Studies on growth performance and health status when substituting fish meal by a mixture of oil seeds meal in diets of Nile tilapia (*Oreochromis niloticus*) and grey mullet (*Mugil cephalus*).

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1- Fish nutrition

2- Fish production

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ABSTRACT

This study was designed to determine the maximum replacing levels of Fish Meal protein (FM) by a mixture of oil seeds mealprotein (OSM) in five ration for Nile tilapia and Grey mullet. The OSM consisted of cottonseed, sunflower, canola and linseed meals. FM in the basal diet was replaced by OSM in the ration at replacing levels of (control) 0, 25, 50, 75 and 100%. A total number of 60 fingerlings; 40 of *Oreochromis niloticus* monosex and 20*Mugil cephalus* per hapa (3*8*1 m-2.5/m^3) were randomly distributed into five treatments, each in two replicates. After 6 months of feeding, replacement of 50% of FM by OSM for Nile tilapia and 25% for grey mullet did not significantly affected Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER), Crude Protein (CP) and Ether Extract (EE), while the highest replacing levels (75 or 100%) significantly ($P<0.05$) reduced these parameters. Growth parameters were relatively parallel to those of FCR and PER whereas, replacement up to 50% exhibited Body Weight (BW), Body Length (BL), Weight Gain (WG) and Specific Growth Rate (SGR) not differing significantly ($P<0.05$) from the fish fed control diet. Compared to control, increasing OSM in the ration significantly reduced Hemoglobin, Hematocrit and the activity of Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST). The incorporation of OSM in ration did not significantly affect whole-body Dry Matter (DM) and Crude Protein (CP).

Based on results obtained in this study and on the economical evaluation, it could be concluded that, replacement of FM by OSM up to 50% in tilapia ration but 25% in mullet ration reduced feed costs/kg diet.

Keywords: Growth performance, oil seeds, *O. niloticus*, *M. cephalus*.

INTRODUCTION

Worldwide fishmeal prices have been doubled more than two fold in recent years (FAO, 2013). Despite the increase in fish feed prices, the farm gate prices of aquaculture products have remained stable, literally threatening on the economic viability of thousands of small-scale producers that form the bulk of the aquaculture sector (Rana *et al*., 2009). Moreover, the increasing price of feed ingredients (fishmeal, fish oil, legumes and cereals), energy and transportation costs have complicated the availability of aqua-feeds to many fish farmers globally. This could influence small-scale producers to shift jobs, result to poverty, vulnerability and loss of livelihood especially in developing countries (Rola and Hasan, 2007). Fish feeds account for the highest operational costs in aquaculture with fish meal being the most expensive diet (Munguti *et al*., 2012). Fish require high proportion of protein in their diet because they metabolize protein as energy source (Aladetohun and Sogbesan, 2013). The development of commercial aqua-feeds has been traditionally based on FM as the main protein source thanks to its high protein content and balanced essential amino acid (EAA) profile (El-Saidy & Gaber, 2003). Compared to other animals, the percentage usage of fishmeal in aquaculture has increased significantly with extruded ration being more expensive than pelleted ones.

In Egypt, the intensification of fish farming made it essential to develop complete and supplemental ration for aquaculture. Traditionally, fish meal is the preferred dietary protein source for many farmed fish species to its amino acid balance, vitamin content, palatability and unidentified growth factors (Tacon, 1993). However, the increasing prices of fish meal restricted its use as a protein source for fish ration. Therefore, plant proteins appear to be the most appropriate alternative for fish meal in fish ration. Plant oilseeds and their byproducts usually constitute a major source of dietary protein within aqua feeds for warm water omnivorous/ herbivorous fish species. Some of the factors which limit incorporation of these ingredients at high levels in fish feed ore low protein content, amino acid imbalance and presence of anti-nutritional factors (Wee, 1991).

Various oil seed meals are produced in Egypt on a large scale as byproducts of the edible oil industry. These include cottonseed, sunflower, soybean and linseed meals. The efficiency of various alternative protein sources as partialor complete replacement for fish meal has been individually evaluated in fish ration, e.g. sunflower meal (Ibrahim, 2007), soybean (Soltan *et al*., 2001), linseed meal (El-Saidy & Gaber, 2001) canola (Soltan, 2005) and cottonseed meal (Saudi, 2008). Individually, these plant by-product meals are fairly rich in protein and favorable essential amino acid profiles, but they are deficient in one or more essential amino acids and contain various quantities of anti-nutritional factors (NRC, 2011). Therefore, a mixture of plant protein sources is more appropriate to obtain adequate amino acid profile compared to the incorporation of a single plant protein source (Regost *et al*., 1999). Recently, Mambrini & Kaushik (1995) suggested that amino acid profile of fish meal reflects well the fish amino acid needs which could imply to supplement plant protein based ration at higher levels than required by NRC (2011). So, the present study was carried out to substitute fish meal by graded levels from a mixture of oil seeds meal; for feeding tilapia and mullets with emphasizing the effect of that on both growth performance and health status.

MATERIALS AND METHODS

O. niloticus monosex and *M. cephalus* fingerlings were obtained from a private nursery farm from Kafr Al-Sheikh Governorate, Egypt.

Feeding regime: Five experimental ration were formulated (Table 1) to be isonitrogenous (35% CP) and isocaloric (about 3400 Kcal DE kg^{-1}). Cottonseed, sunflower, linseed, sesame and canola meals were obtained from local market and these meals were mixed equally (25% for each) to obtain the OSM. Fish meal in the experimental ration was replaced (based on protein content) by OSM at 0, 25, 50, 75 and 100% levels. In preparing the ration, dry ingredients were first ground to a small particle size and mixed thoroughly with added water to obtain a 30% moisture level. Rations were passed through a mincer with diameter of 3 mm to produce pellets and were sun-dried for 3 days, (Jobling, 1983).

Table 1: Composition and chemical analysis of the experimental ration.

Feed ingredients	Experimental ration				
	Diet1	**Diet2**	**Diet3**	**Diet4**	**Diet5**
Fish meal (72% CP)	20	15	10	5	0
Yellow corn (9%)	22	20	15	10	9
Soybean meal (44%)	30	28	30	30	32
Oil seed mealmixture (35%)	0	14	23	29	34
Glutine (60%)	5	5	5	5	7
Rice bran (13%)	10	10	10	10	10
Wheat bran (14%)	10	5	5	5	5
Vegetable oil	3	3	3	3	3
Sum	100	100	100	100	100
Vit. & Min. mixture1	0.3	0.3	0.3	0.3	0.3
Chemical analysis					
Crude protein (CP)2	35.18	35.16	35.01	35.01	34.92
Ether extract (EE)	9.16	8.99	9.63	9.88	9.44
Crude fiber (CF)	10.15	10.55	10.94	11.16	12.81
Ash	10.03	10.17	10.11	10.14	10.49

Culture conditions: At the beginning of the experiment, 10 hapas (3×8× 1 m) installed in the earthen ponds were supplied with agricultural drainage water. Each hapa was stocked by 60 fish; 40 tilapia and 20 mullets. Fish were fed the ration at a daily rate of 3% (during the experimental period), of total biomass. Fish were fed the experimental ration 6 days/week (twice daily at 8.00 am and 2.00 pm). The amount of feed was bi-weekly adjusted according to the changes in body weight throughout the experimental period; 6 months.

Water quality: ammonia, nitrite, dissolved oxygen concentration, water temperature and pH were recorded according to APHA (1992).

Growth and feed utilization parameters: Growth performance and feed utilization parameters were determined according to Cho & Kaushik (1985) as follows:

Specific growth rate (SGR) = [(LnW2-LnW1)/t]×100 Where:- Ln = the natural log, W1= initial fish weight; W2 = the final fish weight in "grams" and t = period in days.

Feed conversion ratio (FCR) = feed intake (g)/wet weight gain (g),

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

Blood samples and liver function tests: Blood samples were obtained from fish at the end of experimental period. Five fish per hapa were randomly taken and anaesthetized (with clove oil at 100 mg L^{-1}). Blood samples were collected from the caudal vein using heparinized 27-gauge needles and tuberculin syringes. Hematocrit (Ht) was determined using the micro-Ht method described by Brown (1988). Hemoglobin (Hb) was determined using the total Hb kit (Sigma Diagnostics, Sigma, St Louis, MO.USA) which is a standardized procedure using the cyanome-themoglobin method. Serum was assigned for determination of Aspartate transaminase (AST) and Alanine transaminase (ALT) according to Reitman and Frankel, (1957).

Chemical analysis: finally, three fish were subjected to the chemical analysis of whole fish body composition (AOAC, 1990).

Statistical analysis: The statistical analysis of data was carried out by applying the computer program, SAS (1996) by adopting the model: $Y_{ij} = \mu + \alpha_i + e_{ij}$

Where, Y_{ij} = the observation on the j_{th} fish eaten the i_{th} diet; μ = overall mean, α_i = the effect of i_{th} diet and e_{ij} = random error.

Differences among means were tested for significancy according to Duncan's multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

Water quality:

During the experimental period, water temperature ranged from 22- 31°C, dissolved oxygen from 4.55 to 7.23 mg L-1, pH from 7.11 to 7.99 and total ammonia from 0.09 to 0.13 mg L-1. There were no significant (P<0.05) differences in water quality parameters within treatments, indicating that the experimental ration was suitable for water quality of experimental fish. Moreover, these values are compatible with the means needed for tilapia and mullet growth (Gui *et al*. 1989) therefore; all fish were in normal activity.

Growth performance:

As described in Table (2), the highest average BW or Nile tilapia (221.28) and grey mullet (187.65) were recorded for control group which fed the basal diet (control). Replacing of 25% or 50% of fish meal protein (FM) by Oil seed mealprotein (OSM) reduced the final BW to 212.00 and 208.34 g for Nile tilapia but these values did not significantly different from that fed the basal diet. While, for grey mullet replacing 25% reduced the final BW to 180.39 g this value did not significantly different from that fed the basal diet (Table 2).

Table 2: Growth performance of tilapia and mullet fed substituted levels of meal (FM) by Oil seed meal (OSM).

Parameter	No.	0% (control)	25%	50%	75%	100%
Nile tilapia						
Initial w	40	15.15±0.61	15.23±0.61	15.09±0.61	15.15±0.61	15.16±0.71
Final w	40	221.28±2.75a	212±2.75ab	208.34±2.75ab	179.9±2.75b	162.9±2.75c
Initial L	40	7.91±0.30	8.31±0.30	7.05±0.30	8.35±0.30	7.29±0.30
Final L	40	24.14±1.12a	23.72±1.12a	23.07±1.12a	21.53±1.12b	21.85±1.12b
Initial K	40	0.85±0.13	0.87±0.13	0.78±0.13	0.89±0.13	0.79±0.13
Final K	40	1.82±0.27b	1.87±0.27b	1.99±0.27ab	2.15±0.27a	1.84±0.27b
Grey mullet						
Initial w	20	19.07±0.62	19.20±0.62	18.515±0.62	18.44±0.62	18.86±0.62
Final w	20	187.65±1.89a	180.39±1.89a	144.05±1.89b	143.35±1.89b	117.69±1.89c
Initial L	20	8.44±0.42	8.33±0.42	8.21±0.42	8.09±0.42	8.17±0.42
Final L	20	26.69±1.49a	25.56±1.49ab	25.80±1.49ab	24.74±1.49b	24.18±1.49b
Initial K	20	1.01±0.17	0.97±0.17	1.18±0.17	1.21±0.17	1.03±0.17
Final K	20	0.83±0.33ab	0.90±0.33a	0.71±0.33b	0.80±0.33ab	0.70±0.33b

Means followed by the different letters in each row for each trait are significantly different (P<0.05).

In *O. niloticus*, compared to fish fed the basal diet, the higher replacing levels of FM by OSM (75 or 100%) significantly (P<0.05) decreased the BW of Nile tilapia fish to 179.9 and 162.9 g, respectively indicating the possibility of replacing 50% of FM in the basal ration of Nile tilapia fish by OSM without adverse effect on the final BW.

But in *M. cephalus*, the higher replacing levels of FM by OSM (50, 75 and 100%) in the rationOSM50, OSM75 and OSM100 significantly (P<0.05) decreased the BW of grey mullet fish to 144.05, 143.35 and 117.69 g, respectively indicating the possibility of replacing 25% of FM in the basal ration of Grey mullet fish by OSM without adverse effect on the final BW.

Plant proteins are almost similar to FM in terms of the protein content and protein and amino acid digestibility. However, their amino acid profile does not match the amino acid requirement of some fish species as FM does (Hardy, 1996). For example Methionine is the limiting amino acid in soybean meal (SBM), while corn gluten meal is deficient in lysine (Gallagher, 1994). Wheat gluten meal is limited in lysine and arginine (Gallagher, 1994). So far, nutrition research has concentrated on the replacement of animal protein by plant proteins (Liti *et al*., 2006) but the palatability of many plant materials is hindered by presence of anti-nutritional factors and low bioavailability (Francis *et al*., 2001). Some plant proteins contain phosphorus phytate, which binds phosphorus, reduces palatability and interferes with the bioavailability of divalent trace elements (Gallagher, 1994). On the other side, Tacon and Metian, 2008 found that plant based feeds containing soybean meal protein, canola meal, extruded pea seed meal, wheat and corn meal supplemented with lysine and methionine has been used in the formulation feeds for catfish, tilapia and carps without affecting their growth performance.

Finally the highest average BL for Nile tilapia (24.14cm) was recorded for fish control group followed in a descending order by those fed the control diet, OSM25 (23.72 cm), OSM50 (23.07), OSM75 (21.53), and OSM100% (21.85), respectively and the differences between fish groups were significant. While, in Grey mullet the highest average BL (26.69cm) was recorded for fish control group followed in a descending order by those fed the control diet, OSM25 (25.56 cm), OSM50 (25.80), OSM75 (24.74), and OSM100 (26.18), respectively and the differences between fish groups were no significant.

The highest average condition factor (K) for Nile tilapia (2.15) was recorded for fish group fed the diet OSM75 followed in descending order by those fed the diet OSM50 (1.99), FFS25 (1.89), OSM100 (1.84), and FFS0 (1.82). And the highest average K for Grey mullet (0.90) was recorded for fish group fed the diet OSM25 followed in descending order by those fed the diet FFS25 (0.83), OSM75(0.80), OSM50 (0.71) and FFS0 (0.70). Growth in the fish can be readily monitored by measuring the increase in weight and length. Another parameter which may be used as index for growth is the K, which provides a measure of fattiness of fish and feed conversion efficiency (Power, 1990).

Weight gain (WG) and specific growth rate (SGR):

Results of Table (3) indicated that, increasing level of substituting levels of FM by OSM up to 50% for Nile tilapia and 25% for Grey mullet did not significantly affected WG of Nile tilapia fish while the highest substituting levels significantly decreased WG and the same trend was also observed for specific growth rate (SGR).

Mucilage in linseed (5-8%) could increase the delay of diet retention in stomach, affecting FI through feedback on satiety signals. Also, mucilage has a large capacity to bind to water and increases intestinal viscosity, thus reducing nutrient digestibility (Fedeniuk & Biliaderis, 1994).

Canola meal contains phenolic compounds (such as sinapin and tannin) that may reduce palatability (McCurdy & March, 1992) and reduce protein digestibility (Krogdahl, 1989). Canola meal also contains glucosinolates which act as anti-thyroid factors (Teskeredzic *et al*., 1995). The high fiber content of canola meal may reduce protein and energy digestibility (Higgs *et al*., 1983).

Phytic acid (present in linseed meal) negatively affects the utilization of minerals which can be seen by its ability to bind up to 75% of all phosphorus (NRC, 1998). It can chelate di- and tri-valent metals including calcium, magnesium, zinc and iron into compounds that are less easily absorbed in the intestine. Phytic acid also has the ability to nonselectively bind to protein and inhibit activities of a number of digestive enzymes such as pepsin, trypsin and alpha-amylase (Liener, 1994). Cyanogenic compounds in linseed meal are a toxic for fish (Poulton, 1989).

Table 3: Daily weight gain and specific growth rate of tilapia and mullet fed substituted levels of meal (FM) by Oil seed meal (OSM).

Parameter	No.	0% (control)	25%	50%	75%	100%
Nile tilapia						
DWG	40	2.11±0.37a	2.02±0.37ab	1.98±0.37ab	1.70±0.37b	1.54±0.37c
SGR	40	3.03±0.41a	2.99±0.41a	2.98±0.4a1	2.84±0.41ab	2.74±0.41b
Grey mullet						
DWG	20	1.84±0.40a	1.77±0.40ab	1.42±0.40b	1.41±0.40b	1.16±0.40c
SGR	20	3.01±0.46a	2.96±0.46a	2.83±0.46b	2.83±0.46b	2.61±0.46c

Means followed by the different letters in each row for each trait are significantly different ($P<0.05$).

Cottonseed meal usually contains 0.4 to 1.7% gossypol. Free gossypol, when present in large quantity in the diet, has been shown to be toxic to monogastric animals including fish (Barros *et al*., 2002). Consequently, the increased levels of OSM in the ration may reduce growth, feed intake, feed and protein utilization, digestibilities of the different nutrients and histological changes in the liver and kidney (Kissil *et al*., 1997).

The finding that the incorporation of more than 50% of FM by OSM significantly decreased fish growth in agreement with the poor growth reported by Fournier *et al*. (2004) who found that replacement of FM by a OSM (lupin, corn gluten and wheat gluten meal) in the ration of juvenile turbot (*Psetta maxima*) up to 50% did not significantly affect growth rate, while the highest replacing levels (75 or 100%) significantly reduced growth rate. On the other hand, El-Saidy & Gaber (2003) substituted FM by a OSM (soybean, cotton seed, sunflower and linseed meal) in ration of Nile tilapia. They found that the partialor complete replacement of FM by OSM exhibited growth performance not differing significantly from the fish fed the control diet. Moreover, Lee *et al*. (2002) with rainbow trout, *Oncorhynchus mykiss* found that FM could be entirely replaced by a mixture of plant proteins (cottonseed meal, soybean meal) and animal by-product proteins without adverse effect on growth rate and feed utilization. Such different findings reflect the fact that the utilization of OSM differs considerably, depending on the kind and quality of meals incorporated inthe ration.

Feed utilization:

The best food conversion ratio (FCR) was obtained for fish fed the control diet while, the best and protein efficiency ratio (PER) was obtained for fish feed25% replacement and these parameters did not significantly affected when 25 to 50% of FM was replaced by OSM. The highest replacing levels (75 or 100%) significantly altered FCR and PER (Table 4). The obtained results clearly showed that, replacing up to 50% for Nile tilapia and 25% for grey mullet of FM by OSM favored FCR and PER.

Possible reasons for the reduced feed utilization, digestibility and growth parameters could be attributed to that the high-crude fiber and poor platability of OSM might reduce FI and adverse FCR and PER (Luo *et al*., 2006). In addition to the presence of identified or unidentified anti-nutritional factors in OSM which increased in the diet with increasing the substitution of FM by OSM that reduced feed utilization for the different nutrients and fish growth.

Table 4: food conversion ratio ant protein efficiency ratio of tilapia and mullet fed substituted levels of meal (FM) by Oil seed meal (OSM).

Parameter	No.	0% (control)	25%	50%	75%	100%
Nile tilapia						
FCR	40	1.91±0.19a	1.87±0.19ab	1.85±0.19ab	1.69±0.19b	1.64±0.19b
PER	40	1.65±0.12b	1.69±0.12b	1.86±0.12a	1.88±0.12a	1.92±0.12a
Grey mullet						
FCR	20	1.80±0.22a	1.72±0.22ab	1.70±0.22ab	1.58±0.22b	1.52±0.22b
PER	20	1.52±0.16b	1.58±0.16b	1.70±0.16ab	1.71±0.16ab	1.80±0.16a

Means followed by the different letters in each row for each trait are significantly different (P<0.05).

Proximate analysis of fish whole-body:

DM of whole body showed no significant variations for CP contents (Table 5). The whole-body content of EE and ash significantly (P<0.05) increased with decreasing the OSM content of tilapia and mullet ration.

Table 5: Proximate analysis of fish whole-body of tilapia and mullet fed substituted levels of meal (FM) by Oil seed meal (OSM).

Parameter	No.	0% (control)	25%	50%	75%	100%
Nile tilapia						
Dry matter	40	28.7 ± 0.74	28.84± 0.74	29.23± 0.74b	29.33± 0.74	27.29± 0.74
Protein	40	63.27±2.64	63.04±2.64	62.26±2.64	62.22±2.64	59.73±2.64
Ether extract	40	22.08±0.32a	21.91±0.32b	21.89±0.32b	21.58±0.32c	21.33±0.32c
Ash	40	12.56±0.28a	12.05±0.28a	12.70±0.28a	12.08±0.28a	15.62±0.28b
Grey mullet						
Dry matter	20	29.92± 0.81	29.97± 0.81	28.97± 0.81	31.06± 0.81	27.95± 0.81
Protein	20	71.09±2.11	71.03±2.11	70.73±2.11	70.37±2.11	70.17±2.11
Ether extract	20	13.03±0.49a	13.03±0.49a	13.01±0.49a	12.94±0.49b	12.89±0.49b
Ash	20	13.27±0.30b	13.16±0.30b	13.41±0.30b	13.90±0.30ab	14.14±0.30a

Means followed by the different letters in each row for each trait are significantly different (P<0.05).

Concerning proximate whole-body composition, DM and CP contents of Nile tilapia and grey mullet were not affected by dietary protein source. More or less, El-Saidy & Gaber (2003) in Nile tilapia, Regost *et al*. (1999) in turbot, Moyano *et al*. (1992) in rainbow trout, Pongmaneerat *et al*. (1993) in carp and Shimeno *et al*. (1993) in yellowtail did not find any effects of OSM on the whole-body protein content. In contrast to our results, they also found that the whole-body fat and ash contents had not significantly varied when compared to the control. This is expected as fish in all treatments did not grow essentially at the same rate. Both Barros *et al*. (2000) and Yildirim *et al*. (2003) reported that body fat content is closely related to weight gain and inversely related to body moisture content.

Blood parameters and liver function:

Hematological parameters of fish are closely related to the response of fish to environmental and biological factors. For example, in response to ecological and physiological conditions, major changes occur in the fish blood composition, such as fluctuations in the levels of red blood cells, white blood cells, hormones, hematocrit, hemoglobin concentration, leukocytes counts, and other basic components. Therefore, the analysis of blood indices is a valuable guide in assessing the condition of fish, as it provides a reliable index of their physiological condition, a set of data that is especially important in sturgeon aquaculture, (Fernandes and Mazon 2003).

Compared to the control group, hemoglobin and hematocrit readings decreased proportionally with increasing substituting levels of OSM in the experimental ration (Table 6). All fish fed ration with OSM protein replacement had significantly (P<0.05) lower hematocrit and hemoglobin readings compared to the control group.

The few data that have been published on the effect of the CGM and sesame oil cake on hematocrit are not always consistent. What is more, there are no clear relationships between the replacement level of fishmeal with alternative proteins in the diet and deterioration of hematological parameters of the cultured fish (Moreau *et al.*, 1999).

The values of hemoglobin and hematocritare an indicator for the rate of hemoglobin synthesis during red cell formation and also erythrocyte fragility (Barraza *et al*., 1991). The hemoglobin and hematocrit readings of control group (Table 6) in our study were within the normal levels (Sun *et al*., 1995). Hemoglobin and hematocrit levels in fish fed ration containing 100% OSM protein were about half lower than the control group. Interpreted to that OSM-containing rationhelps binding of phytic acid and gossypol molecules and the other toxic factors in OSM to minerals (iron) and/or amine group of amino acids, causing their low availabilities in the body and increased erythrocyte fragility.

On the other side, an opposite trend was observed for the values of liver enzymes (ALT and AST), in which increased levels of OSM in the ration significantly increased the levels of ALT and AST. Large amounts of ALT and AST released into blood mostly due to liver cell damage. Thus, detection of serum level of ALT and AST provessome liver cell damage. Regarding the serum level of ALT and AST in the control group significant increase with increasing the substitution by OSM in the experimental ration was observed (Canli, 1996). Cellular damage indicators (ALT and AST) significantly ($P<0.001$) increased as OSM increased in the ration, indicating the abnormal liver function and this may be due to increasing the identified or un-identified anti-nutritional and toxic factors presented in OSM. The increasing levels of toxic factors as the level of OSM increased in the ration showed the degree of liver cells damage. These results came close to the findings of Domezain *et al*. (2002) who mentioned that Food quality strongly influences the morphological characteristics of blood, and the qualitative and quantitative properties of hemoglobin in fish.

Table 6: Haematology and serology of tilapia and mullet fed substituted levels of meal (FM) by Oil seed meal (OSM).

Parameter	No.	0% (control)	25%	50%	75%	100%
Nile tilapia						
Hemoglobin (g/dl)	40	8.10±0.09a	6.50±0.09b	6.27±0.09b	6.63±0.09b	5.43±0.09c
Hematocrit (%)	40	27.90±0.83a	26.87±0.83b	24.00±0.83c	23.50±0.83d	20.37±0.83e
ALT	40	53.17±0.71e	67.67±0.71d	72.33±0.71c	78.00±0.71b	83.00±0.71a
AST	40	60.00±0.57d	61.67±0.57d	70.00±0.57c	76.33±0.57b	85.33±0.57a
Grey mullet						
Hemoglobin (g/dl)	20	7.68±0.12a	6.37±0.12b	6.23±0.12b	5.77±0.12c	4.56±0.12d
Hematocrit (%)	20	25.13±0.87a	24.80±0.87ab	23.50±0.87b	21.37±0.87c	20.12±0.87c
ALT	20	57.06±0.68d	63.33±0.68c	66.67±0.68c	76.77±0.68b	85.79±0.68a
AST	20	69.19±0.49d	75.67±0.49c	77.33±0.49c	80.00±0.49b	99.88±0.49a

Means followed by the different letters in each row for each trait are significantly different ($P<0.05$).

CONCLUSION

The present study indicted the potential of PPM for inclusion in commercial Nile tilapia feeds, as well as being of immediate importance for feed production in Egypt. From the all aforementioned results, it could be detected that PPM could be utilized by tilapia safely and efficiently as alternative protein instead of 50% for Nile tilapia and 25% for grey mullet of FM without adverse effects on the performance of tilapia. This observation is supported by the ADC for DM, CP and EE values for diets containing mixtures of plant protein meals. In addition, these plant protein sources are locally available at much lower prices than imported FM.

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ARABIC SUMMARY

دراسات على أداء النمو والحالة الصحية عند استبدال مسحوق السمك بمخلوط أكساب بروتين نباتى فى علائق أسماك البلطى النيلى والبورى

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٣- قسم تغذية الاسماك.

صممت هذه الدراسة لتحديد الحد الأقصى لإحلال خليط من بروتين بذورالمحاصيل الزيتية محل مستويات بروتين مسحوق السمك. أستخدمت خمسة معاملات لأسماك البلطي النيلي والبوري. و يتكون هذا الخليط من بذرة القطن ودوارالشمس وبذرالكانولا وبذرالكتان بنسب متساوية. تم استبدال مسحوق السمك في النظام الغذائي القاعدي بواسطة خليط من بروتين بذور المحاصيل الزيتية بخمس مستويات ٠، ٢٥، ٥٠، ٧٥ و ١٠٠٪. تم تسكين ٦٠ إصبعية لكل هابة ٤٠ إصبعية من البلطي النيلي وحيد الجنس و ٢٠ إصبعية من البورى في الهابة (٣ x ٨ x ١م - ٢.٥ / م٣ - مكررتين لكل معاملة). إستمرت التجربة ٦ أشهر، وفى نهاية التجربة وجد أن يمكن إحلال ٥٠٪ خليط من بروتين بذورالمحاصيل الزيتية محل مسحوق السمك عن البلطي النيلي و ٢٥٪ للبوري حيث لم يتأثر بشكل كبير معدل التحويل الغذائى ومعامل كفاءة البروتين، البروتين الخام ومستخلص الأثير، في حين أن مستويات أعلى من الإحلال (٧٥ أو ١٠٠٪) كان له تأثير معنوي. وكان أداء النمو موازي نسبيا لمعدل التحويل الغذائى ومعامل كفاءة البروتين، واستبدال ما يصل الى ٥٠٪ لأسماك البلطى النيلى و ٢٥٪ لأسماك البورى لم تؤثر فى وزن الجسم، طول الجسم، زيادة هذه الدراسة، وعلى تقييم اقتصادي، يمكن أن نخلص إلى أن استبدال مسحوق بخليط من بروتين بذور المحاصيل الزيتية بنسبة تصل إلى ٥٠٪ في علائق البلطي النيلى ولكن ٢٥٪ في علائق البوري خفضت تكاليف العليقة بنسبة ٢٥% لكل كيلو جرام عليقة.