EFFECT OF DIETARY PROTEIN LEVELS AND SOURCES ON GROWTH PERFORMANCE AND FEED UTILIZATION OF NILE TILAPIA *OREOCHROMIS NILOTICUS* (L.) BROODSTOCK.

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Abstract

This experiment was undertaken to investigate the effects of using different dietary protein levels and sources on growth performance and protein and feed utilization of Nile tilapia *Oreochromis niloticus* (L.) broodstock. Two dietary protein levels (25 and 40% CP) were tested using three main dietary protein sources [fish meal (FM) 65% CP; soybean meal (SBM), 44% CP and a mixture of FM and SBM proteins]. The experiment was assigned according to 2×3 factorial design with two replicates/ treatment giving total number of 12 spawning happas. The highest average final weight (AFW), average weight gain (AWG), average daily gain (ADG) and specific growth rate (SGR) of male and female broodstock were recorded for broodstock fed the 40% CP from animal protein source while, the worst values of male AFW, AWG, ADG and SGR and female AFW were found in group fed 25%CP from plant protein. No significant differences in survival rates were found among fish groups fed different protein levels and sources and all treatments had 100% survival rates. Broodstock fed diet containing 40 % CP recorded higher values of AFW, AWG, ADG and SGR than those fed diets containing 25% CP. The AFW, AWG, ADG, and SGR were in favor of the animal protein source. Feed intake, FCR, PER, PPV and EU (%) were significantly ($P \leq 0.05$) affected by the six experimental treatments. Regardless of dietary protein sources, it was found that, there were significant differences ($P \leq 0.05$) between protein levels in terms of feed intake, FCR, PER, PPV (%) and EU (%). The group fed (40% CP) utilized protein and feed more efficiently than those fed the lower dietary protein level (25% CP). The results revealed that, in order to have efficient broodstock growth performance and protein and feed utilization, it is recommended to use diets containing high protein level (up to 40% CP) of good quality protein (animal source).

INTRODUCTION

Ideal broodfish should be maintained under controlled conditions, which as far as possible match or improve upon those to which the fish will have been exposed in the wild. In practice, however it may not be possible to manage all of the rearing conditions. Water quality, feeding regime and diet, stocking density, exposure to pathogens and handling stress parameters may be optimized by appropriate management and husbandry practices. Although such improvement may be difficult for species of fish, which have only recently become farmed, mainly because the establishment of the best husbandry practices requires a number of years for development and experimentation. The effect of stress on broodstock is somewhat of a paradox. In many ways, broodfish, possibly by virtue of their age, size and metabolic requirements and reserves, are far more tolerant of stress than fry or juvenile fish. Stresses, which result in minimal apparent or measurable effects in broodstock often, cause acute stress and mortality in young animals; e.g., broodfish are far more tolerant of poor quality waters than juvenile fish. However, one aspect of the biology of broodfish, which clearly has much lower threshold of effect of stress, is reproduction (Bromage and Roberts, 1995). Maximizing seed productivity in hatcheries is the ultimate aim of broodstock management. During the last two decades, more attention has been paid to the level of different nutrients in broodstock diets. However, studies on broodstock nutrition are limited and relatively expensive to conduct (Izquierdo *et al.,* 2001). The aim of the present study was to evaluate the effects of using different dietary protein levels and sources on growth performance and protein and feed utilization of Nile tilapia *Oreochromis niloticus* (L.) broodstock

MATERIALS AND METHODS

The present work was carried out during spawning season of 2004 to investigate the effects of using different dietary protein levels and sources on broodstock growth performance, feed efficiency, protein utilization, reproductive performance and seed output of Nile tilapia broodstock. The present work was conducted under the conditions of hapa- in pond- based hatchery system. All spawning hapas, each measuring 2×1×1 m^3 (length× width× highest) was suspended in an earthen pond of 10.000 m2. The water depth in each hapa was maintained at a bout of 0.5 m to attain a total water volume of about 1 m^3 per hapa.

Experimental design

Two dietary protein levels (25 and 40% CP) were tested using three main dietary protein sources [fishmeal (FM) of protein, 65% CP; soybean meal (SBM), of 44% CP and a mixture of FM and SBM proteins]. The six protein level/ source

Symbol	Protein level (% CP)	Protein source
T1	25	Soybean meal (44% CP).
T2	25	Fish meal (65% CP) + Soybean meal (44% CP).
T3	25	Fish meal (65% CP).
T4	40	Soybean meal (44% CP).
T5	40	Fish meal (65% CP) + Soybean meal (44% CP).
T6	40	Fish meal (65% CP).

combinations (treatments) were assigned according to 2×3 factorial design with two replicates/ treatment giving total number of 12 spawning hapas. The experimental treatments were subjected to be studied as follows, -

Experimental fish

An over-wintered Nile tilapia, *Oreochromis niloticus*, broodstock were obtained from commercial fish farm located in Kafr El-Sheikh Governorate.

Broodstock were netted from earthen ponds, manually selected, sexed and transferred to conditioning hapas (3×6×1 m^3), where they were held and kept separately for 25 days to be acclimatized to the new environment until starting the experiment (8^{th} of June, 2004). Twenty-four and seventy-two Nile tilapia males and females broodstock, respectively were stocked at a sex ratio of three females to one male with a stocking density of eight (two males, six females) fish/ m^2 in each experimental hapa ($1m^3$). The mature broodstock selected for the experiment were ranged from 136.500± 2.00 to 140.500± 2.500 g for females and from 144.0± 2.00 to 152.0± 2.00 g for males. Random samples of females and males tilapia broodstock were taken, individually weighed, immediately killed and frozen at -18 °C until proximate analysis at the end of the experiment. Body weight was recorded at the beginning, subsequent spawning and at the end of experiment, which lasted for 110 days.

Experimental diets

Three different protein sources and two protein levels (25 and 40%CP) were used to formulate six experimental diets for feeding broodstock (Table 1). The dietary protein sources were:

-Plant protein [soybean meal (SBM), 44% CP].

-A mixture from both animal (FM, 65% CP) and plant (SBM, 44% CP) proteins.

-Animal protein [fish meal (FM), 65% CP].

Protein energy ratio ranged between 69.40 to 70.43 mg protein / Kcal ME for diets containing 25%CP, while diets containing 40% CP, protein energy ratio ranged between 103–106 mg protein/ Kcal ME. Broodstock were fed the experimental diets at a feeding rate of 3 % of fresh biomass in each hapa (six days per week). Broodstock were fed two times daily at 9.00 am and 4 pm with feed amounts adjusted at approximately 15–20 days intervals in response to weight gain.

Table 1. Composition and proximate analysis of the experimental diets.

Experimental Diets	1	2	3	4	5	6
Ingredients,- Fish meal (65 % CP)	----	4.0	32.0	----	7.0	60.0
Soybean meal (44 % CP)	50.0	41.0	----	91.0	79.0	----
Corn grain	43.0	23.0	61.0	2.0	7.0	33.0
Wheat bran	----	25	----	----	----	----
Corn Oil	3.0	3.0	3.0	3.0	3.0	3.0
Molasses	2.0	2.0	2.0	2.0	2.0	2.0
Minerals[1]	1.0	1.0	1.0	1.0	1.0	1.0
Vitamins[2]	1.0	1.0	1.0	1.0	1.0	1.0
Proximate analysis						
Dry matter (%)	91.5	92.0	91.0	91.4	90.0	92.0
Crude protein (%)	25.4	25.4	25.7	40.2	39.9	40.0
Ether extract (%)	5.84	5.21	6.00	5.94	5.51	7.25
Crude fiber (%)[3]	3.28	3.95	2.97	4.19	3.09	3.49
Ash (%)	7.35	6.81	7.62	5.95	5.51	7.85
Nitrogen free extract (%)	58.1	59.6	58.6	43.7	43.2	41.4
Metabolizable energy (K Cal / Kg)[4]	3666	3614	3688	3788	3752	3881
Protein energy ratio (mg protein/K Cal)	69.4	70.4	69.6	106.3	106.3	103.1

1- *Minerals (g/ Kg),* - Ca CO_3 ,314 g; KH_3PO_4 ,469.2; Mg SO_4 .7 H_2O ,147.4; Na Cl, ,49.8; Trace elements 19.6 g consists of Fe^{+2} – gluconate; Mn $SO_4.H_2O$,10900 mg; Zn SO_4 .7 H_2O ,3120; Cu SO_4 .5 H_2O, 620 mg; KI,160; Cl CO_3 .6 H_2O; Ammonium molybdate , 60; Na_2SeO_3 (Sodium selenate),20 mg.

2- *Vitamins,* - Vit. A, 1,000,000 IU; Vit. D3, 85.714 IU; Vit. E, 100,000 IU; Vit. B1, 5,000 mg; Vit. B2, 10,000 mg; Vit. B6, 10,000 mg; Vit. B12, 10,000 mg; Vit.C, 20,000 mg; Biotin, 500 mg; folic acid, 2,000 mg and pantothenic acid 20.000 mg.Vit. K_3 2,000 mg.

3- *Crude fiber* did not include in calculating ME of the diets.

4-*Metabolizable energy (ME),-)* calculated using values of 4.50, 8.1 and 3.49 K Cal for protein, fat and carbohydrate, respectively according to Pantha (1982).

Amino acid determination

Amino acids content of each experimental broodstock and fry diets were determined using a high performance amino acid analyzer as described by Moor *et al.* (1958). Amino acids content of experimental diets are shown in table (2).

Analytical methods

At the end of the experiment, all broodstock in each hapa were netted, weighed and finally frozen for final body composition analysis. Representative samples of the experimental fish were randomly taken at the beginning and at the end of the experiment. Fish samples were killed and kept frozen (-18°C) until performing the body chemical analysis. Samples of the experimental fish diets were taken, ground and stored in a deep freezer at -18oC until proximate analysis. All of chemical analyses of fish and fish diets were determined according to A.O.A.C. (1990). Initial analyses were carried out on a pooled sample of fish, which were weighed and frozen prior to the experiment.

Growth performance parameters

The growth performance parameters are calculated according to the following equations:-

Average Weight Gain (AWG) = Average final weight (g) – Average initial weight (g).

Average Daily Gain (ADG) = [Average final weight (g) – Average initial weight (g)] / time (days).

Specific Growth Rate (SGR %/day) = 100 [Ln Wt1 – Ln Wt 0 / t] Where, - Wt 0, initial weight (g), Wt 1, final weight (g) and T, time of days.

Feed and protein utilization parameters

Feed and protein utilization parameters are calculated according to the following equations:-

Feed conversion Ratio (FCR) = Total feed consumption/ weight gain.

Feed efficiency (FE) = weight gain/ Total feed consumption

Protein efficiency ratio (PER) = body weight gain (g)/ protein intake (g). Protein production value (PPV %) = 100 [Retained protein (g)/ protein intake].

Energy utilization (EU %) = 100 [Retained energy (Kcal)]/ energy intake (Kcal).

Water quality parameters

Air and water temperatures were determined four times weekly at 6.00 am and 2.00 pm by using a thermometer. Water dissolved oxygen (DO) content and water pH were measured weekly at 2.00 pm using a digital dissolved oxygen meter (Jenway model 9070) and a digital pH meter (model checker 1 produced by Hanna Instrument Co.), respectively. Water salinity (mg/L) was determined biweekly using a digital conductivity meter (Jenway model 4075). Water alkalinity and total ammonia nitrogen (TAN mg/ L) were weekly determined following the methods described by Chattopadhyay (1998).

Statistical analysis

Statistical analysis of the experiment was done using SAS Version 9 (SAS Institute, 2002) statistical package. Data were statistically analysed in a factorial design procedure. Mean of treatments were compared by Duncan (1955) multiple range test. Duncan test ($p<0.05$) was used to compare means and ($F<0.05$) was considered for the variance analyses.

Table 2. Amino acid contents of the Nile tilapia, *Oreochromis niloticus* (L.) broodstock diets.

Amino acid	Diet 1 (25% CP)	Diet 2 (25% CP)	Diet 3 (25% CP)	Diet 4 (40% CP)	Diet 5 (40%CP)	Diet 6 (40%CP)	Requirements*
Arginine	1.94	1.89	1..99	1.87	2.2	2.05	1.18
Histidine	0.75	0.72	0.76	0.90	0.92	0.74	0.48
Isoleucine	1.49	1.54	2.15	2.65	2.18	2.75	0.87
Leucine	2.15	2.00	1.46	1.60	1.55	1.50	0.95
Lysine	2.00	1.90	2.16	2.85	2.50	2.90	1.43
Methionin	0.87	0.85	0.88	1.01	1.00	0.95	0.75
Phenylalanine	1.30	1.45	1.65	1.75	1.60	1.85	1.05
Threonine	1.15	1.25	1.43	1.89	1.75	1.65	1.05
Tryptophan	0.45	0.49	0.50	0.40	0.33	0.45	0.28
Valine	1.25	1.44	1.80	1.32	1.56	1.85	0.78

*Source, Santiago and Lovell (1988).

RESULTS AND DISCUSSION

Means of water quality parameters measured throughout the present experiment are shown in Table 3. Ponds water temperatures, pH, pre-sunrise and afternoon dissolved oxygen (DO) levels, total ammonia nitrogen and total alkalinity in the present work were suitable for the normal growth of warm water fish (Tahoun, 2002 and 2007). It may be preliminarily concluded that physical and chemical variables have not affected the results of this experiment.

Table 3. Water quality criteria or through the experimental period.

Month	Temperature (ºC)			pH	Dissolved oxygen (mg/ L)		Total ammonia Nitrogen (mg/L)	Total Alkalinity (mg/L)
	Air	Water (am)	Water (pm)		am	pm		
June	30.8	24.9	29.0	7.90	1.53	7.50	0.010	195.0
July	32.7	26.4	28.3	8.35	1.34	7.50	0.020	219.0
August	31.0	24.50	28.0	8.20	1.15	7.60	0.029	230.0
September	28.2	21.8	26.70	7.60	1.59	8.10	0.010	198.0
October	27.7	24.5	21.2	8.30	1.60	7.90	0.120	200.0

Broodstock growth performance and survival rates

As shown in table 4, there were significant ($P\leq0.05$) differences among broodstock groups fed different protein levels and sources. The highest AFW, AWG, ADG and specific growth rate SGR of male broodstock were recorded for T6 (broodstock fed the 40% CP from animal protein source) while, the worst values of male AFW, AWG, ADG and SGR were found in T1 (broodstock fed 25% CP from plant protein source). The highest values of female AFW, AWG, ADG and SGR were also recorded for T6 while the lowest female AFW was found in T1. The treatment No.4 showed the lowest female AWG, ADG and SGR. All broodstock groups fed different protein levels and sources had 100% survival rates.

Table 4. Growth performance and survival rates of Nile tilapia, *Oreochromis niloticus* (L.) broodstock as affected by dietary protein levels and sources.

Treat.	AIW (g)		AFW (g)		AWG (g)		ADG (g/ day)		SGR (%/day)	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
T1	152.0a	136.50a	203.0c	186.0 b	51.0c	49.5 bc	0.52c	0.51bc	0.30 c	0.32b
T2	148.5ab	136.50a	210.5bc	190.5ab	62.5bc	54.0 b	0.63bc	0.55b	0.35 bc	0.34ab
T3	146.0ab	137.0a	214.0ab	190.0a b	68.5 ab	53.0b	0.71ab	0.55b	0.40 ab	0.34ab
T4	146.5ab	140.5a	209.0cb	187.5 ab	62.5bc	47.0c	0.65bc	0.49c	0.37 b	0.30b
T5	145.0b	137.0a	218.5ab	188.5ab	73.50ab	51.5bc	0.74ab	0.52cb	0.41 ab	0.32b
T6	144.0b	140.5a	222.0a	201.0 a	78. a	60.50a	0.81a	0.62a	0.45a	0.3a

Means in the same column having different letters are significantly ($P \leq 0.05$) different.

T1,- Broodstock fed 25% CP diet from plant protein source.

T2,- Broodstock fed 25% CP die from a mix. of plant and animal protein

T3,- Broodstock fed 25% diet CP from animal protein source.

T4,- Broodstock fed 40% CP from plant protein source.

T5,- Broodstock fed 40% CP from a mix. of plant and animal protein

T6,- Broodstock fed 40% CP diet from animal protein source.

Table 5 shows the effect of different protein levels regardless of protein sources on growth performance parameters of Nile tilapia broodstock. Nile tilapia broodstock group fed diet containing 40 % CP recorded higher values of AFW, AWG, ADG and SGR than those fed diets containing 25% CP. No significant differences were found among different broodstock groups fed different protein levels in survival rates (all treatments had 100%). The results on broodstock growth parameters in the present study are in accordance with those reported by Omar (1994), who indicated that, the growth of tilapia increased as the level of dietary protein increased. She observed that the maximum growth was obtained with diet containing higher protein levels. Thus, inadequate protein level in the diets resulted in a reduction or cessation of growth and a loss of weight due to withdrawal of protein from less vital tissues. Similar results were reported by De Silva *et al.* (1991) on red tilapia and Hassanen *et al.* (1998) on thin-lipped mullet. In this context, Jauncey (1982) found that specific growth rate increased almost linearly with increasing dietary protein to energy (P/ E) ratios up to 40% CP and then reached a plateau, decreasing only slightly at much higher dietary protein levels of 48% and 56% CP. The results on the growth of female tilapia broodstock in our study were confirmed by those of Santiago *et al.* (1983) who found an increase in the mean total growth of all female breeders as the dietary protein level increased from 20 to 50%. The total growth of females fed with 20 %CP was 32.67 g that was significantly different from all other treatments while total growth of females fed with 50%CP was 57.95 g, representing a 72% increase over those fed with 20%CP. There was a corresponding increase in mean weight gain of the males as the dietary protein increased up to 50% and this was confirmed by the findings of our results. The present findings are also in a parallel line with those of Al-Hafedh *et al.* (1999) who tested different protein levels (25, 30, 35, 40 and 45 % CP) on gonad maturation, size and age at first maturity, fecundity and growth of Nile tilapia and found that the dietary protein level significantly ($P \leq 0.05$) influenced the mean body weight, SGR. Maximum growth was recorded for fish fed 40–45% protein diet. Inversely, El-Saidy and Gaber (2005) did not observe any significant increase in growth of Nile tilapia *O. niloticus* (61.9 g BW reared in concrete tanks) with increasing dietary protein levels from 25 to 30% CP. The increased growth performance parameters (AWG, ADG and SGR of Nile tilapia broodstock (both sexes) as affected by the dietary protein levels without the consideration of dietary protein sources in the present work may be also attributed to the higher protein to energy ratio (P/ E) of the 40% CP diets (diets 4, 5 and 6) as compared to the 25% diets (No. 1, 2 and 3). Dietary protein/energy ratios of the experimental diets were 69.40, 70.43 and 69.64 mg protein/K Cal ME for experimental diets (No. 1, 2, 3 respectively) and increased to 106.28, 106.26 and 103.06 mg protein/K Cal ME for the experimental diets (4, 5 and 6, respectively, Table1). These findings are in a disagreement with those reported by Siddiqui *et* *al.* (1988) and Shiau and Huang (1990) who recommended lower P/ E ratio (70-75 and 67.78 mg protein/K Cal) as the optimum P/E ratio for Nile and hybrid tilapia fingerlings. In contrast, many workers recommended much higher P/E ratios ranged from 104-137 mg protein/K Cal (El-Sayed and Teshima, 1992; Tahoun, 2002 and El-Waly, 1999). Recently, Jeremiah *et al.* (2007) stated that, dietary energy level significantly influenced the body composition of tilapia, *O. shiranus* and demonstrated that, to maximize growth, they should be fed diets containing 20.50 kJ/ g gross energy. It can easily noted that, there are a great discrepancies among investigators even for fish of the same species and size and this may be attributed to differences in feeding husbandry, limitations in the experimental design and other culture conditions (Tahoun, 2002). Supplying adequate amounts of energy in the diet are important, because if the energy is too high, the consumption of protein and other nutrients may be restricted leading to growth retardation. Furthermore, excess of energy may produce fatty fish, which can be undesirable, especially if it reduces the dress-out yield and decreases the durability of the frozen fish. When the diet is deficient in energy, protein may be catabilized to cover energy requirements resulting in poor growth. Reduction of the dietary protein requirements for maximum growth by increasing the non-protein energy (protein-sparing) should be a goal in fish nutrition (Magouz, 1990; Jauncey, 2000 and Naz *et al.*, 2005).

Table 5 . Effect of protein levels regardless of protein sources on growth performance of Nile tilapia, *Oreochromis niloticus* (L.) broodstock (Mean ± SE).

Treat.	Initial weight (g)		Final weight (g)		Weight gain (g)		ADG (g/ day)		SGR (%/ day)	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
T1	148.83a ± 1.49	136.67a ± 1.20	209.33b ± 2.51	188.83 ± 1.91	60.50b ± 3.85	52.17b ± 1.25	0.62b ± 0.04	٠,٤١b± 0.01	0.35b ± 0.02	0.29b ± 0.01
T2	145.17b ± 0.70	139.33a ± 1.63	216.50a ± 2.74	192.33a ± ٣,٢٣	71.33a ± 3.06	53.00a ± 2.53	0.73a ± 0.03	0.54a ± 0.03	0.41a ± 0.02	0.33a ± 0.02

Means in the same column having different letters are significantly (P≤0.05) different.

T1,- Broodstock fed 25% CP diet. T2 ,- Broodstock fed 40% CP diet.

Table 6. Effect of protein sources regardless of protein levels on growth performance of Nile tilapia *Oreochromis niloticus* (L.) broodstock (Mean ± SE).

Treat.	Initial weight (g)		Final weight (g)		Weight gain (g)		ADG (g/ day)		SGR (%/ day)	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
T1	149.3a± 1.80	138.5 a± 2.10	206.0 ± 1.96	186.8 b± 1.70	56.75c± 3.33	48.25c ± 103	0.59b ± 0.04	0.50 c ± 0.01	0.33c± 0.02	0.31c± 0.01
T2	146.8a± 1.18	136.8 a± 2.06	214.5 b± 2.78	189.5 b± 2.38	67.75b± 3.82	52.75b ± 0.85	0.68a ± 0.04	0.53 b ± 0.01	0.38b± 0.02	0.33ab± 0.01
T3	145.0a± 1.58	138.8a± 1.60	218.3a ± 3.09	195.5a ± 4.03	73.25a± 4.13	56.75a± 2.50	0.76a± 0.04	0.59a± 0.02	0.42a ± 0.02	0.35a ± 0.01

Means in the same column having different letters are significantly (P≤0.05) different

T1,- Broodstock fed dietary protein from plant source.

T2,- Broodstock fed dietary protein from a mixture of plant and animal

T3,- Broodstock fed dietary protein from animal protein source.

Recently, Abidin *et al.* (2006) determined the effects of different dietary protein levels on growth, body composition and egg quality in female catfish broodstock. Three semi-purified iso-energetic diets (395 kJ/ g) containing 30%, 35% and 40% CP. Fish fed the 35% protein diet had the significantly (P≤0.05) highest final weight and specific growth rate. Fish fed the 30% protein diet had the lowest carcass protein composition, indicating that this level is insufficient to fulfil the requirement of the female and hence, the need to utilize body reserves for gonadal development and maturation (Gunasekera *et al.* 1996; Al-Hafedh *et al.*, 1999). The increase in growth performance may be due to the efficient utilization of animal protein versus plant protein (had lower amino acids levels, Table 2). In this context, Jauncey (2000) stated that, however essential amino acids which may be chemically measurable in the dietary protein, this dose not necessarily mean that they will be biologically available and this should be also taken into account when considering the protein requirements. The significant effect of dietary protein sources without consideration of dietary protein levels was confirmed by the findings of Viola *et al.* (1988) who developed an animal protein-free diet of nutritional value equal to a standard commercial fishmeal based-diet. A diet based on soybean meal and supplemented with amino acids resulted in growth performance and body composition equal to those on a fish meal-based diet. In the same regard Pantha (1982) observed no significant differences in feed utilization efficiency of Nile tilapia fry fed diet containing 40% CP, when all of the dietary protein was supplied either from fish meal or from fish meal and full fat soybean at a ratio of 1,3 as well as the supplementation of DL-methionine. In this context, Santiago *et al.* (1983) found that the influence of increasing dietary crude protein on growth and spawning frequency of females is not considerable when, the diets contain high quality proteins (from fish meal and soybean meal) and the amounts of daily food allowance are at satiation level. Moreover, El-Waly (1999) worked on Nile tilapia and found that AWG, ADG and SGR significantly improved with increasing fishmeal protein in the diet and this was also supported by the results of Tacon (1993) and Eid *et al.* (1995) who stated the fact that fish meal has approximately similar amino acid profile as in fish tissues themselves. Comparable results were obtained by Tahoun (2002) on mono-sex Nile tilapia fingerlings. Rinchard *et al.* (2002) found that, the growth of male and female tilapia was significantly ($P \leq 0.05$) depressed during a 16-week period when fish were fed diets formulated to replace 75 or 100% of fish meal with cotton seed meal (plant protein source). It appears that cotton seed meal can be used to replace up to 50% of FM protein without compromising growth of tilapia. El-Sayed *et al.* (2003) reported that when fishmeal was completely replaced with a mixture containing 250 g/ kg soybean meal, 250 g/ kg cottonseed meal, 250 g /kg sunflower meal and 250 g/ kg linseed meal, replacement of 100% of fishmeal in diets fed to Nile tilapia, growth performance was not significantly impaired. Recently, Gaber (2006) cited that replacement of fishmeal (FM) is of prime importance in fish feed formulation and is likely to become even more so in the near future as FM availability just higher demand and prices for this commodity rises. The rising cost of FM has led to investigations of either lowering the FM content or replacing FM with less expensive plant protein sources. He demonstrated that as much as 50% of the FM protein could be replaced by broad bean protein in commercial production of Nile tilapia. From the above results, it can be concluded that, additional supplementation of methionine and lysine to these diets maintained a growth rate similar to that provided by the fishmeal based-diet. Addition of fishmeal to animal diets increases feed efficiency and growth through better food palatability, and enhances nutrient uptake, digestion, and absorption. The balanced amino acid composition of fishmeal complements and provides synergistic effects with other animal and vegetable proteins in the diet to promote fast growth and reduce feeding costs (Miles and Chapman, 2006).

Broodstock protein and feed utilization

As shown in Table 7, it is clear that feed intake, FCR, PER, PPV and EU (%) significantly ($P \leq 0.05$) affected by the six experimental treatments (2 protein levels X 3 dietary protein sources).

Table 7. Protein and feed utilization of Nile tilapia, *Oreochromis niloticus* (L.) broodstock (both sexes) as affected by dietary protein levels and sources (Mean ± SE).

Treat.	Feed intake (g)	FCR	PER	PPV (%)	EU (%)
T1	95.93 b ± 1.583	1.910 a ± 0.060	1.550 b ± 0.079	27.879 c ± 0.302	21.305 b ± 0.538
T2	106.94 a ± 1.660	1.845 a ± 0.350	1.494 b ± 0.012	27.387 c ± 0.738	21.819 b± 0.335
T3	111.11 ab ± 12.315	1.825 a ± 0.045	1.499 b ± 0.045	33.354 b ± 1.782	21.284 b± 0.371
T4	96.38 b ± 5.368	1.760 b ± 0.090	2.251 a± 0.071	39.104 a ± 1.052	21.442 b ± 0.245
T5	116.53 ab ± 2.793	1.865 a ± 0.015	2.318 a ± 0.044	40.846 a± 0.687	23.081± 0.572b
T6	125.70 a ± 4.263	1.815 b ± 0.055	2.346 a ± 0.058	38.866 a ± 0.431	26.879 a± 0.014

Means in the same column having different letters are significantly ($P \leq 0.05$) different.

T1,- Broodstock fed 25% CP diet from plant protein source.

T2,- Broodstock fed 25% CP die from a mixture of plant and animal protein source.

T3,- Broodstock fed 25% diet CP from animal protein source.

T4,- Broodstock fed 40% CP from plant protein source.

T5,- Broodstock fed 40% CP from a mixture of plant and animal protein.

T6,- Broodstock fed 40% CP diet from animal protein source.

Treatment No. 6 (broodstock fed 40% CP diet from animal protein source), significantly had the highest feed intake (125.70± 4.26 g), while T1 recorded the lowest feed intake value (95.93±1.58 g). The best protein efficiency ratio, FCR, PPV (%) and EU (%) values were recorded for T6 (broodstock fed 40% CP from animal protein source). The broodstock group fed 25% CP from plant protein source significantly (P≤0.05) showed the worst protein and feed utilization in terms of FCR, PER, PPV (%) and EU (%).

The effect of different protein levels regardless of dietary protein source on protein and feed utilization of Nile tilapia broodstock are shown in Table 8. There were significant (P≤0.05) differences between the dietary protein levels in terms of feed intake, FCR, PER, PPV% and EU%. The group fed the dietary protein level (40% CP) utilized protein and feed more efficiently than those fed the lower dietary protein level. (25% CP). The significant differences in FCR between 25 and 40% CP diets in our study was confirmed by the findings of El-Saidy and Gaber (2005) on Nile tilapia (61.9 g BW) reared in concrete tanks. The present results on nutrients (protein and energy) utilization of Nile tilapia broodfish are in disagreement with those obtained by El-Ebiary (1994) who found that, increasing the dietary protein level from 25 to 35%CP decreases the value of PPV (%) in tilapia.

Table 8. Protein and feed utilization of Nile tilapia, *Oreochromis niloticus* (L.) broodstock (both sexes) as affected by dietary protein levels regardless of sources (Mean ± SE).

Treatments	Feed intake (g)	FCR	PER	PPV (%)	EU (%)
T1	104.66 b ± 4.319	1.81 b ± 0.03	1.51 b ± 0.26	29.54 b ± 1.31	21.47 b ± 0.220
T2	112.87 a ± 5.80	1.86 a ± 0.27	2.31 a ± 0.03	39.61 a ± 0.52	23.80 a ± 1.09

Means in the same column having different letters are significantly (P≤0.05) different.
T1, - Broodstock fed 25% CP diet. T2, - Broodstock fed 40% CP diet.

The effects of different of protein sources regardless of protein level on feed and protein utilization of Nile tilapia broodstock (both sexes) are shown in Table 9. Feed intake, FCR, PER, PPV (%) and EU (%) were significantly affected by the source of dietary protein. Animal protein source (T3) significantly had the best values of the above measurements as compared to T1 (plant protein source) and T2 (the mixture of plant and animal protein source).

Table 9. Protein and feed utilization of Nile tilapia, *Oreochromis niloticus* (L.) broodstock (both sexes) as affected by dietary protein sources regardless of levels (Mean ± SE).

Treatments	Feed intake (g)	FCR	PER	PPV (%)	EU (%)
T1	96.1 b ± 2.29	1.84 a ± 0.06	1.60 b ± 0.21	33.49 b ± 3.271	21.37 b ± 0.25
T2	111.74 a ± 3.07	1.8 a ± 0.017	1.90 b ± 0.24	34.12 ab ± 3.907	22.45 ab ± 0.55
T3	118.40 a ± 6.78	1.82 b ± 0.029	1.92 a ± 0.25	36.11 a ± 1.758	24.08 a± 1.72

Means in the same column having different letters are significantly (P≤0.05) different.

T1,-Broodstock fed dietary protein from plant source.

T2,- Broodstock fed dietary protein from a mixture of plant and animal source.

T3,- Broodstock fed dietary protein from animal resource.

Shiau *et al.* (1987) cited that at 32% CP diets, the 30 %CP replacement from fish meal protein by soybean meal protein increased the feed conversion ratio significantly from (1.17) with diets (100% fish meal protein). Chengwei *et al.* (1988) found the best feed conversion ratio of tilapia, *O. niloticus* obtained when fed fish meal (1.13) than with soybean meal cake meal inclusion in diets (2.75). Davies *et al.* (1989) found that replacing fish meal protein from 25 to 75% increased the feed conversion of Nile tilapia as increasing soybean meal protein levels in diets from 2.32 for control diet (100% fish meal) to 2.52 for diet (75% soybean meal). Animal proteins and fats, by-products of the animal-rendering industry, can be used in aquaculture diets because they also provide essential amino acids and fatty acids. These "fishmeal substitutes" will be used more extensively by the aquaculture industry in the future (Miles and Chapman, 2006). From the results of the present study, it can be concluded that, in order to have efficient broodstock growth performance and protein and feed utilization, it is recommended to use diets containing high level (up to 40% CP) of good quality protein (from animal protein source).

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دراسة تأثير مستويات ومصادر مختلفة من البروتين علي كل من النمو وكفاءة الاستفادة من الغذاء في قطعان تفريخ أسماك البلطي النيلي

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أجريت هذه التجربة في مفرخ ومزرعة تجارية بمحافظة الإسماعيلية في موسم تفريخ ٢٠٠٤ بهدف دراسة تأثير استخدام مستويات و مصادر مختلفة من البروتين علي كل من أداء النمو وكفاءة الاستفادة من الغذاء والأداء التناسلي. تم اختبار مستويين مختلفين من البروتين(٢٥% و ٤٠% بروتين خام) من ٣ مصادر بروتينية رئيسية (مسحوق سمك ٦٥% بروتين خام؛ كسب فول الصويا ٤٤ % بروتين خام و خليط من مسحوق سمك ٦٥% + كسب فول الصويا ٤٤%) في تجربة عامليه و في مكررتين لكل معاملة (١٢ وحدة تجريبية) وتم دراسة المعاملات كما يلي ،-

المعاملة الأولي،-أسماك غذيت علي علائق ٢٥% بروتين خام من مصدر بروتين نباتي.

المعاملة الثانية،- أسماك غذيت علي علائق ٢٥% بروتين خام من خليط من مصدر بروتين نباتي وحيواني.

المعاملة الثالثة،- أسماك غذيت علي علائق ٢٥% بروتين خام من مصدر بروتين حيواني.

المعاملة الرابعة،- أسماك غذيت علي علائق ٤٠% بروتين خام من مصدر بروتين نباتي.

المعاملة الخامسة،- أسماك غذيت علي علائق ٤٠% بروتين خام من خليط من مصدر بروتين نباتي وحيواني.

المعاملة السادسة،- أسماك غذيت علي علائق ٤٠% بروتين خام من مصدر بروتين حيواني.

بينت قياسات معايير جودة المياه خلال الفترة التجريبية من شهر يونيو إلى شهر سبتمبر والتي شملت درجة حرارة المياه و pH والأكسجين الذائب في الماء والقلوية الكلية للمياه أن جميعها داخل المدى الملائم لحياة ونمو وتناسل قطعان التفريخ في أسماك البلطي النيلي. تأثرت معنوياً متوسطات الوزن النهائي والزيادة في وزن الجسم AWG ومعدل النمو اليومي والنوعي في كل من ذكور وإناث قطيع التفريخ المستخدم في الدراسة بالمعاملات

التجريبية (مستوى البروتين الغذائي ومصادره) ، حيث سجلت المعاملة السادسة (مستوى البروتين ٤٠% من مصدر حيواني) أفضل قيم لمقاييس أداء النمو مقارنة بالمعاملات التجريبية الأخرى، بينما لم تتأثر معنوياً قيم معدلات الحياة باختلاف المعاملات التجريبية والتي كانت جميعها ١٠٠%، كما تأثرت وبشكل معنوي قيم معايير النمو بمستوى البروتين في علائق قطيع التفريخ (بغض النظر عن مصادر البروتين الغذائي)، حيث تفوقت أسماك قطيع التفريخ المغذى على العلائق ٤٠% بروتين خام على مثيلاتها والتي تمت تغذيتها على مستوى ٢٥% بروتين خام في كل من متوسطات النمو المختلفة (متوسط الوزن الابتدائي والنهائي والزيادة في وزن الجسم ومعدل النمو اليومي والنوعي). بينما كانت الفروق في معدلات الحياة بين كل من مستويات البروتين المستخدمة في الدراسة غير معنوية إحصائيا.

بينت النتائج أيضا أن قيم مقاييس النمو المختلفة تأثرت معنوياً باختلاف مصدر البروتين الغذائي (بغض النظر عن مستوى البروتين الغذائي) حيث كانت أفضل قيم لهذه المعايير في أسماك المجموعة الثالثة (مصدر البروتين الحيواني) مقارنة بالمجموعات الأخرى والتي تغذت على البروتين النباتي (المجموعة الأولى) وخليط من البروتين النباتي والحيواني معاً بينما لم تكن لمصادر البروتين المختلفة أية تأثيرات على معدلات حياة الأسماك . وبالنسبة إلي كفاءة قطيع التفريخ في الاستفادة من البروتين والغذاء، سجلت المعاملة السادسة أفضل قيم لمتوسط الغذاء المأكول و الكفاءة النسبية للبروتين PER والقيمة الإنتاجية للبروتين(%) PPV وكفاءة الاستفادة من الطاقة (%) EU مقارنة بباقي المجموعات التجريبية الأخرى وتأثرت معنوياً قيم مقاييس الاستفادة من البروتين والغذاء بمستوى البروتين الغذائي في العلائق التجريبية (بغض النظر عن مصادر البروتين)حيث سجلت المعاملة الثانية (علائق ٤٠% بروتين خام) أفضل قيم لهذه المقاييس بالمقارنة بالمعاملة الأولى (علائق ٢٥% بروتين خام) كما تأثرت معنوياً قيم معايير الاستفادة من البروتين والغذاء بمصادر البروتين الغذائي (بغض النظر عن مستوى البروتين) حيث سجلت أفضل القيم لمجموعة الأسماك التي غذيت على مصدر بروتين حيواني مقارنة بأسماك كل من المجموعة الأولى (غذيت على مصدر بروتين نباتي) وأسماك المجموعة الثانية (غذيت على مصدر بروتين نباتي وحيواني) .