PARTIAL AND COMPLETE REPLACEMENT OF FISH MEAL WITH POULTRY BY–PRODUCT MEAL PROTEIN IN DIETS FOR MONOSEX NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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Abstract

A 15-week experiment was conducted to evaluate the use of poultry by – product meal (PBM) in practical diets for all male monosex Nile tilapia, *Oreochromis niloticus* (30.1+0.01 g) as replaced for fish meal. Five isonitrogenous diets (25% protein) were formulated in which (PBM) replaced 0.0%, 25 %, 50 %, 75% and 100% of the protein supplied by herring fish meal (HFM). Fish were fed one of the tested diets at the rate of 3 % of body. Diets were offered 6 days a week; 2 times a day (9.00 and 14.00). Results demonstrated that PBM has good potential as a complete substitute of the protein supplied by HFM in monosex-Nile tilapia diets with no significant (P > 0.05) adverse effects on growth performance, feed efficiency and protein utilization compared to fish fed the HFM – based diet (control diet). Survival rates of monosex-Nile tilapia fed all the tested diets were high and ranged from 96.70 % to 100 % without significantly difference among them (P > 0.05). At the end of the study, partial or complete replacement of PBM for HFM –protein in diets did not affect fish composition of dry mater, protein, or fat levels compared to the control treatment. The study clearly indicated that PBM could serve as a complete replacement for fish meal in practical diets for monosex-Nile tilapia.

Keywords: Poultry by-product, monosex-Nile tilapia, growth, feed utilization, proximate chemical composition.

INTRODUCTION

Aquaculture is the fastest expanding food production system in the world. This rapid development largely depends upon fish meal, a major protein source, which constitutes 40-60 % of the total cost of feed production for aquaculture (Hardy and Tacon, 2002). The continuous increasing demand for fish meal use in animal feed especially in aqua feed has resulted in fish meal becoming difficult to obtain and more expensive. Therefore, the search for alternatives to fish meal is an international research priority (Chamberlain, 1993; Hardy and kisser, 1997; Abdelghany, 2003; Abdelghany *et al.*, 2005; Ahmad, 2008). The shortage in world production of fish meal coupled with the increased demand for fish meal in feeds for livestock and poultry is likely to reduce the dependence on fish meal as a single protein source in aqua feeds (El-Sayed, 1999). Therefore, fish nutritionists have made several attempts to partial or totally replacement of fish meal with less expensive locally available protein sources.

Poultry by-product processing in formal and informal abattoirs in Egypt produces tremendous quantities of by–product (meat, offal, blood, bone, etc.). Recycling of these wastes gave two advantages 1– less environmental pollution 2– an acceptable source of animal protein in the diet of fish which is a big challenge in the pursuit of sustained production of inexpensive fish feed. Poultry by-product meal is a rich source of animal protein (> 65 % CP on dry matter basis) and is less expensive than fish meal, and requires successive studies evolving its use as partial or complete substitute to the traditionally utilized fish meal. Therefore, this study was carried out to evaluate the use of poultry by- product meal (PBM) as a herring fish meal (HFM) substitute in practical diets for all male monosex Nile tilapia and its relation to fish growth, feed utilization, whole-fish body composition.

MATERIALS AND METHODS

Diet preparation and feeding regimen

Five diets were formulated to be (25.2 % crude protein) and isolipidic (6.92% crude fat). A consideration was also given to the equivalence of other components such as fiber. The composition of the diets is shown in Table (4): Diet – 1 (control) contained herring fish meal (HFM) as a sole source of animal protein, Diet 5 contained poultry by-product meal (PBM) as a sole source of animal protein. Diets 2 to 4 contained mixtures of HFM and PBM as source of animal protein supplements with the proportions of each adjusted so that each of the two ingredients provided similar graded levels of animal protein in the diet. Graded levels of protein replacements were 100%, 75%, 50 %, 25 % and 0% respectively. All diets contained a constant level of plant protein from soybean meal (SBM), corn meal and wheat bran to complete the protein requirement. The proximate chemical compositions of the main ingredients in the diets were analyzed and are shown in Table (2). Essential amino acids (AA) profile for HFM, PBM, SBM and CNM are shown in Table (2).

In the present study, the poultry by – product meal was a product brought from the Egyptian company of poultry (Mariottia, Giza, Egypt). It consists of the rendered, clean parts of the carcass of slaughtered poultry, such as necks, feet, intestines, blood and skin exclusive of feathers, except such amounts as might occur unavoidably in good processing practices. The diets were prepared palletized, stored and previously described by Abdelghany (2003).

Fish culture technique

Hormone treated all male monosex Nile tilapia was divided into 15 groups (in fifteen cages), each one was stocked by 10 fish (average weight 30.1 g each). Each subgroup of fish was transferred at random into cage (1 x 1 x 1 m^2). The fish cages were inserted in Manzalla Lake at the Port Said government. The feeding rate was 3 % of fish body weight during the course of the experiment. Feed was offered to fish two times daily; 6 days a week. All fish from each cage were collected every two weeks and collectively weighed and the ration was adjusted each time according to the fish weight.

Proximate analysis of diet and fish

At the start of the experiment, 50 fish were taken and kept frozen for proximate chemical analyses. At the end of the experiment, the basal diet and 15 fish from each treatment were chemically analyzed according to the standard methods of AOAC (1990) for determination of moisture, crude protein, total lipids, and ash. Moisture content was estimated by draying samples in an oven at 85 °C till constant weight and calculating weight loss. Nitrogen content was measured using a microkldahl apparatus and crude protein was estimated by multiplying nitrogen content by 6.25. Lipid content was determined by ether extraction for 16 hours and ash was determined by combusting samples in a muffle furnace at 550 °C for 6 hours

Growth parameters

Growth performance was determined and feed utilization was calculated as following:

Weight gain = $W_2 - W_1$.

Specific growth rate (SGR) = 100 ($\ln W_2 - \ln W_1$) / T; where W_1 and W_2 are the initial and final weight, respectively, and T is the number of days in the experimental period.

Feed conversion ratio (FCR) = feed intake / weight gain.

Feed efficiency ratio (FER) = weight gain / feed intake.

Protein efficiency ratio (PER) = weight gain / protein intake.

Analysis of water quality

Water samples were collected every 2 weeks from the entrance, the middle and the end of cages location. Water temperature and dissolved oxygen were measured by oxygen-meter YSI model 58, USA, pH degree was measured by a pH-meter, Fisher Scientific, USA, and water conductivity and salinity were measured by conductivity-meter YSI model 33, USA. Water transparency was measured by Secchi disk.

Table 1.Water quality parameters in cages during the experimental period 2007.

Site	Temp. °C	D.O. mg/l	S.D. cm	pH	NH4 mg/l	TDS g/l	Salinity g/l
Water entrance to cages	22.5-29.5	0.5-4	67	8	1.1-2.2	2.232	1.1
Cage in middle	23.5-29.5	0.3-3.5	65	8	1.3-2.4	2.238	1.1
Cage in the end	23-30	0.1-3.2	64	8	1.4-2.4	2.241	1.1

TABLE 2. Proximate chemical analysis of HFM, PBM, SBM and CNM (%; on dry matter basis).

	Herring fish meal (HFM)	Poultry by – product meal (PBM)	Soybean meal (SBM)	Corn meal (CNM)
Chemical analysis				
Dry matter	92.50	85.52	93.81	88.37
Crude protein	71.26	59.75	45.62	9.30
Total lipids	14.18	14.19	6.27	5.47
Ash	11.05	10.98	7.87	1.2
NFE*	2.81	14.78	34.79	68.89
Crude fiber	0.70	0.30	5.42	15.14
GE/100 g diet**	536.65	531.69	459.64	388.38

*Nitrogen-Free Extract (calculated by difference) = 100 – (protein + lipid + ash + fiber).

**Gross energy was calculated from (NRC, 1993) as 5.65, 9.45, and 4.1 kcal/g for protein, lipid, and carbohydrates, respectively.

Table 3. Essential amino acids (AA) profile (g / 100 g protein)* for HFM, PBM, SBM CNM and amino acid requirements for Nile Tilapia (AARec.) as (% of dietary protein).

A.A. Profile	HFM	PBM	SBM	CNM	AA Req.
Arginine	6.41	6.42	7.15	4.41	4.20
Histidine	2.30	1.72	2.64	2.66	1.72
Lysine	7.45	4.94	6.50	2.57	5.12
Isoleucine	4.36	4.04	6.12	3.58	3.11
Leucine	7.20	6.82	8.43	12.57	3.39
Methionine	2.90	1.80	1.51	1.74	2.68
Cystine	1.03	1.56	1.32	2.29	0.54
Phenylalanine	3.75	3.14	5.14	4.95	3.75
Tyrosine	3.05	1.61	3.61	3.94	1.79
Threonine	4.04	3.31	4.03	3.67	3.75
Tryptophan	1.06	0.80	1.43	0.83	1.00
Valine	5.98	4.87	5.30	4.59	2.80

Table 4. Ingredients and chemical composition of the experimental diets (on dry matter basis).

Ingredients	(%) Replacement of HFM by PBM in experimental rations				
	0.0	25	50	75	100
HFM	7.88	5.91	3.94	1.98	0.00
PBM	0	2.36	4.70	7.05	9.41
Soybean meal	31.11	31.11	31.11	31.11	31.1
Corn meal	19.50	19.50	19.50	19.50	19.50
Wheat bran	27.68	27.68	27.68	27.68	27.68
Starch	4.00	3.65	3.31	2.96	2.65
Cod - liver oil	0.83	0.79	0.76	0.72	0.65
Corn oil	1.50	1.50	1.50	1.50	1.50
Vit1. +Min. premix[2(1 :1)]	2.00	2.00	2.00	2.00	2.00
Binding agent (starch)	2.00	2.00	2.00	2.00	2.00
Cellulose	3.50	3.50	3.50	3.50	3.50
Total	100	100	100	100	100
Chemical analyses (%)					
Moisture	91.47	91.33	91.35	91.23	91.32
Crude protein	25.10	25.27	25.39	25.01	24.99
Ether extract	6.88	6.98	7.01	6.91	6.89
Ash	6.10	6.00	6.34	6.17	6.59
Crude fiber	5.60	5.44	5.81	5.39	5.66
NFE[3]	56.32	56.31	55.45	56.52	55.87
GE (kcal/100g)[4]	437.75	439.61	437.04	438.34	435.37
P/E ratio	57.34	57.48	58.10	57.06	57.40

[1] Vitamin premix (per kg of premix): thiamine, 2.5 g; riboflavin, 2.5 g; pyridoxine, 2.0 g; inositol, 100.0 g; biotin, 0.3 g; pantothenic acid, 100.0 g; folic acid, 0.75 g; para-aminobenzoic acid, 2.5 g; choline, 200.0 g; nicotinic acid, 10.0 g; cyanocobalamine, 0.005 g; a-tocopherol acetate, 20.1 g; menadione, 2.0 g; retinol palmitate, 100,000 IU; cholecalciferol, 500,000 IU.

[2] Mineral premix (g/kg of premix): $CaHPO_4.2H_2O$, 727.2; $MgCO_4.7H_2O$, 127.5; KCl 50.0; NaCl, 60.0; $FeC_6H_5O_7.3H_2O$, 25.0; $ZnCO_3$, 5.5; $MnCl_2.4H_2O$, 2.5; $Cu(OAc)_2.H_2O$, 0.785; $CoCl_3.6H_2O$, 0.477; $CaIO_3.6H_2O$, 0.295; $CrCl_3.6H_2O$, 0.128; $AlCl_3.6H_2O$, 0.54; Na_2SeO_3, 0.03.

[3] Nitrogen-Free Extract (calculated by difference) = 100 – (protein + lipid + ash + fiber).

[4] Gross energy (GE) was calculated from (NRC, 1993) as 5.65, 9.45, and 4.11 kcal/g factors for protein, lipid, and carbohydrates, respectively

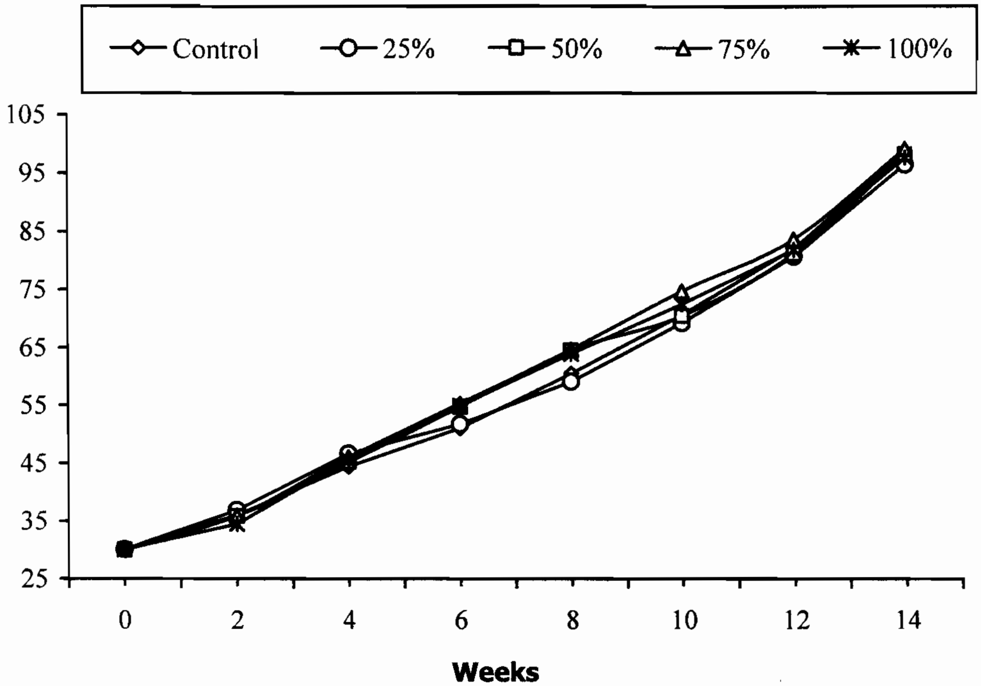

Figure 1. Changes in live body weight (g) of Nile tilapia fed different levels of PBM

Table 5. Growth performance and feed utilization of Nile tilapia fed diets containing different levels of PBM

	PBM levels (%)				
	0.0	25	50	75	100
Initial weight (g)	30.07±0.08a	30.03±0.03 a	30.07±0.08a	30.03±0.02 a	30.00±0.05a
Final weight (g)	96.33±1.96a	96.43±1.99 a	98.13±0.86 a	99.03±1.36 a	97.57+1.36a
Weight gain (g)	66.26±2.02a	66.40±1.90 a	68.06±0.75a	69.00±1.31 a	67.57±2.77 a
Weight gain%	220.35±4.21a	221.11±3.48a	226.34±1.10a	229.77±2.52a	225.23±4.9a
SGR (%g/d)	1.11±0.07a	1.11±0.02 a	1.13±0.01 a	1.14±0.02 a	1.12±0.02a
FI (g feed/ fish)	134.76±1.85a	134.04±0.12a	137.32±1.77a	139.93±1.57a	137.88±3.35a
FCR	2.03±0.04a	2.02±0.01a	2.02±0.03a	2.03±0.02a	2.04±0.03a
FER	49.17±0.22a	49.54±081 a	49.59±0.96a	49.33±1.05a	49.02±0.91a
PER	2.15±0.03a	2.17±0.02a	2.17±0.01a	2.16±0.02a	2.14±0.01a
Survival rate (%)	100±0.0ab	96.7±1.7ab	100±0.0a	98.9±1.1ab	100±0.00a
Cost (LE/ ton diet	2665.00	2542.73	2380.67	2158.71	1963.00

The same letter in the same row is not significantly different at $P < 0.05$.

Table 6. Proximate chemical analyses (%; on dry matter basis) of Nile tilapia fed diets containing different levels of PBM.

	PBM levels (%)				
	0.0	25	50	75	100
Dry matter	24.08±0.44a	24.83±0.37a	25.25±0.80 a	25.37±0.56 a	25.25±0.35 a
Crude protein	61.46±0.28 a	62.11±0.85a	61.85±0.38a	62.45±0.65a	63.03±0.14 a
Total lipid	16.09±0.21 b	16.38±0.68b	16.57±0.52b	17.17±0.15ab	17.51±0.49ab
Ash	21.16a±0.58ab	21.07±0.44ab	20.91±0.45ab	20.3±0.48ab	19.60±0.26b

The same letter in the same row is not significantly different at $P < 0.05$.

The values of these parameters are within the acceptable range of fish farming except dissolved oxygen (Boyd, 1984).

Statistical analysis

The obtained data in this study are presented as means ± SD of three replicates and analyzed by one-way ANOVA to test the effect of PBM inclusion in fish diet according to Snedecor and Cochran (1982). All differences among means were considered significant at $P \leq 0.05$ using Duncan's multiple range test (Duncan 1955).

Economical evaluation

The cost of feed to raise unit biomass of fish was estimated by a simple economic analysis. The estimation was based on local retail sale market price of all the dietary ingredients at the time of the study. These prices (in LE/kg) were as follows: herring fish meal, 12.0; PBM, 2.25; soybean meal, 2.0; corn meal, 1.40; wheat bran, 1.40; starch, 2.0; fish oil, 7.0; corn oil, 5.0; vitamin premix, 7.0; mineral mixture, 3.0; cellulose 3.0. An additional 50.0 LE/ton was added as a manufacturing cost.

RESULTS

The chemical analysis of the ingredients (HFM, PBM, SBM, and CNM) is present in Table (2).Based on the results PBM analysis is a good alternative protein source and may replace HFM protein in fish diets. All monoxes-Nile tilapia became accustomed to the experimental diets and were observed to feed actively throughout the duration of this study. Change in live body weight (g) of monosex Nile tilapia fed different levels of PBM during experimental. Figure (1).Initial body weigh at all experimental treatments did not differ significantly (Table 5). Partial or complete replacement of PBM for HFM in all experimental diets did not significantly influenced fish survivability (Table 5). Survival rate of monosex-Nile tilapia fed all the treatments was high and ranged from 96.7 to 100 % without significant difference among them ($P > 0.05$; Table 5). The present study showed that growth performance (final body weight, weight gain, weight gain% and specific growth rate) was not significantly ($P > 0.05$) differed. All diets were well accepted by Nile tilapia. Diet utilization (feed intake, FCR, FER, and PER) was not significantly ($P > 0.05$) affected by PBM inclusion levels.

The whole-body composition of monosex Nile tilapia of dry matter, crude protein, fat and ash at the end of the study are shown in Table 6. Partial or complete replacement of PBM for HFM–protein in diets did not reduce fish composition of dry matter, protein or fat levels compared to the control treatment. Ash levels were irregularly fluctuated in fish bodies among treatment at the end of the experiment.

Economic evaluation showed that diets containing higher levels of PBM were cheaper than diets containing higher levels of HFM (Table 5). As PBM inclusion in the diets increased up to 100 % level of replacement for HFM-protein, the cost of 1 ton from control = 2665 LE, while the cost of 1 ton from diet containing 100 % PBM = 1963 i.e. 1 ton from diet containing 100 % PBM was less with 702 LE when compared with control diet.

DISCUSSION

In the present study, monosex Nile tilapias fed diets actively on all the experimental diets and grow efficiently without external sign of nutritional deficiency. Partial or complete replacement of PBM for HFM protein in experimental diets for monosex Nile tilapia in the present study resulted in dietary amino acid profiles that meet the requirement of this species. These results showed that the amino acid profile of protein from PBM is a good as HFM and the quality of protein in terms of the quantitative essential amino acids of both ingredients are similar. Growth performance (final body weight, weight gain, weight gain% and specific growth rate) of monosex Nile tilapia fed diets containing various levels of PBM were similar to those of fish fed a control diet in this study.

The results of growth performance and feed utilization (Table 4) clearly indicated that protein from PBM is digested and utilized in a manner similar source of protein for HFM and its use in practical diets for monosex Nile tilapia is feasible. These results are in agreement with Abdelghany *et al.* (2005) who reported that Nile tilapia fed diets, in which PBM replaced up to 100 % of the protein supplied by HFM had similar growth performance. Also, Webster *et al.* (1999) reported that sun shin bass fed a diet with PBM and a formulation some what similar to the diets used in the present study but not containing higher level of protein, had similar growth to fish fed a control diet. Also, the present results coincide with the findings of Abdelghany *et al.* (2005) who observed no significant difference ($P > 0.05$) in final weight of monosex Nile tilapia which were fed diets for 90 days in which 10%, 25%, 50%, 75%, 90%, and 100 % of the herring fish meal had been replaced with a poultry by-product meal.

These observations suggested that the PBM diets contained all the necessary growth factors required by monosex Nile tilapia. In addition, the isoniterogenous, isolipidic, and isocaloric nature of the experimental diets explained why there was no disparity in fish growth and feed utilization. The high improvement by replaced the HFM by PBM products in the present study did not coincide with the results of previous studies for sunshin bass, *Morone chrysops* x *Morone saxatilis* (Muzinic *et al.*, 2006), gibel carp, *Carassius auratus gibelio* (Yang *et al.*, 2006), and Black Sea turbot, *Psetta maeotica* (Yigit *et al.*, 2006).

In the present study, monosex Nile tilapia fed diets in which PBM replaced up to 100% of the protein supplied by HFM had similar feed utilization efficiency (FI, FCR, FER, and PER) to fish fed the HFM- based diet (Table 4). Partial and totally replacement of PBM of HFM protein in monosex Nile Tilapia diets did not affect FER and PER when compared with fish fed HFM (Table 4). These results agree with

Abdelghany *et al.* (2005) who reported that fish fed diets in which PBM replaced up to 100 % of the protein supplied by HFM had similar FCR, FER and PER to fish fed the HFM–based diet. Also, Yang *et al.* (2006) found that FI, PER, FER, PRE, and ERE estimated for gable carp diet containing different PBM levels were higher than those in fish fed the control diet. In general, partial or complete replacement of PBM for HFM protein in the experimental diets for Nile tilapia in the present study resulted in dietary amino acid profiles that meet the requirements of this species. These results demonstrated that the amino acids profile of PBM is as good as HFM and the quality of protein in terms of the quantitative essential amino acids of both ingredients are similar.

Dry matter and protein contents in whole-fish body received PBM diets were not significantly affected due to PBM inclusion in fish diets (Table 5). These results indicated that partial or complete replacement of PBM for HFM – protein did not alter the nutritional value of the fish produced. The results also suggested that monosex Nile tilapia efficiently ingested, digested, assimilated and utilized protein from PBM similar to HFM. These results are in agreement with Abdelghany (2003) who reported that partial or complete replacement of HFM with GFM did not affected body composition (protein, fat, and dry mater) of red tilapia. Yang *et al.* (2006) found no significant changes was observed in whole–body moisture and fat content resulted from the different replacement of fish meal with poultry by-product meal.

Conclusion

As a conclusion of this study it is suggested that without amino acid supplementation, PBM could safely replace up to 100 % of HFM in practical diets for monosex Nile tilapia. These results may allow for formulation of less expensive diet for Nile tilapia and may reduce the diet cost for producers

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الإحلال الجزئي والكلى لمسحوق السمك بمسحوق مخلفات مجازر الدواجن فى علائق أسماك البلطى النيلى وحيد الجنس

احمد سعيد دياب ، محمد حسن احمد

١. *المعمل المركزى لبحوث الثروة السمكية-قسم امراض الاسماك.*

٢. *المعمل المركزى لبحوث الثروة السمكية-قسم تغذية الاسماك.*

تم تغذية أصبعيات أسماك البلطى النيلى وحيد الجنس(٣٠جم) فى علائق تتفق فيما بينها فى نسب البروتين (٢٥%) والدهون (٧%) ولكنها تختلف فى نسب احلال مسحوق مخلفات مجازر الدواجن محل مسحوق الأسماك ، حيث كانت نسب الاحلال كالأتى: صفر ، ٢٥ ، ٥٠ ، ٧٥ ، ١٠٠% على أساس وحدة البروتين.

أظهرت النتائج أن احلال مسحوق المجازر محل مسحوق السمك كليا (على أساس وحدة البروتين) لم يؤثر معنويا على نمو أسماك البلطى وحيد الجنس أو كفاءة تحويل الغذاء أو على التركيب الكيماوى للجسم وذلك بالمقارنة بالأسماك التى تناولت العليقة الكنترول والخالية من مسحوق مخلفات مجازر الدواجن. وأن نسبة الأسماك الحية فى نهاية التجربة كانت عالية ومتماثلة إحصائيا فى المعاملات المختلفة . ونستنتج من هذه الدراسة أنه يمكن احلال مخلفات مجازر الدواجن محل مسحوق السمك بنسبة ١٠٠ % فى علائق أسماك البلطى النيلى على اعتبار أنه مصدر رخيص للبروتين .