقة ممثلة مع (٦٠ : ٣٠) بروتين مسحوق السمك إلى بروتين مسحوق كسب فول الصويا تبدو كافية للحصول على أعلى معدل نمو لأسماك البلطى النيلى.