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RELATIONSHIP BETWEEN PROTEIN QUALITY AND LIPID LEVELS IN TILAPIA, *Oreochromis niloticus*, FEEDS

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ABSTRACT

This experiment was conducted at Regional Center for Food and Feed (RCFF), to determine the capability of tilapia, *Oreochromis niloticus*, to utilize high levels of dietary lipid in compensation for the poor quality of dietary protein. Three types of dietary protein quality were used, the first type contained 18% fish meal, the second type contained 9% fish meal and the third one composed of plant ingredients. Each type of feed was supplemented with corn oil to contain either 5% or 12% lipid. These experimental diets were fed for 7 weeks to triplicate groups of tilapia. Weight gain was not statistically different ($p \geq 0.05$) among the experimental groups of fish. Feed conversion, was statistically affected ($p \leq 0.05$) by increasing dietary lipid at the whole plant ingredient diets. The efficiency by which the feeds were converted into live weigh gain indicated that increasing lipid levels in tilapia, *Oreochromis niloticus*, feeds up to 12% did not economically reduce the feeding cost of one Kg of fish.

INTRODUCTION

Tilapia as well as other fish spices required high levels of protein of excellent quality in their prepared feeds. Fish meals has been used as the major protein source in fish feeds (Lovell, 1981) .The exceptionally high price of fish meal and expected reduction in the fish meal supply have urged toward exploring alternative protein sources to be used in formulating fish diets (El Sayed, 1990; Kaushik, 1990; Hilton and Slinger,1986; Jackson *et al.*,1982; Reinitz,1980). However, Fish meal has come closest to being the "ideal" protein source for fish diets. Therefore, most fish diets should have a significant proportion of Fish meal (Ross, 1989). Consequently, protein is responsible for a large part of the cost of feeds.

The protein- sparing action by dietary Lipid in fish has been quantatively reported (Hassanen *et al.*, 1998; Chou and Shiau, 1996; De Silva *et al.*, 1991; El Sayed and Garling, 1988). It will be useful to determine and utilize the protein- sparing capabilities of lipid in fish diet. This may help in the formation of cost effective diets. (Hassanen *et al.*, 1998).

The present study was carried out on (*Oreochromis niloticus*) fingerlings to determine their response to a series of diets of different protein quality at two lipid levels and thereby their protein- sparing capabilities. Growth performance, feed efficiencies, body chemical composition of fish, and feed conversion economic efficiency were studied.

MATERIALS AND METHODS

The experiment was carried out at regional Centre for Food and Feed for a period of 7 weeks, using a mixed sex Nile tilapia (*Oreochromis niloticus*, 8, 7 g average weight) fingerlings purchased from Elwafaa farm ,Giza ,Egypt).

The experimental system was a closed recirculating water system consisting of 18 fiberglass aquarium of 60 liter (L) each, water flow out of each aquarium 2L/min into a submerged bio filter after passing through a mesh net to remove solid impurities. Water was then collected in a common reservoir from which the filtered water is pumped up to the rearing units. The water used in the system was stored-tap water, which was aerated using a blower aerator-type. Five percent of the total water volume was renewed daily. A thermo controlled electric heater was used to adjust water temperature. Range of values representing water quality is shown in the table (1).

The fish were kept in plastic tanks into 18 groups of fish. Each group was transferred into the rearing aquarium and kept for a period of 2 weeks to be accustomed to the laboratory conditions before the implementation of the experimental treatments.

Table (1): Ranges of water temperature °C, pH, dissolved oxygen, ammonia and nitrate mg/L during the feeding experiment.

Temperature °C	pH	Dissolved O_2 mg/L	Ammonia mg/L	Nitrate mg/L
25-28	6.5-7.5	5.5-6.7	Not detected	39-42.5

Six experimental diets belonging to three series of protein quality. The first series consisted of two diets that contained a mixture of fish meal (18%), plant protein sources and 5% or 12% lipid, each (diets ALL and AHL, respectively). The second series consisted of two diets that contained a mixture of fish meal (9%), plant protein sources supplement with DL-methionine and lysine-HCl and 5% or 12% lipid, each (diets BLL and BHL, respectively). The third series consisted of two diets that contained only plant protein sourced supplemented with DL-methionine, lysine HCl and 5% or 12% lipid, each (diets CLL and CHL, respectively). All diets were isonitrogenous and cover amino acid requirements for tilapia. Table 2 shows the diets formulation, table 3 shows their chemical composition and table 4 shows their amino acids composition.

Feed ingredients were finely grinded and different ingredients were mixed manually. Water was added to each diet till paste was formed and then passed through a meat mincing machine to convert the mixture into pellets. The wet pellets were sundried and stored at -4°C. Each diet was fed to the three replicate groups of 15 fish, each at daily rate of 3% of body weight for 7 weeks. At the 7th day of each week, fish in each aquarium were weighed and the percentage of the ration offered was altered according to their weight change. At the beginning of the experiment, one hundred fish were killed, as a control group and were kept frozen for chemical analysis. At the end of the experimental period, fish of each aquarium were killed.

Analysis of the different experimental feed ingredients, formulated diets and whole fish body were carried out for moisture, nitrogen, ether extract, crude fiber according to the procedures of the Association of the Official Analytical Chemists (A.O.A.C., 2000). Amino acids were determined according to (Official methods of analysis of AOAC international 18th Edition, 2005 Current through revision1, 2006).

Means of weight gain (wg) and relative weight gain (wg %) were calculated as follows:

$$Wg = w_1 - w_0$$

$$Wg\,\% = \frac{w_1 - w_0}{w_0} \times 100$$

Where w_0 means initial weight and w_1 means final weight.

Averages of feed conversion ratio (FCR), protein efficiency ratio (PER) and protein retained were calculated as follows:

$$FCR = \frac{\text{Feed intake (g)}}{\text{wg (g)}}$$

$$PER = \frac{\text{Weight gain (g)}}{\text{Protein intake (g)}}$$

$$\text{Protein retained\%} = \frac{B - B_0}{BI} \times 100$$

Table (2): Formulation of experimental diets containing different protein qualities at two levels of lipid (as fed basis).

Ingredients%	ALL	AHL	BLL	BHL	CLL	CHL
Fish meal	18.00	18.00	9.00	9.00	--	--
S.bean meal	12.63	13.00	18.60	19.15	24.78	25.30
Corn gluten	12.63	13.00	18.60	19.15	24.78	25.30
Y.corn	52.40	44.46	47.41	39.07	41.95	33.66
Min. &Vim.mix.[1]	3.00	3.00	3.00	3.00	3.00	3.00
Mono calcium phosphate	--	--	1.00	1.00	2.00	2.00
DL.Met.	--	--	0.06	0.06	0.12	0.12
Lys.HCl	--	--	0.31	0.31	0.65	0.65
Oil	1.34	8.54	2.02	9.26	2.72	9.97
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

[1] **Vitamin – mineral mixture supplied per Kg: Vit. A, 12000 I. U; Vit. D3, 2200 I. U; Vit. E, 10 mg; Vit. K3, 2 mg; Vit. B1, 1mg; Vit. B2, 4mg; Vit. B6, 1.5mg; Vit. B12, 10µg; Niacin, 20 mg; Pantothenic acid, 10 mg; Folc acid, 1mg; Biotin, 50 µg; Choline choride, 500mg; Copper, 10mg; Iodine, 1mg; Iron, 30mg; Manganese, 55 mg; Zinc, 50 mg and Selenium, 0.1 mg.**

Where B_0 means initial body protein content (g); B means final body protein content (g); BI means protein intake (g).

Water temperature, P^H, dissolved oxygen, ammonia NH_3, and nitrate NO_3, were all periodically measured during the feeding trials. Water temperature °C was measured using thermometer, P^H using ORION, P^H, ISE meter model 710A, ATI ORION con meter was used with ammonia electrode model 93:07 and oxygen electrode model 97.08. Nitrate was measured according to standard methods (APHA, 1989). Economical evaluation of the experimental diets was done in the form of the cost (L.E) of production of one kg fish weight gain. Data were statically analyzed using the general linear model for analysis of variance (SAS Institute, 1990). Significant differences among treatment means were separated by Duncan's new multiple range test (Duncan, 1955).

Table (3): Chemical composition of experimental diets containing different protein qualities at two levels of lipid (as fed basis).

Ingredients %	ALL	AHL	BLL	BHL	CLL	CHL
Moisture	11.3	12.5	10.9	11.7	12.1	11.5
Crude protein	29.96	28.95	29.84	29.2	28.88	29.12
Ether extract	5.11	11.5	4.97	11.71	4.88	11.95
Ash	4.64	4.55	3.63	3.28	2.65	2.57
Fiber	2.91	2.73	2.5	2.33	2.71	2.53
Nitrogen free extract[1]	46.08	39.77	49.94	41.79	48.78	42.33
Calcium	0.71	0.73	0.71	0.70	0.68	0.69
Phosphorus	0.64	0.62	0.63	0.59	0.60	0.63
Digestible energy Kcal/ 100gm diet[2]	287.95	327.79	293.81	334.88	285.88	290.01

[1] NFE = 100- (Moisture + Crude protein + Ether extract + Ash + Fiber).

[2] Digestible energy, based on 5.0 Kcal/g protein, 9.0 Kcal/g lipid, and 2.0 Kcal/g carbohydrate (wee and shu,1989).

Table (4): Amino acids composition of experimental diets containing different qualities at two levels of lipid (% as fed basis).

Mean Values	ALL	AHL	BLL	BHL	CLL	CHL
Aspartic acid	2.48	2.53	2.42	2.47	2.42	2.51
Thrionine	1.21	1.19	1.17	1.20	1.30	1.27
Serine	1.28	1.38	1.42	1.39	1.50	1.41
Glutamic acid	4.98	4.67	5.01	5.1	5.4	5.33
Glycine	1.46	1.40	1.24	1.35	1.20	1.29
Alanine	2.20	2.24	2.29	2.27	2.36	2.29
Cystine	0.42	0.46	0.50	0.49	0.55	0.51
Valine	1.32	1.38	1.39	1.36	1.39	1.39
Methionine	0.81	0.80	0.80	0.82	0.80	0.83
Isoleucine	1.15	1.18	1.19	1.18	1.20	1.26
Leucine	3.18	3.15	3.21	3.19	3.18	3.41
Phenylalanine	1.63	1.64	1.58	1.60	1.62	1.59
Histidine	0.60	0.62	0.64	0.59	6.1	0.57
Lysine	1.57	1.56	1.52	1.54	1.53	1.55
Arginine	1.54	1.49	1.50	1.48	1.47	1.51
Praline	1.88	1.81	1.82	1.87	1.86	1.80

RESULTS AND DISCUSSION

Data representing initial weight, final weight, weight gain, relative weight gain, feed conversion, protein efficiency ratio and protein retained in fish are given in table (5). The statistical analysis of the data is presented in table (6).

Table (5): Growth and feeding Performance of Tilapia fed diets containing different protein qualities at two levels of lipid (as fed basis).

Mean Values	ALL	AHL	BLL	BHL	CLL	CHL
Initial weight/g	$8.63_{\pm0.48}$	$9.08_{\pm0.4}$	$8.67_{\pm0.17}$	$8.70_{\pm0.30}$	$8.50_{\pm0.25}$	$8.62_{\pm0.63}$
Final weight/g	$27.62_{\pm2.07}$	$29.72_{\pm1.9}$	$26.71_{\pm2.87}$	$27.78_{\pm1.8}$	$23.84_{\pm1.3}$	$26.00_{\pm1.7}$
Weight gain	$18.99_{\pm2.5}$	$20.64_{\pm1.2}$	$18.04_{\pm2.8}$	$19.08_{\pm1.7}$	$15.34_{\pm1.8}$	$17.38_{\pm1.6}$
Weight gain %	$220.04_{\pm40.6}$	$227.31_{\pm25.0}$	$208.07_{\pm34.4}$	$219.31_{\pm19.8}$	$180.47_{\pm26.5}$	$201.62_{\pm31.7}$
Feed conversion ratio	$1.23^{a}_{\pm0.09}$	$1.18^{a}_{\pm0.09}$	$1.45^{ab}_{\pm0.12}$	$1.36^{ab}_{\pm0.08}$	$1.95^{c}_{\pm0.07}$	$1.63^{b}_{\pm1.0}$
Protein efficiency ratio	$2.72^{bc}_{\pm0.11}$	$2.93^{c}_{\pm0.34}$	$2.31^{ab}_{\pm0.17}$	$2.51^{abc}_{\pm0.29}$	$1.77^{a}_{\pm0.16}$	$2.1^{ab}_{\pm0.15}$
Protein retained%	$41.94^{c}_{\pm4.0}$	$40.95^{c}_{\pm2.5}$	$35.13^{bc}_{\pm2.9}$	$44.2^{c}_{\pm4.17}$	$24.19^{b}_{\pm3.2}$	$28.85^{ab}_{\pm3.8}$

Values with the same letter for each parameter are not significantly deferent (p> 0.05).

Table (6): Analysis of covariance for data given in Table 5

Mean Values	S.O.V.	DF	M.S	F
Initial weight/g	Between Groups	5	0.118	0.240
	Within Groups	12	0.491	
	Total	17	-	
Final weight/g	Between Groups	5	11.666	1.204
	Within Groups	12	9.688	
	Total	17	-	
Weight gain	Between Groups	5	10.948	0.909
	Within Groups	12	12.038	
	Total	17	-	
Weight gain %	Between Groups	5	909.951	0.326
	Within Groups	12	2787.872	
	Total	17	-	
Feed conversion ratio	Between Groups	5	0.246	9.164
	Within Groups	12	0.027	
	Total	17	-	
Protein efficiency ratio	Between Groups	5	-0.645	4.287
	Within Groups	12	0.151	
	Total	17	-	
Protein retained%	Between Groups	5	191.153	6.740
	Within Groups	12	28.361	
	Total	17	-	

Mean values for final weight, weight gain and relative weight gain were not statistically different ($p \geq 0.05$) among the experimental fish groups. Irrespective of dietary lipid level, fish given diets containing high percentage of fish meal (diets ALL, AHL) had the best growth while fish given diets containing low percentage of fish meal (diets BLL, BHL) had intermediate growth. The lowest growth has been produced when fish fed all plant protein diets (diets CLL, CHL). Webster *et al.* (1992 a) in channel catfish, *Ictalurus punetatus*; Shiau *et al.* (1990) in tilapia, *Oreochromis nilctucus x O. aureus*, reported that growth of fish decreased as the dietary fish meal decreased.

Also, Sitasit and Sitaşit (1977) recorded that *(Oreochromis niloticus)* had higher growth when fed diets containing a mixture of animal protein and plant protein compared with a diet containing plant protein only. This reduction may have been due to the fact that fish meal has highest biological value, digestible energy, available phosphorus (Lovell, 1981). Fish meal is also rich in polyunsaturated fatty acids, highly palatable to most fish and contains some unknown growth factors (Andrews and page, 1974).

Also, decreasing dietary fish meal in the various experimental diets generally increase feed conversion, reduce protein efficiency ratio, and protein retained in fish. However, at 5% dietary lipid feed conversion was not statistically different ($p \geq 0.05$) between fish given diet containing 18% fish meal and those given diet containing 9% fish meal. Feed conversion was statistically ($p \leq 0.05$) higher in fish given the whole plant protein diet (CLL) comparing to those given either diet All or BLL. Protein efficiency ratio and protein retained were not statistically different ($p \geq 0.05$) between fish given neither diet ALL nor BLL, and between those fed neither CLL or BLL. Protein efficiency ratio and protein retained in fish given the whole plant protein diet CLL was statistically lower ($p \geq 0.05$) than those given diet ALL. Webster *et al.* (1992 a) observed a significant improvement in protein efficiency ratio when they increased the fish meal from 0 up to 12% in channel catfish, *Ictalurus punetatus,* diets.

The present results revealed that increasing the level of lipid, within each dietary protein series, from 5 up to 12 % did not statistically improve ($P \geq 0.05$) growth performance of fish as it is shown in diets ALL & AHL, BLL & BHL, and CLL & CHL, respectively. However , growth of fish fed on diets containing 12% lipid (diets, AHL, BHL, or CHL) tended to be better than those given 5% lipid (diets, ALL, BLL or CLL). Similar results have been observed by Hassanen *et al* (1998) in grey mullet, *Liza ramada*. The relationship of dietary protein to lipid ratio (P/L) and rate of growth perhaps is indicative of this ratio that gives optimal growth at a particular dietary protein level. In the present work (table 3), the calculated values of protein (P/L) for diets ALL, AHL, BLL, BHL, CLL and CHL were 5.86, 2.51, 6.0, 2.49, 5.91, and 2.43, respectively. While the best growth was observed at diets AHL, BHL and CHL. Thus, the possible optimum dietary P/L in the present work may have been close to 2.5.These results were in agreement with those calculated from data of De Silva *et al* (1991). They obtained higher growth of red tilapia *Oreochromis mossambicus x Oreochromis niloticus* at 2.5 P/L compared to those given diets of 4.77 P/L. Jover *et al.*, (1999) concluded that maximum utilization of diets could be achieved by defining the optimum ratio for carbohydrate, protein and lipid in fish feeds. In the present work (table 3), the calculated values of carbohydrate / lipid ratio for diets ALL, AHL, BLL, BHL, CLL and CHL were 9.0, 3.4, 10.0, 3.5, 9.9 and 3.5, respectively. While the best growth was observed at diet AHL, BHL and CHL. Thus ,the possible optimum carbohydrate/lipid in the present work may have been close to 3.5. Chou and Shiau, (1996) Suggested that hybrid tilapia can perform equally well on diets containing carbohydrate/lipid ratio from 1.13 - 8.4.

Feed conversion of fish given diet containing high percentage of fish meal and 12% lipid (diet AHL) was not statistically improved ($P \geq 0.05$) over that of fish fed diet containing the same percentage of fish meal and 5% lipid (diet ALL). Similarly, fish given diet containing low percentage of fish meal and 12% lipid (diet BHL) did not had statistically better ($P \geq 0.05$) feed conversion ratio than that of fish given diet containing the same percentage of fish meal and 5% lipid (diet BLL). Contrarily, feed conversion of fish given the whole plant protein diet and 12% lipid (diet CHL) was statistically better ($P \leq 0.05$) than that of fish given the whole plant protein diet and 5% lipid (diet CLL). Moreover, feed conversion of fish given diet CHL was not statistically different ($P \geq 0.05$) than those given neither diet BLL nor BHL .Protein efficiency ratio of fish fed on diets containing 12% lipid (diets, AHL, BHL, CHL) were not statistically ($P \geq 0.05$) better than those fed on diet containing 5% Lipid (diets, ALL, BLL, CLL), regardless of dietary protein quality. EL-Sayed and Garling (1988) indicated that increasing dietary oil up to 15% resulted in a significant improvement in protein efficiency ratio and protein productive value in *Tilapia zilli*. De silva *et al.* (1991) reported that the final weight gain of young red tilapia fed 30% protein and12% lipid was significantly higher than those fed 30% protein and 6% lipid. They also found that the feed conversion, protein efficiency ratio and net protein utilization was not significantly better between the two groups of fish. Hassanen *et al.*, (1998) reported that feed conversion, protein efficiency ratio and protein productive value of greymullet, *Liza ramada*, improved with increasing dietary lipid content up to 12 % at all protein levels tested.

Table (7) shows body chemical composition of fish fed the different experimental diets. The statistical analysis of the data is present in table (8). Body moisture, crude protein, ether extract and ash contents were not statistically different ($P \geq 0.05$) among fish given the various experimental diets. However, feeding fish a whole plant protein diets has tended to produce less protein and higher ether extract in fish body than feeding fish a diets containing fish meal. Viola *et al.* (1988) stated that *Oreochromis niloticusx O. aureus* fed a diet containing soybean meal as the sole protein source tended to slightly accumulate fat in their body. Also, no significant increase in body crude protein of blue catfish (*Ictalurus fucatus*) was observed when fish fed on diets containing 13% & 48%, 9% & 55%, 4% & 62%,0% & 69% fish meal & soybean meal, respectively (Webster *et al* 1992 b).

The present results show that increasing dietary Lipid has tended to produce higher ether extract in fish body. Similarly, Grisdale- Helland *et al.* (2008) reported that the lipid concentration in the liver of cod increased with increasing dietary lipid level. Kim and Lee (2005) stated that the whole body lipid contents of bagrid catfish fed a high lipid diet was significantly higher than that of fish fed a low lipid diet at the same protein level. They concluded that the positive correlation between body lipid content and dietary lipid may indicate that when dietary lipid is supplied in excess, a proportion of this lipid is deposited as body fat. This is in agreement with the result on other fish species such as rainbow trout (Lee and Putnum, 1973), channel catfish (Garling and Wilson, 1977), common carp (Takeuchi *et al.*, 1979), red drum

(Ellis and Reigh, 1991) and hybrid Clarias catfish (Jantrarotai *et al.*, 1994). Chou and Shiau (1996) concluded that increasing the levels of dietary lipid from 5 – 15% resulted in increased body lipid; however, this did not reflect the change of the biomass of the fish (hybrid tilapia) fed the 5 – 15% lipid diets. Similar weight gain of the fish in these dietary groups was obtained suggesting that tilapia do not utilize the additional energy provided by the supplementary lipid (over 5% dietary level) for growth.

Table (7): Body chemical composition of Tilapia fed diets containing different protein qualities at two levels of lipid (as fed basis).

Mean Values	Initial	ALL	AHL	BLL	BHL	CLL	CHL
Dry matter	20.79	23.69	24.57	23.10	25.1	21.88	22.66
Protein	60.50	60.00	61.03	60.32	62.11	60.42	61.78
Lipid	22.60	22.62	22.77	23.35	24.91	23.33	24.20
Ash	14.92	15.41	16.02	16.4	15.96	15.32	15.13

Table (8): Analysis of covariance for data given in Table 7

Mean Values	S.O.V.	DF	M.S	F
Moisture	Between Groups	5	4.346	0.988
	Within Groups	12	40.126	
	Total	17	-	
Protein	Between Groups	5	10.909	0.548
	Within Groups	12	13.020	
	Total	17	-	
Lipid	Between Groups	5	2.363	0.909
	Within Groups	12	8.103	
	Total	17	-	
Ash	Between Groups	5	0.728	0.991
	Within Groups	12	7.572	
	Total	17	-	

The cost per ton of feed (Table 9) decreased as a result of decreasing fish meal content in the diets. Increasing dietary levels of lipid increased cost per ton of feed. The efficiency by which the feeds were converted into live weigh gain indicated that increasing lipid levels in tilapia, *Oreochromis niloticus*, feeds up to 12% did not economically reduce the feeding cost of one Kg of fish.

Table (9): Cost (L.E.) Per ton of feed and the feed required for production of one Kg weight gain Of *O. niloticus* fed the different experimental diets*

Items	ALL	AHL	BLL	BHL	CLL	CHL
Cost (L.E.) / Ton of feed	3186	3470	3119	3413	3064	3357
Relative feed cost as percentage of ALL	100	108	97	107	96	105
Feeding cost (L.E.) / Kg of fish gain	3.9	4.1	4.5	4.6	5.9	5.4
Relative feed cost / Kg fish gain as percentage of ALL diet	100	105	115	117	151	138

* Local prices of ingredient:
Fish meal 7000 L.E./Ton. - Soybean meal 3170 L.E./Ton. - Corn gluten 5000 L.E./Ton. Yellow corn 1350 L.E./Ton. - Corn oil 5000 L.E./Ton. - Mono calcium Phosphate 4000 L.E./TonDL. Methionine 30000 L.E./Ton. - L.Lysine HCL 15000 L.E./Ton. - Min. & Vit. Mix 4000 L.E./Ton.

It is concluded that increasing lipid levels in tilapia feeds in compensation for the poor quality of dietary protein did not statistically increase ($P \geq 0.05$) growth performance and feed efficiency. Feed conversion was statistically affected ($p \leq 0.05$) by increasing dietary lipid at the whole plant ingredient diets. Also, increasing lipid level did not economically reduce the feeding cost of one Kg of fish. The most efficient formulation of tilapia feeds in the present work was 18% fish meal and 5% lipid at 30% dietary protein.

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العلاقة بين جودة البروتين ومستوى الدهن في علائق أسماك البلطي النيلي

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أجريت هذه التجربة لتحديد إمكانية رفع الدهن فى علائق البلطي النيلي لتعويض إنخفاض جودة مثل تلك العلائق كنتيجة لإنخفاض أو عدم وجود مسحوق السمك فيها. تـم تكوين ثلاثة أنواع من العلائق يختلف فيها نوعية البروتين. النـوع الأول إحتـوى علـى ١٨% مسحوق سمك، و الثانى ٩% مسحوق سمك و الأخير لا يحتـوى علـى مـسحوق سمك. و داخل كل نوع من الأنواع السابقة تم تكوين عليقتين إحتوت إحداهما على ٥% و الأخرى على ١٢ % دهن. تم تغذية هذة العلائق لستة مجاميع من أسماك البلطي النيلـي إحتوت كل مجموعة على ثلاثة مكررات ولمدة ٧ أسابيع. و كانت نتـائج هـذة التجربـة كالتالي: لم يحدث تحسناً معنوياً في معدل نمو الأسماك التى غذيت على مثل هذة العلائق. معدل تحويل الغذاء قد تحسن معنوياً عند نسبة دهون ١٢% في العليقة المكونة من خامات علف نباتية. زيادة نسبة الدهن إلى ١٢% لم يؤدى إلى خفض تكلفة إنتاج اسماك البلطـي النيلي. أظهرت النتائج أن احتواء علائق البلطي النيلي على ١٨% مسحوق سـمك عنـد مستوى بروتين ٣٠% ومستوى دهن ٥% هو الأفضل.