Effect of Fishmeal Substitution by Plant Protein Sources on Growth Performance of Seabass *(Dicentrarchus labrax)* Fingerlings

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Abstract: Partial and complete replacement of fishmeal by mixture of plant protein (PP) sources (corn gluten and soybean meal) was fed to Seabass fingerlings for 120 days. No significant differences were observed for specific growth rate (SGR) and feed efficiency among Seabass fingerlings fed diets containing FM, PP25 and PP50. Liver weight and hepatosomatic index decreased with the plant protein inclusion but liver fat increased with plant protein inclusion. These results suggest the PP25 and PP50 can replace fishmeal in diets for Seabass fingerlings.

Keywords: Fishmeal replacement, growth performance, Seabass

INTRODUCTION

Protein is the single most expensive ingredient in fish diets. Fish meal is mostly imported at higher prices and there costs increase every year. Therefore, it is urgent to find out alternative protein sources to replace such imported ones. In the last decade the increasing demand, price and world supply fluctuations of fish meal (FM) has emphasized the need to look for alternative protein sources in aquafeeds. Therefore an intensive effort during these last decades has been made in order to evaluate the potential of alternative protein sources in aquafeeds (Alexis, 1997).From the all plant protein feedstuffs, soybean meal considered to be the most nutritive and it is used as the major protein source in many fish diets. Partial or even total replacement of dietary fish meal by soybean meal protein sources had successfully accomplished in tilapia diets (Soltan, *et al*, 2001; Fagbenro and Davies 2002; Wilson, *et al.*, 2004; Soltan, 2005 and Magdy, 2006).

Some studies in gilthead sea bream have shown that partial replacement of FM by PP is possible (Robaina, *et al.*, 1995; Hassanen, 1997a,b; 1998; Kissil, *et al.*, 2000; Pereira and Oliva-Teles 2002, 2003).

The objective of this study was conducted to investigate the effect of partial or complete replacement of fish meal by plant protein sources on growth performance, feed efficiency and cost of production of Seabass fingerlings diets.

MATERIALS AND METHODS

Diet preparation

Five isocoloric and isonitrogenous diets were formulated (Table 1). They were based on FM as the only protein source or a mixture of PP (plant protein sources, corn gluten and soybean meal) which were formulated to replace 25, 50, 75 and 100 of the FM (fishmeal protein). Fish oil was added as a major dietary lipid source to make all the diet isolipidic (Table 1). The diets were pelleted using grinder of kitchen aid with a 1.5 mm diameter and kept frozen until the experiment started. Diets were analyzed for crude protein, crude lipid, crude fiber and ash according to A.O.A.C. (1995) as shown in Table 2. During the growth period (120 days), each diet was randomly allocated to triplicate tanks of fish. Feed was offered by hand in two meals / day (8:00h and 15:00 hours) at 3% of body weight and the amount of diets were readjusted after each weighing.

Table (1): Composition of the experimental diets

Ingredient (g/100g)	Diet				
	FM	PP/25	PP/50	PP/75	PP/100
Fish meal (CP 70%)	71.5	53.5	35.5	18	-
Corn gluten meal (62%)	-	10	25.5	48	70
Soybean meal (44%)	-	14.5	21	18	15
Yellow corn	16.5	9	4	2	-
Fish oil	10	11	12	12	13
Vit & Min mix[1]	2	2	2	2	2
Total	100	100	100	100	100

1. Vit. Min mix each (kg) contain.

Vitamin A	20 000 I.E	Vitamin D	2 000 I.E
Vitamin E	66 mg	Vitamin B_1	10 mg
Vitamin B_6	20 mg	Vitamin B_2	20 mg
nicotinamide	60 mg	Pantothenic acid	66.6 mg
choline chloride	1 000 mg	Vitamin B_{12}	0.027 mg
Folice acid	33.3 mg	Inosital	455 mg
Vitamin C	400 mg	Vitamin K	3.33 mg
Zinc	33 mg	Cobalt	0.7 mg
manganese	50 mg	Iron	50 mg
dicalcium phosphate	10 000 mg		

Table (2): Proximate analysis of the experimental diets

Chemical analysis	Diet				
	FM	PP/25	PP/50	PP/75	PP/100
Moisture	8.50	8.00	8.30	8.70	8.80
Crude protein	50.2	50.1	50.1	50.2	50.3
Crude fat	16.50	16.01	15.99	15.25	15.14
Crude fiber	1.01	1.94	2.75	3.98	2.17
Crude ash	9.45	8.21	6.81	4.26	3.51
NFE[1]	14.34	15.74	16.05	17.61	20.08
Gross Energy (kcal/100gm)[2]	498.35	498.89	499.97	499.94	509.59
P/E Ratio (mg protein/Kcal)	100.7	100.4	100.2	100.4	98.7

1. Nitrogen free extract.
2. Based on 5.65 Kcal/g protein, 9.45 Kcal/g fat and 4.1 carbohydrate Kcal/g (NRC, 1993)

Experimental design

Seabass fingerlings were obtained from Ashtom El gamel, Port-Said governorate. Fish were acclimated to laboratory conditions for 2 weeks before being randomly distributed into fiberglass tank of 300-L water capacity each. Fish of 10±0.2 g initial body weight were distributed into 15 experimental tanks in triplicate groups of 50 fish each. Water temperature was maintained at 25°C by a 250- watt immersion heater with thermostat. Water temperature and dissolved oxygen were recorded daily (by metteler Toledo, model 128.s/No1242), other water quality parameters including pH and ammonia every were measured two days by pH meter (Orion model 720A,s/No 13062) and ammonia meter (Hanna ammonia meter). Water salinity was 34ppt. The average water quality criteria of all tanks are presented in Table 3. The experiment was lasted for 120 days. All fish in each tank were weighed every 10 days.

Table3: Average water quality parameters in the experimental tanks used in the study

Parameter	Means*
Temperature	25±1°C
Oxygen (mg/L)	5±1
Ammonia NH_3(mg/L)	0.001±0.0001
pH	7.0±0.10
Salinity ppt	34.0±0.8

*Means ±SD.

Statistical analysis

All of the data were subjected to one way analysis ($P<0.05$) of variance using the SPSS version 10/PC program (Statistical Package Computer Software, Chicago, Illinois, USA, 2001).The treatment means were compared according to method of Duncan new multiple range test (Duncan.,1955). The used model was: $Yij = \mu + Ti + eij$

Where

μ = over all mean.

Yij =the observation of the individual from T treatment

Ti= the fixed effect of T the diet.

Eij= the experimental random error associated with individual J.

RESULTS AND DISCUSSION

The growth performance of Seabass fingerlings which fed different diets are shown in Table 4. Average body weight (g) of Seabass fed experimental diets at the start did not differ, indicating that groups were homogenous. At the end of the experimental period (120 days) the group of fish fed fishmeal diet and group which contains PP25 had a significantly ($P<0.05$) higher weight gain, feed efficiency than the rest of experimental groups. Whereas the lowest BW (88.3 g) was achieved by group of fish fed PP100 (FM was totally replaced by plant protein sources). On the other hand the groups of fish fed on FM, PP25 and PP50 had a significantly ($P<0.05$) higher SGR, PER than the rest of experimental groups. However at the end of the trial, SGR were 1.94, 1.92, 1.84 and 1.81 for groups of fish fed on FM, PP25, PP50 and PP75, respectively and their FE was significantly improved in comparison to group of fish fed FM diet in agreement with Gomes, *et al.*, (1995a); Gomes, *et al.*, (1995b) for rainbow trout. They reported that replacement of fishmeal by plant protein sources had no adverse effects on growth and feed utilization. Also, Gallgher (1994) reported that up to 75% of fishmeal protein of hybrid striped bass diets can be replaced with soybean meal protein. It is close to the results of the present study. Moreover, Asitjo-Bobadilla, *et al.*, (2005) reported that up to 75% of fishmeal protein can be replaced by plant protein sources for juvenile sea bream, which in agreement of the present study for Seabass fingerlings. However, PP100 had significantly ($P<0.05$) the lowest weight gain, SGR, PER, FE and the highest FCR. These are in agreement with Asitjo-Bobadilla, *et al.*, (2005) and Tibaldi, *et al.*,(2006). In the recent years, significant amount of research has been conducted on the replacement of FM by different PP. The suitability of this replacement in terms of growth performance has resulted to be highly variable among fish species and experimental conditions. Thus, specific trials have to be performed for each species. In European Seabass (*D.labrax*) (Kaushik, *et al.*, 2004) and gilthead sea bream (*S.aurata*) (Pereira and Oliva-Teles, 2003; Gómez-Requeni, *et al.*, 2004), recent short-term studies have shown that at least 60-75% of FM can be replaced by mixture of PP without compromising growth performance. In the present study, the effects of FM replacement were studied on growth performance. This scenario, a high level of FM replacement (50-75%) produced a slight reduction in growth performance.

In all experimental groups, liver weight and hepatosomatic index decreased significantly (P<0.05) with increasing PP sources in the diets (75 and 100% replacement) (Table 4). However, liver fat percent increased significantly (P<0.05) with replacing fishmeal by 75 and 100%, which in agreement with the study of Asitjo-Bobadilla *et al.*, (2005).

Economic Evaluation

Calculation of the economical efficiency of the tested diets was based on the costs of feed because the other costs were equal for all studied treatments. As described in Table (5) feed costs (L.E) were the highest for the fishmeal diet and gradually decreased with increasing the replacing levels of plant protein sources. These results indicate that incorporation of PP in Seabass diets reduced the total costs. However, all replacing levels of fishmeal by PP (75 and 100) Adversely affected all the growth and feed utilization parameters (Table 4), but the incorporation of PP in Seabass diets seemed to be economic as incorporation of PP in the diets sharply reduced feed costs by 25.31, 35.40 and 44.10% for PP25, PP50 and PP75, respectively. The reduction of feed costs was easily observed for the feed costs per Kg weight gain which decreased with increasing incorporation levels of PP in agreement with Soltan (2005) for Nile tilapia.

Table (4): Growth performance, liver fat content of Seabass (*D. labrax*) fed the experimental diets

Parameters	Diet				
	FM	PP 25	PP50	PP75	PP100
Average Initial body weight (g)	10.4±0.05	10.4±0.25	10.5±0.10	10.4±0.10	10.4±0.23
Average Final body weight (g)	106.6±0.2^{a}	104.3±0.3^{a}	95.7±0.20^{b}	91.2±0.2^{c}	88.3±0.20^{c}
Average Weight gain (g)	96.2±1.1^{a}	93.9±1.2^{a}	85.2±0.9^{b}	80.8±0.10^{c}	77.9±1.10^{c}
SGR (%)[1]	1.94±0.02^{a}	1.92±0.01^{a}	1.84±0.02^{b}	1.81±0.09^{b}	1.78±0.01^{c}
Feed intake (g)	153.92±0.4^{d}	161.50±0.2^{c}	166.14±0.10^{b}	161.6±0.2^{c}	177.38±0.10^{a}
Feed conversion[2]	1.60±0.10^{d}	1.72±0.1^{d}	1.95±0.10^{c}	2.0±0.1^{b}	2.28±0.20^{a}
Protein efficiency ratio[3]	1.24±0.01^{a}	1.16±0.02^{b}	1.02±0.01^{c}	99.6±0.10^{c}	0.87±0.20^{d}
Feed efficiency[4]	0.62±0.1^{a}	0.58±0.10^{a}	0.51±0.10^{b}	0.50±0.10^{b}	0.44±0.12^{c}
Liver weight (g)	3.20±0.10^{a}	3.10±0.10^{a}	2.75±0.12^{b}	2.51±0.01^{c}	2.26±0.10^{d}
HSI (%)[5]	3.00±0.1^{a}	2.97±0.1^{a}	2.87±0.12^{b}	2.75±0.01^{c}	2.56±0.12^{d}
Liver fat (% wet mater)	7.1±0.1^{c}	7.3±0.2^{c}	7.5±0.12^{b}	7.7±0.2^{a}	7.7±0.13^{a}
Mortality (%)	5.0±1.0	5.0±1.0	6±1.0	5.0±1.0	6±1.0

Values in the same row with a common superscript letter are not significantly different (P<0.05).

1- Specific growth rate = (100 x [(Ln final wt (g) – (Ln initial wt (g) / days.]
2- Feed conversion = feed intake (g) / body weight gain (g).
3- Protein efficiency ratio (PER) = gain in weight (g) / protein intake (g).
4- Feed efficiency = body weight gain (g) / feed intake (g).
5- Hepatosomotic index = 100 x liver wt / fish wt.

Table (5): Feed cost (L.E) for producing one Kg weight gain by Seabass (*D.labrax*) fingerlings fed on the experimental diets

Experimental diets	Cost (L.E)/kg	Relative fishmeal diets	Decrease in feed cost (%)	FCR	Feed cost (L.E/Kg) weight gain	Relative to fish meal diet
FM	6.44	100	0.00	1.60	10.30	100
PP25	4.81	74.70	25.31	1.72	8.27	80.29
PP50	4.16	64.60	35.40	1.95	8.11	78.73
PP75	3.60	55.90	44.10	2.00	7.20	69.90
PP100	2.98	46.30	53.73	2.28	6.79	65.92

Feed ingredients price of 2004.

CONCLUSION

From the aforementioned results, it could be concluded that incorporation of plant protein sources (Corn gluten and soybean meal) in Seabass fingerlings diets, at level 25 and 50% of fish meal protein under the present study.

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تأثيرأحلال مسحوق السمك بمصادر بروتينية نباتية على أداء النمو لإصبعيات سمك القاروص

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تم إحلال مخلوط من البروتين النباتى (كسب فول الصويا – جلوتين الذرة) بدلاً من مسحوق السمك بنسب إحلال ٢٥ و ٥٠ و٧٥ و١٠٠% فى علائق غذيت بها إصبعيات سمك القاروص لمدة ١٢٠ يوم. وقد وجد أنه لا توجد فروق معنوية بين مجموعات الأسماك التى غذيت على مخلوط من البروتين النباتى بنسب إحلال ٢٥ و ٥٠% مقارنة بالمجموعة التى غذيت على مسحوق السمك بمفرده وذلك فى معدل النمو النسبى والكفاءة الغذائية. كما وجد أنه يقل وزن الكبد ودليل الكبد البنكرياسى و يزداد دهن الكبد بزيادة نسب الإحلال بالمصادر النباتية. ويستنتج من هذه الدراسة أنه يمكن إحلال مخلوط من البروتين النباتى (كسب فول الصويا – جلوتين الذرة) بنسبة ٢٥ و ٥٠% محل مسحوق السمك فى علائق سمك القاروص.