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EFFECT OF DIETARY PROTEIN LEVELS ON GROWTH PERFORMANCE, FEED UTILIZATION AND BODY COMPOSITION OF MONOSEX NILE TILAPIA (*Oreochromis niloticus*) FINGERLINGS.

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ABSTRACT

This study was conducted to determine the nutritional value of different protein levels of practical diets for Nile tilapia (*Oreochromis niloticus*) fingerlings (mean initial body weight 14.78g). The experimental diets were designed to contain four different dietary protein (CP) levels, 20(D1), 25(D2), 30(D3) and 35% (D4). The results showed that there were significant differences ($P<0.05$) among the final average body weight of fish (at the end of the 12 weeks feeding period). The average final body weights of fish fed the experimental diets were 99.62, 100.74, 107.32 and 116.91g for fish fed D1, D2, D3 and D4, respectively. Total feed intake was significantly ($P<0.05$) increased with increase in dietary protein level. The values of feed intake (FI) were 143.61, 149.22, 152.31 and 161.82g for tilapia fed D1, D2, D3 and D4, respectively. Also, specific growth rate (SGR) showed a similar trend with significant differences ($P<0.05$) among treatments with values being 2.29, 2.27, 2.37 and 2.45%/d for fish fed the four experimental diets in respective order. Feed conversion ratio (FCR) almost significantly ($P<0.05$) decreased with decreasing dietary protein level in the diet, being 1.69, 1.74, 1.64 and 1.59 for fish fed D1, D2, D3 and D4, respectively. Protein efficiency ratio (PER) decreased significantly for fish fed D3 (2.01) and D4(1.80) compared with the other two diets D1(2.60) and D2(2.27). Also, protein productive value (PPV) decreased with increasing dietary protein level with significant differences ($P<0.05$). The viscera-somatic index (VSI) and hepatosomatic index (HSI) showed significant differences ($P<0.05$) among treatments. Data of proximate analysis of whole fish bodies showed that dietary protein level had no significance different ($P>0.05$) in dry matter, protein and ash contents of whole fish body. Whereas, fish fed D3 and D4 had significantly ($P<0.05$) higher ether extract (EE) contents in their bodies compared with fish fed D1 and D2. The results of the present study indicated that, the optimal protein requirements of monosex Nile tilapia fingerlings reared in fiberglass tanks ranged between 30 and 35% without any natural foods.

Keywords: Monosex Nile tilapia, Dietary crude protein, Growth performance, Feed utilization, Whole body composition.

INTRODUCTION

Many studies have been focused that the optimum dietary protein level for growth of Nile tilapia (*Oreochromis niloticus*) is 40% for fry and 30% for juvenile (40g) and young tilapia (96-264g) and decrease as fish grow (Siddiqui *et al.*, 1988 and Al-Hafedh, 1999). Also, NRC (1993) reported a 32% dietary protein requirement for the grow out of tilapia.

The level of dietary protein produce maximum fish growth varied between 25 and 56% (Jauncey, 1982; Magouz, 1990; El-Dahhar, 1994; Wu

et al., 1996 and Hassanen, 1997). The most important factors affected the optimum dietary protein level for fish are feeding rate, fish size, fish species, environmental conditions, quality of protein and dietary energy contents (Lovell, 1998). Also, the optimum dietary protein level for fish is affected by the balance between dietary protein and energy (P/E ratio), amino acid, composition, protein digestibility, the physiological status of the fish and feed intake level (Jauncey and Ross 1982). Furthermore, protein in the high protein diets may be used as energy source, therefore more ammonia is produced and more energy is lost as heat (Cho and Kaushik, 1985).

Egyptian aquaculture in the recent years has developed rapidly. Nile tilapia is the most widely cultured species in Egypt. It has been expanded dramatically in recent years in Egypt and worldwide (El-Sayed, 2006). However, it is important to consider various protein levels and how they may affect tilapia growth and feed utilization. Total aquaculture production of tilapia increased from 24916 metric tonnes in 1990 to ¥486000 metric tonnes year^{-1} in 2005 in Egypt (GAFRD, 2006). The most important and economical species of tilapia are *Oreochromis niloticus*, *O. aureus* and *Sarotherdon galilacus* (FAO, 2004).

The choice of species for farming depends mainly on dietary protein requirement, fry and fingerlings availability, growth rate and environmental tolerance. The best one for culture under warm water temperature is Nile tilapia. There is a little information available concerning the effects of dietary protein levels on Nile tilapia reared in fiberglass tanks where natural food is not available.

The purpose of the present study was to determine the effect of graded dietary protein levels on growth performance, feed efficiency and body composition of mono sex Nile tilapia fingerlings reared in fiberglass tanks to evaluate the optimal protein requirements for tilapia fingerlings.

MATERIALS AND METHODS

Experimental diets

Four experimental diets were formulated to contain variable protein levels. Chemical composition for all ingredients of crude protein, lipid, ash and crude fiber were described in Table (1). All diets were designed to be nearly equal in gross nutrient terms and were adjusted at appropriate levels to contain 20(D1), 25(D2), 30(D3) and 35%(D4) crude protein, 10.62-11.41% lipid and 4341.6-4543 Kcal gross energy / kg diet.

Table (1): Chemical composition (%DM basis) different feed ingredients used for formulating the experimental diets.

Items	DM	CP	EE	Ash	CF	NFE
Herring fish meal	93.10	72.30	9.80	13.62	0.80	3.48
Soybean meal	92.30	43.86	1.70	6.93	9.22	38.29
Corn gluten meal	91.70	60.30	2.40	٢,٥٢	١,٩٠	٣٢,٨٨
Wheat bran	88.77	14.60	3.92	6.37	12.32	62.79
Yellow corn	89.61	9.43	4.21	1.62	5.12	79.62

Table (2) shows the proximate feed formulation and composition of the experimental diets. All ingredients used in the experimental diets were obtained from the local market. They were ground to pass though a 1mm mesh screen and processed into 3mm diameter pellets using a mincing machine with 3mm die {(Hergestellt in der Deutschen Demokratischen Republik (ASCOBLOC) Kenn-Nr (HU-1)} at Faculty of Agriculture, Al-Azhar University Cairo, and the pellets were sun dried.

Table (2): Formulation and chemical composition (% DM basis) of the experimental diets fed to monosex Nile tilapia.

Diet No. / Feed Ingredients	D1 20% CP	D2 25% CP	D3 30% CP	D4 35% CP
Fish meal	5.00	10.00	18.00	24.00
Soybean meal (SBM)	18.00	20.00	20.00	20.00
Corn gluten meal (CGM)	6.00	7.00	6.00	10.00
Wheat bran	20.00	20.00	20.00	15.00
Yellow corn	35.00	30.00	25.00	15.00
Corn oil	8.00	6.50	6.00	6.00
Dl-methionine	1.00	1.00	—	—
L-lysine	0.50	0.50	—	—
Vit. & Min. mix.[1]	3.00	3.00	3.00	3.00
Binder[2]	2.00	2.00	2.00	2.00
Cellulose	1.50	—	—	5.00
Chemical composition (on DM basis).				
DM	91.66	92.89	92.21	92.74
CP	20.79	25.30	30.22	34.85
EE	11.06	10.86	11.41	10.62
CF	8.21	7.64	6.32	7.21
Ash	9.42	9.86	10.21	10.68
NFE[3]	50.52	46.34	41.84	36.64
GE Kcal/Kg[4]	4341.6	4402.0	4543.0	4511.7
ME Kcal/Kg[5]	2503.9	2596.9	2760.8	2795.2
P/E ratio[6]	83.03	97.42	109.46	124.68

[1]Vitamins & minerals mixture : each 1 kg contains : Vit A, 4.8million IU; D_3, 0.8million IU; E, 4g, K 0.8g,; B_1 0.4g, B_2 1.6g, B_6 0.6g; B_{12} 4g, Pantothenic acid 4g; Nicotinic acid 8g; Folic acid 400mg; Biotin 20mg; Choline chloride 299g; Copper 4g; Iron 12g; Manganese 22g; Zinc 22g; and Selenium 0.04g.

[2]Carboxymethyl Cellulose

[3]Nitrogen free extract (NFE) = 100-(CP+EE+CF+Ash).

[4]Gross energy (GE) calculated using the factors 5.65, 9.45 and 4.2 Kcal/g for CP, EE, and NFE, respectively according to Hepher, *et al.*, 1983.

[5]Metabolizable energy (ME) calculated usin the factors 3.9, 8.0 and 1.6 Kcal/g for CP, EE, and NFE respectively (NRC, 1993).

[6]mg protein /Kcal ME.

Experimental fish

Hormone treated monosex all male Nile tilapia (*O. niloticus*) were obtained from Abbassa Fish Hatchery, Abouhammad, Sharkia Governorate, Egypt. After one week adaptation period, a number of fish representing about

25% of the population was netted from the stock tank and weighed individually to obtain the nearest average initial weight of the experimental fish. A total number of 256 fingerlings with initial average body weight (14.78g) was randomly distributed among 8 fibreglasses at 32 fish per tank; two replicate tanks were used for test each experimental diet. All experimental fish were weighed biweekly to adjust the daily feed intake. Forty fish at the beginning of the experimental were stored frozen (at –20 ^{0}C) to determine the initial body composition. Six fish were randomly collected from each treatment at the end of the experiment to determine the whole body proximate composition. Also, six fish were randomly collected from each treatment at the end to remove the liver and viscera to determine the HSI and VSI. All experimental fish were apparently healthy.

Feeding regime and Experimental system

The feeding experiment was conducted at the Fish Experimental Station belonging to Department of Animal Production, Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt. The experimental fish were stocked in eight rectangular fiberglass tanks (1 × 2 × 0.5m) supplied with dechlorinated tap water through a closed water recycling system provided with mechanical and biological filter tanks. Fish were fed for one week for acclimatization to each test diet, the experimental system and to free their gastrointestinal tract from the pre-experimental diet until the feeding response was uniform. Fish were fed twice daily by hand at a rate of 3% body weight throughout the experimental period (12 weeks). Tank water was aerated continuously using an air compressor (Fini compressors, Type 132, HP 15 KW, Phase 3 Hz 50) provided by filters (HiROSS HF No. 24). Water quality parameters were determined at the start of the experiment and every week thereafter, dissolved oxygen was ranged between 5-7.5 mg/l determined using an oxygen meter (Jenway model 9070). Water temperature was measured using the same apparatus and ranged between 24-27 ^{0}C, pH was determined via a pH meter (Jenways model). Toxic ammonia (NH_3), nitrite (NO^{-}_2), nitrate (NO^{-}_3) and total ammonia were monitored weekly and remained at acceptable levels throughout the experimental period using 722 Grating spectrophotometer.

Proximate analysis

Proximate analysis of feed ingredients, diets and whole fish body were performed according to AOAC (1990) for dry matter (DM), crude protein (CP) ether extract (EE) ash and crude fiber (CF%, for the feeds only).

Statistical analysis

All data were statistically analyzed by applying SAS program (Statistical Analysis System, 1999) using one-way analysis of variance (ANOVA). Duncan's Multiple Range test (1955) was used to compare between treatment means. Differences were considered significant at 0.05 probability level. All statistical analysis were performed using.

RESULTS AND DISCUSSION

Growth performance

Growth performance and feed utilization data for monosex Nile tilapia (*Oreochromis niloticus*) fingerlings fed the experimental diets are shown in Table (4). Average of initial body weight ranged between 14.61 and 14.96g with insignificant differences ($P>0.05$) among the treatments. There were significant differences among the final average body weights of fish fed different experimental diets. The final average body weights were (99.62, 100.74, 107.32 and 116.91g) for D1(20), D2(25), D3(30) and D4(35%CP), respectively and there was no significant difference between fish fed D1 and D2. Also, average weight gain values were 85.01, 85.83, 92.68 and 101.95g for fish fed diets contained 20, 25, 30 and 35% CP, respectively. These results indicated that body weight and weight gain of Nile tilapia (*Oreochromis niloticus*) fingerlings increased with increasing dietary protein level. The highest weight gain (101.95g) was attained in fish group fed D4 followed by those fed diet D3 (92.68g), while the lowest weight gains values (85.01 and 85.83g) were observed for fish fed D1 and D2, respectively.

These results revealed that the dietary crude protein requirements for Nile tilapia fingerlings reared in tanks lie between 30 and 35% CP, since diets containing 20 and 25% crude protein had more plant ingredients as protein sources, which may be deficient in some essential amino acids (Table 3) compared with diets contained 30 and 35% crude protein that contained sufficient level of fish meal (Table 2) . These results are in accordance with those of Abdel-Hakim and Mustafa (2000) who found that dietary protein requirements of Nile tilapia *Oreochromis niloticus* reread in cages depending only on artificial feeds lie between 28 and 30%. Also, Abdel-Hakim *et al.* (2001) reported that increasing dietary protein level from 25 to 30% increased fish body weight. Cisse (1996) demonstrated that tilapia fed a 20% crude protein diet showed poorer weight gain compared to fish fed 30% crude protein diet. Also, Ng and Hanim (2007) found that increasing the dietary protein level by 10% led to a further 10% increased in the final weight gain of genetically improved farmed tilapia but no further increase was observed in weight gain of hybrid red tilapia fed 25 and 35% dietary CP. Results of the present study are also in agreement with the finding of Zheng *et al.* (1988), Ragab and Hanafy (2002), Soltan *et al.* (2002) and Wafa (2002), they reported that increasing protein percent in diets increased the growth of fish.

Also, El-Dahhar and Lovell (1995) demonstrated that weight gain of *Oreochromis niloticus* fry increased by increasing dietary protein level from 23 to 30%. In the present study, the results indicated that metabolizable energy level ranged between 2503.9 – 2795.2 kcal/kg in the diet affected also growth. These results are in accordance with those of Ragab and Hanafy (2002), they demonstrated that final weight of *Oreochromis niloticus* fingerlings increased with increasing protein content from 25 to 30% with the lowest and moderate energy metabolizable levels (3000 – 3400 kcal/kg), while it decreased for fish fed the highest metabolizable energy level (3800 kcal/kg).

Table (3): Essential amino acids profile (g/100g protein) for herring fish meal (HFM), soybean meal (SBM), corn gluten meal, yellow corn (YC) and wheat bran (WB).

Amino acids	HFM	SBM	CGM	YC	WB
Arginine	4.54	3.39	2.02	0.43	0.86
Cystine	0.74	0.70	1.20	0.22	0.26
Histidine	1.65	1.19	1.31	0.26	0.39
Isoleucine	3.13	2.02	2.54	0.35	0.51
Leucine	5.19	3.49	10.20	1.21	0.92
Lysine	5.57	2.85	1.11	0.25	0.58
Methionine	2.08	0.57	1.63	0.17	0.19
Phenylalanine	2.71	2.22	3.96	0.48	0.55
Threonine	2.90	1.78	2.07	0.35	0.46
Tryptophan	0.77	0.64	0.43	0.08	0.25
Valine	4.30	2.02	3.09	0.44	0.69

NRC (1993)

Specific growth rate Table 4 showed that SGR values were 2.29, 2.27, 2.37 and 2.45%/d for fish fed D1, D2, D3 and D4, respectively with significant differences ($P<0.05$). These results indicated that SGR for tilapia increased with each increase in protein level. Soltan *et al.* (2002) and Ogunji and Wirth (2000) came to the same conclusion with tilapia fish, they found that SGR increased with increasing dietary protein level. These results are in accordance with the results of the present study. Also Abdel-Hakim and Mustafa (2000) found that SGR of Nile tilapia reared in cages improved with each increase in the dietary protein level fed from 20 to 32% protein. Also, Eid (2005) found similar results of final body weight and SGR increased as the dietary protein level increased from 32 to 36% for grey mullet (*Mugil cephalus*).

Al-Hafedh (1999) found that growth rate of Nile tilapia was significantly increased as dietary protein level increased from 25 to 45% (with increment of 5%). Abdel-Hakim *et al.* (2001) found that SGR for *Oreochromis niloticus* reared in fiberglass tanks was improved when dietary protein level increased from 25 to 30%. Also, Ahmed *et al.* (2004) pointed that protein requirement for Nile tilapia is depending on the size; however, fry need 45% CP, fingerlings need 35% CP and fattening fish need 25% CP.

In contrast, Clark *et al.* (1990) reported that SGR of Florida red tilapia did not differ significantly when fish fed diets contained 20, 25 or 30% crude protein. Results obtained in the present study of SGR Table (4) indicated that the highest values were 2.37 (30%CP) and 2.45 (35%CP) were recorded for fish fed diets contained 109.46 and 124.68 P/E ratio Table (2), respectively. While the lowest SGR values were shown for fish fed 20 and 25% dietary CP which contained P/E ratio 83.03 and 97.42, respectively. These results indicated that there is a relationship between the content of protein level in the diet and energy level (P/E). Therefore, it is to be suggested that diet for tilapia may incorporate on basis of P and E considerations. Soltan *et al.* (2002) found that increasing dietary protein level increased SGR but dietary

energy level had the opposite effect. Results of the current study are in agreement with those found by Siddiqui *et al.* (1988), they reported that the best growth was obtained when Nile tilapia *Oreochromis niloticus* fed diets differ in P/E ratio (68, 107, 145 and 175mg protein/kcal).

Table (4): Growth performance and feed utilization values (x̄ ± SE) of monosex Nile tilapia fingerlings fed the experimental diets.

Items \ Diet No.	D1 (20%CP)	D2 (25% CP)	D3 (30% CP)	D4 (35%CP)
Mean initial body weight (g)	14.61±0.35	14.91±0.67	14.64±0.82	14.96±0.44
Final body weight (g)	99.62^{c}±2.41	100.74^{c}±1.73	107.32^{b}±1.82	116.91^{a}± 1.62
Weight gain (g)	85.01^{c}±0.84	85.83^{c}±0.86	92.68^{b}±0.1.23	101.95^{a}±1.41
SGR[3] (%/d)	2.29^{c}±0.06	2.27^{c}±0.04	2.37^{b}±0.04	2.45^{a}±0.05
Total feed intake (g/fish)	143.61^{d}±3.71	149.22^{c}±4.12	152.31^{b}±3.26	161.82^{a}±2.89
Protein consumption (g/fish)	28.72^{d}±1.81	37.75^{c}±1.32	46.03^{b}±1.64	56.64^{a}±1.59
FCR[2]	1.69^{a}±0.07	1.74^{a}±0.12	1.64^{b}±0.09	1.59^{b}±0.08
PER[3]	2.60^{a}±0.08	2.27^{b}±0.10	2.01^{c}±0.13	1.80^{d}±0.06
PPV[4] (%)	42.43^{a}±0.49	33.01^{b}±0.56	27.47^{c}±0.78	24.54^{c}±0.64
HSI[5] (%)	1.98^{c}±0.08	2.12^{c}±0.07	2.36^{b}±0.08	2.62^{a}±0.10
VSI[6] (%)	1.73^{c}±0.05	1.74^{b}±0.03	1.78^{ab}±0.04	1.82^{a}±0.03

[1] Specific growth rate (SGR): (Ln final BW -Ln initial BW /experimental period) ×100
[2] Feed conversion ratio (FCR): Feed intake (g)/body weight gain (g).
[3] Protein efficiency ratio (PER):Body weight gain (g)/protein intake (g).
[4] Protein productive value (PPV) : (Retained protein (g) / protein consumption (g)) ×100
[5] Hepatosomatic index (HSI) : (Liver weight (g)/fish weight (g)) ×100
[6] Viscera-somatic index (VSI): (viscera weight (g)/fish weight (g)) × 100
Values within the same row with the same superscript are not significantly different ($P > 0.05$)

Feed intake and feed utilization

As shown in Table (4), feed intake (FI) values were 143.61, 149.22, 152.31 and 161.82 for groups fed D1, D2, D3 and D4, respectively with significant differences ($P<0.05$) among the treatments. These results indicated that, as protein content in Nile tilapia diets increased feed intake increased significantly ($P<0.05$). These data are in accordance with those obtained by El-Dahhar, (2000) and Soltan *et al.* (2002) who reported that, feed consumption increased as dietary protein level increased for tilapia fry. Also, these results indicated that amount feed intake was increased with increasing P/E ratio and this agrees with results of Wafa (2002) who demonstrated that feed intake of hybrid tilapia (*Oreochromis niloticus* × *Oreochromis aureus*) increased with increasing P/E ratio.

Feed conversion ratio (FCR), Table 4 values were 1.69 1.74, 1.64 and 1.59 for fish fed D1, D2, D3 and D4, respectively with significant differences ($P<0.05$). These data indicated that FCR was improved with increasing dietary protein level. This was in agreement with the findings of Siddiqui *et al.* (1988), Cisse (1996) and Al-Hafedh (1999). They reported that FCR of Nile tilapia was improved with increasing dietary protein level. Abdel-

Hakim *et al.* (2001) demonstrated that increasing dietary protein level from 25 to 30% improved FCR of Nile tilapia.

Protein efficiency ratio (PER) results in Table 4 were significantly different (*P<0.05*), with values of 2.60, 2.27, 2.01 and 1.80 for tilapia fed D1, D2, D3, and D4, respectively. Soltan *et al.* (2002) came to the same results, who reported that increasing protein level in the diets for tilapia lowered PER. Also, Shiau and Huang (1989) found that PER for hybrid tilapia (*Oreochromis niloticus* × *Oreochromis aureus*) fed purified diets containing 0% to 56% protein was improved with increasing dietary protein level. On the other hand, Abdelhamid *et al.* (1997) and Twibell and Brown (1998) reported that PER was unaffected when dietary protein level increasing from 25 to 35% for *Oreochromis niloticus*. However, the current study indicated that PER was improved with increasing dietary P/E ratio in the diet, this is in agreement with data obtained by Soltan *et al.* (2002).

Results of protein productive value (PPV%) of Nile tilapia as affected by the treatments (Table 4) showed with significant differences (*P<0.05*) among D1, D2, D3 and D4 which decreased with increasing dietary protein level, values were 42.43, 33.01, 27.47 and 24.54%, respectively. These results are in agreement with Ng and Hanim (2007) who found that protein efficiency ratio and net protein utilization were influenced by diets contained 25 and 35%CP for tilapia genotype. Values of PER and PPV% are used as indicators of protein quality and quantity in the fish diets and fish body. So that, these parameters are used to determine protein utilization and turnover, where they are related to dietary protein consumption and its conversion into protein gain.

Hepato-somatic index (HSI) significantly (*P<0.05*) increased with each increase in dietary protein level (Table 4). Values for tilapia fed D1, D2, D3 and D4 being 1.98, 2.12, 2.36 and 2.62%, respectively. These results are in accordance with those of Peragon *et al.* (1994) who reported that high protein diet resulted in a higher efficiency in feed utilization, higher growth rates and moderate alternation in the myosomatic and hepatosomatic ratio evolution curves.

The viscera-somatic index (VSI) data also showed similar trend as that observed with HSI in tilapia fish sampled at the end of the study. Values obtained were 1.73, 1.74, 1.78, and 1.82% for fish fed D1, D2, D3 and D4, respectively indicating that VSI increased with each increase in dietary protein level, but the differences were mostly not significant.

Proximate analysis of whole fish body

Data of proximate analysis of whole fish bodies of all dietary treatments are presented in Table (5). The dry matter contents of whole body of fish were 25.78, 26.31, 24.62 and 24.82% for fish fed D1, D2, D3 and D4, respectively. The differences in DM contents were not significant (*P>0.05*) and the same trend was also observed for ash percentages, being 23.62, 23.71, 22.31 and 22.02% for fish fed the four dietary protein levels tested in the current study in respective order. These results are in agreement with those of Eid (2005) who reported that the ash content was unaffected by different dietary protein levels. The obtained results revealed no significant differences (*P>0.05*) among treatment in protein content of whole body

composition with values of 54.01, 53.49, 54.21 and 55.98% for fish fed D1, D2, D3 and D4 respectively. These results agree with those obtained by Abdel-Gawad *et al.* (2002). However, Winfree and Stickney (1981) reported that carcass protein content was not clearly affected by dietary protein to energy ratio. Also, the results of whole body protein content are in agreement with those reported by Shiau and Huang (1990), El-Dahhar and Lovell (1995) and Staat (1997).

Average percentages of ether extract (EE) content in whole body are presented in Table (5). Protein level in the diets have a significant ($P<0.05$) effect on EE content of the whole body which ranging between 20.14 to 22.51%. These results also indicated that diets contained high energy (Table 2) gave high EE content in the whole body, this might be due to increased the energy level in the diets. These results are in agreement with those of Abdel-Gawad *et al.* (2002) they pointed out that the content of EE of the whole fish body composition was significantly increased by increasing dietary energy level.

The inferior performance of fish receiving the low protein diets compared with those receiving the high protein diets, in most studies, is possibly a result of tne lower availability of nutrients and amino acids imbalance as well as the different size of fish. Also, the palatability of low protein diets for fish is a problem and should be addressed for even omnivorous fish such as tilapia. Therefore, protein is probably the most important nutritional contributor to growth, because it provides the necessary amino acids for maintenance and enlargement of muscle mass, which takes place during development and growth. In the present study, (comparing the effects of four diets containing different levels of protein), high protein diet resulted in a higher efficiency in feed utilization, higher growth rates and slightly increase in the hepatosomatic and viscera-somatic indices. Diet containing insufficient protein caused a significant decrease in weight gain, probably due to the fact that most of the protein and other dietary nutrients were used for maintenance of the basal metabolic rate, making them unavailable for growth precursors

Table (5): Proximate analysis (% on dry matter basis) of whole body of monosex Nile tilapia fed the experimental diets.

Proximate composition	Initial fish	D1 (20%CP)	D2 (25%CP)	D3 (30%CP)	D4 (35%CP)
Dry matter	21.43	25.78^{a}±0.32	26.31^{a}±0.26	24.62^{a}±0.37	24.82^{a}±0.21
Protein	53.65	54.01^{a}±0.52	53.49^{a}±0.68	54.21^{a}±0.48	55.98^{a}±0.59
Ether extract	23.51	20.14^{b}±0.24	20.61^{b}±0.18	22.51^{a}±0.12	22.00^{a}±0.22
Ash	22.83	23.62^{a}±0.14	23.71^{a}±0.09	22.31^{a}±0.11	22.02^{a}±0.21

Values within the same row with the same superscript are not significantly different ($P>0.05$).

In conclusion, results of the present study indicated that diets containing 30 and 35% crude protein fed at 3% body weight/day appear to be suitable for monosex Nile tilapia (*Oreochromis niloticus*) fingerlings reared in fibreglass tanks. It can be concluded that a diet including high protein level showed significant increase in weight gain and improved feed utilization.

Future investigation should consider some important factors such as environmental factors, protein to energy ratio and amino acids supplementation. Also, it is more important to carry out such experiments under field conditions. So that, recommended dietary protein for tilapia might be less than 30% when tilapia cultured in earthen pond, rich in natural food. Also, the proper balance between dietary protein and energy is essential in tilapia feed formulation.

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تأثير مستوى البروتين في العليقة على أداء النمو والاستفادة الغذائية وتركيب الجسم في اصبعيات البلطي النيلي وحيد الجنس.

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أجريت هذه الدراسة لتقدير القيمة الغذائية لمستويات مختلفة من البروتين في علائق اصبعيات البلطي النيلي وحيد الجنس، وكان متوسط الوزن عند بداية التجربة ١٤,٧٨جم. استخدمت في هذه الدراسة أربعة علائق تحتوى على أربع مستويات من البروتين، وهى عليقه ١ (٢٠%)، عليقه ٢ (٢٥%)، عليقه٣ (٣٠%)، وعليقه ٤ (٣٥%) بروتين خام. وأظهرت النتائج في نهاية التجربة (١٢ أسبوعا) أن هناك اختلافات معنوية في الأوزان النهائية للأسماك بين المعاملات المختلفة وكان متوسط الوزن النهائي ٩٩,٦٢، ١٠٠,٧٤، ١٠٧,٣٢ و ١١٦,٩١جم للأسماك التي غذيت على العلائق ١، ٢، ٣ و ٤ على التوالي. وكذلك كان هناك تأثير معنوي على الغذاء المستهلك بين المعاملات والتي زاد مع زيادة نسبة البروتين في العليقة، وكانت النتائج المتحصل عليها كالآتي ١٤٣,٦١ ، ١٤٩,٢٢ ، ١٥٢,٣١ ، ١٦١,٨٢ جم/سمكة للعلائق ١ ، ٢ ، ٣ ، ٤ على التوالي. وكذلك أظهرت النتائج أن معدل النمو النوعي له نفس الاتجاه مع اختلافات معنوية، وكانت النتائج كالتالي ٢,٢٩ ، ٢,٢٧ ، ٢,٣٧ و ٢,٤٥ %/ يوم لعلائق التجربة. وأظهرت نتائج التحويل الغذائي أن أقلها كانت للأسماك التي غذيت على علائق منخفضة في نسب البروتين وكانت كالتالي ١,٦٩ ، ١,٧٤ ، ١,٦٤ و ١,٥٩ للعلائق ١ ، ٢ ، ٣ و ٤ على التوالي. وكذلك كفاءة تحويل البروتين أظهرت انخفاضا في الأسماك التي غذيت على العليقتين ٣(٢,٠١) و ٤(١,٨٠) عند مقارنتها مع العليقتين ١(٢,٦٠) و ٢(٢,٢٧). وكذلك هناك اختلافات معنوية في قيم البروتين المنتج في الجسم (PPV) والتي انخفضت مع زيادة نسبة البروتين في العليقة. وأظهر الفحص الداخلي للكبد والأمعاء أن هناك اختلافات معنوية بين المعاملات. وبالنسبة للتركيب الكيميائي أظهر أنه ليس هناك اختلافات معنوية في المادة الجافة ونسبة البروتين والرماد في جسم أسماك البلطي بينما كان هناك اختلاف معنوي ملحوظ في نسبة الدهن بين المعاملات. ودلت هذه الدراسة على أن احتياجات اصبعيات أسماك البلطي النيلي وحيد الجنس المربأة في أحواض الفيبرجلاس من البروتين والحد الأمثل له تتراوح بين ٣٠ و ٣٥% دون وجود تغذية طبيعية في مياه الأحواض. وأدت هذه التجربة إلى تحسن في أداء النمو وكفاءة تحويل الغذاء دون حدوث أي مشاكل صحية للأسماك خلال فترة التجربة.