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Effect of Fishmeal Substitution by Plant Protein Sources on Growth Performance and Body Composition of gilthead sea bream *(Sparus aurata)* Fingerlings

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ABSTRACT

This experiment was conducted to investigate the effect of partial and complete replacement of fishmeal protein by mixture of plant protein (PP) sources (corn gluten and soybean meal) on growth performance, body composition and economical efficiency of sea bream (*S aurata*) fingerlings. In this experiment, 750 fingerlings of sea bream with an average body weight (10.0±0.2g) were reared in five nutritional groups for 120 days on optimal conditions. No significant differences were observed for specific growth rate (SGR) and feed efficiency among sea bream fingerlings fed diets containing FM, PP25 and PP50%. Apparent protein digestibility was decreased for sea bream fingerlings fed diets with PP levels of 75 and 100%. Hepato-somatic index decreased with the increase of inclusion of plant protein in the experimental diets. In terms of blood measurements, no significant differences were detected in plasma total protein, plasma albumin and plasma globulins of fish fed the experimental diets, also economical efficiency showed that the reduction of feed costs was easily observed for the feed costs per Kg weight gain which decreased with increasing incorporation levels of PP. Therefore, it could be concluded that the PP25 and PP50% can replace fishmeal protein in diets for sea bream fingerlings under similar experimental conditions.

Keywords: Fishmeal replacement, growth performance, sea bream.

INTRODUCTION

Gilthead sea bream production in Mediterranean countries increased from 30 000 tons in 1996 to 90 000 tons in 2005,which mean that sale prices dropped considerably, from 6.6 € /

kg in 1996 to 5 € / kg in 2005, with an historic minimum of 4 € / kg in 2002 (APROMAR, 2006). To maintain the profitability of gilthead sea bream farms, cutting production costs is necessary, mainly through feeding, which represents between 38 and 45% of operational costs (Lisac & Muir, 2000 and Merinero *et al.*, 2005). Reductions in feeding costs can be obtained by optimizing feeding strategies, nutrient levels in diets, and by using vegetable sources as substitutes for fish oil and fish meal. This aspect is also very important to improve the sustainability of aquaculture, as it would reduce dependence on fish sources. The requirements of dietary protein for gilthead sea bream are 45 – 50 % (Kissil *et al.*, 2000). Therefore, it is urgent to find out alternative protein sources to replace such imported ones (Abdelhamid *et al.*, 2001, 2004, 2005 a&b). 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. Some plant ingredients have been studied in gilthead sea bream (lupin seed meal, extruded peas and rapeseed meal) but *Poaceae* and *Fabaceae* seeds and their by- products, among which corn gluten and soybean meal, in particular, are widely used in fish nutrition because of their high protein content (40-60%), low cost and relative widespread availability. Therefore, soybean meal being 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 with tilapia diets (Soltan *et al.*, 2001; Fagbenro and Davies, 2002; Wilson, *et al.*, 2004, Abdelhamid *et al.*, 2006 and Magdy, 2006). Some studies with gilthead sea bream have shown that partial replacement of FM by PPs is possible (Robaina, *et al.*, 1995; Hassanen, 1997a, b; 1998; Kissil, *et al.*, 2000; Sitja-Bobadilla *et al.*, 2005 and Martinez-Llorens *et al.*, 2009). Studies with sea bass have also reported some success to partial replacing of FM by PPs (Lanari, 2005 and Tibaldi, *et al.*, 2006). Studies of using corn gluten to feed carnivorous fish (sea bream) are very limited; therefore, the scope of the present study was to evaluate the effect of partial or complete replacement of fish meal with increasing levels of plant protein origin like corn gluten and soybean meal on growth performance, feed utilization, body composition and cost production of sea bream fingerlings‘ diets.

MATERIALS AND METHODS

Diet preparation

Five isocaloric and isonitrogenous diets were formulated (Table 1). They were based on FM as the only animal protein source or a mixture of PPs (plant protein sources, corn gluten and soybean meal) which were formulated to replace 25, 50, 75 and 100% of the FM (fishmeal protein). Crystalline amino acids (L-lysine and DL-methionine) were added to diets PP 25, 50, 75 and PP100% to become similar to control diets. Fish oil and soya oil were added as dietary lipid sources (Table 1). The diets were pelleted using grinder of kitchen aid with a 1.5 mm diameter and kept frozen until the experiment was started. During the growth period (120 days), each diet was randomly allocated to triplicate tanks of fish. Feed was offered by hand at two meals / day (8:00h and 15:00) at 3% of body weight daily and the amount of diets were readjusted after each weighing.

Experimental design

Sea bream fingerlings were obtained from a private fish farm in Damietta governorate. Fish were acclimated to laboratory conditions for 2 weeks before being randomly distributed into fiberglass tank of 300-L water capacity each, in Ashtom Elgamel, Port-Said governorate. The water was obtained from channel comes from Mediterranean sea. Fish of 10±0.2 g initial body weight were distributed into 15 experimental tanks in triplicate groups of 50 fish each. The photoperiod was regulated to be 12h light: 12h dark. Water temperature was maintained at 25ºC 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 were measured every 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. All

Table (1): ***Composition of the experimental diets.***

Ingredients (g/100g)*	Diet				
	FM	PP/25	PP/50	PP/75	PP/100
Fish meal (CP 68%)	**63**	**47.24**	**31.52**	**15.78**	**-**
Corn gluten meal (62%)	**-**	**9**	**20**	**45**	**62**
Soybean meal (44%)	**-**	**13.7**	**24**	**13**	**15**
Yellow corn	**21.5**	**14.3**	**8.22**	**8.93**	**6.05**
Fish oil+ Soya oil (1:1) [1**]	**12**	**12**	**12**	**12**	**12**
L-Lysine	**--**	**0.26**	**0.62**	**1.69**	**1.32**
DL- Methionine	**--**	**--**	**0.16**	**0.13**	**0.13**
Vit & Min mix [2]	**3**	**3**	**3**	**3**	**3**
Cr_2O_3 [3]	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
Total	**100**	**100**	**100**	**100**	**100**

1- Mixture of fish oil and soybean oil (1:1 w/w).
2- Each Kg vitamin & mineral mixture premix contained Vitamin A, 4.8 million IU, D_3, 0.8 million IU; E, 4 g; K, 0.8 g; B_1,
0.4 g; Riboflavin, 1.6 g; B_6, 0.6 g, B_{12}, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg
, Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.
3- Cr2O3: Chromic Oxide
**** obtained from the local market.***
*** **Requirement according to Kissil et al., 2000**.*

fish in each tank were weighed every 10 days.

Experimental methodology

The tested diets and feaces were analyzed for crude protein (CP %), ether extract (EE %), crude fiber (CF %), ash (%) and moisture while whole body composition of sea bream fish samples was also analyzed except for crude fiber (CF %) according to the procedures described by A.O.A.C. (1995) as shown in Table 2 and Table 5. The nitrogen free-extract (NFE %) was calculated by difference. Blood samples were collected using heparinized syringes from caudal vein of the experimental fish at the termination of the experiment. Blood was centrifuged at 3000rpm for 5 minutes to allow separation of plasma which was subjected to determination of plasma total protein (Armstrong and Carr, 1964) and plasma albumin (Doumas, *et al.*, 1977). Apparent protein digestibility was determined using the method of Furukawa and Tasukahara (1966). For determination of protein digestibility the diets and faeces were collected during the last 15 days of the experimental period. Any uneaten feed or faeces from each tank was carefully removed by siphoning about 30 min after the last feeding. Faeces were collected by siphoning separately from each replicate tank before feeding in the morning. Collected faeces were then filtered, dried in an oven at 60^{o}C and kept in airtight containers for subsequent chemical analysis.

Statistical analysis

All data of growth performance, body composition and blood parameters were analyzed by one-way analysis of variance (ANOVA) using the general linear models procedure of statistical analysis system (SAS) version 8.02, (1998). Duncan's multiple range test (Duncan, 1955) was used to resolve differences among treatment means at 5% significant level using the following model:

$$Yij = \mu + Ti + Eij$$

Where

µ = over all mean.

Yij = the observation of the individual from T treatment

Ti = the fixed effect of T diet.

Ei j = the experimental random error associated with individual J.

Table (2): ***Proximate analysis of the experimental diets (% as fed)***

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*	**44.71**	**45.0**	**45.1**	**45.1**	**45.6**
Crude fat	**17.56**	**16.42**	**15.32**	**14.48**	**13.32**
Crude fiber	**1.14**	**1.95**	**2.57**	**2.00**	**2.18**
Crude ash	**9.30**	**8.00**	**6.55**	**4.14**	**2.33**
Nitrogen free extract	**18.79**	**20.63**	**22.16**	**25.58**	**27.77**
Metabolizable Energy (kcal/100gm) [1]	**409**	**407.5**	**404.4**	**409.5**	**410.0**
P/E Ratio (mg protein/Kcal) [2]	**109**	**110**	**111**	**110**	**111**

1.Based on 4.5 Kcal/g protein, 8.1 Kcal/g fat and 3.49 Kcal/g carbohydrate (NRC, 1993).

2 Protein/Energy Ratio (mg protein/Kcal)

**** Requirement according to Kissil et al., 2000.***

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RESULTS

Growth performance and feed utilization

The growth performance of gilthead sea bream *(sparus aurata)* fingerlings which fed different diets is shown in Table 4. Average body weight (g) of sea bream fingerlings fed the experimental diets at the start did not differ, indicating that groups were homogenous. At the end of growth experimental period

Table (3): ***Average water quality parameters in the experimental tanks used in the study.***

Parameter	Means ± SD
Temperature (ºC)	**25 ±1**
Oxygen (mg/L)	**5.4 ±1**
Ammonia (NH_3, mg/L)	**0.011± 0.0001**
Ph	**7.1 ± 0.10**
Salinity (ppt)	**34.0 ± 0.4**

(120 days), the group of fish fed on fishmeal diet as a sole source of protein and groups of fish fed diets contained 25 and 50 PPs% had a significantly ($P \leq 0.05$) higher weight gain than the rest of experimental groups. Whereas the lowest body weight BW (68.9g) was achieved by group of fish fed on diet containing 100%PPs (FM was totally replaced by plant protein sources). On the other hand, the groups of fish fed on FM or 25 and 50 PPs % had a significantly ($P \leq 0.05$) higher specific growth rate (SGR %/ d) than the rest of experimental groups, however at the end of the experiment, SGR values were 1.93, 1.91, 1.87 and 1.78 %/d for group of fish fed on FM, 25PPs,50PPs, and 75PPs%, respectively. The lowest SGR was found to be 1.72%/ d in the group fed on free fish meal diet (100%PPs). Results of feed utilization in terms of FCR, PER and FE are presented in Table 4. An averages of feed conversion ratio (FCR) of the FM, 25,50,75 and 100%PPs groups were found to be 1.64,1.67,1.75,2.13 and 2.31, respectively. These results indicated that the best ($P \leq 0.05$) FCR recorded were obtained by the FM and 25%PPs followed by 50 and 75%PPs. The worst FCR was observed by diet 100%PPs. The same trend was reported with protein efficiency ratio (PER) which was found to be 1.35, 1.32, 1.27, 1.04 and 0.95, respectively. Also, the results of feed efficiency (FE) followed the same trend as FCR and PER which were found to be 0.61 and 0.60 for diets FM and 25%PPs and 0.43 for diet 100%PPs. Results also revealed that, the plant protein sources PPs (corn gluten and soybean meal) could replace up to 50% of fishmeal protein in growing sea bream fingerlings diets without any adverse effects on

Table (4): ***Growth performance and feed utilization of sea bream (S. aurata) fed the experimental diets***

Parameters	Diet				
	FM	PPs 25	PPs50	PPs75	PPs100
Average Initial body weight (g)	**10.1±0.05**	**10.2±0.25**	**10.3±0.10**	**10.1±0.10**	**10.0±0.23**
Average Final body weight (g)	**102.6 a ±2.2**	**101.3 a ±0.3**	**97.7 b ±0.20**	**85.2 c ±0.2**	**78.9 d ±0.20**
Average Weight gain (g)	**92.5 a ±1.1**	**91.1a±1.2**	**87.4 b ±0.9**	**75.1c±0.10**	**68.9 d±1.10**
SGR (% / d)[1]	**1.93 a ±0.02**	**1.91 a ±0.01**	**1.87 a ±0.02**	**1.78 b ±0.09**	**1.72 b ±0.01**
Feed intake (g)	**151.93a±0.4**	**152.51a±0.2**	**153.15 a ±0.10**	**159.62b±0.2**	**159.30b ±0.10**
Feed conversion ratio (FCR[2]	**1.64 d ±0.10**	**1.67 d±0.1**	**1.75 c ±0.10**	**2.13 b ±0.1**	**2.31 a ±0.20**
Protein efficiency ratio[3]	**1.35 a ±0.01**	**1.32 a ±0.02**	**1.27 a ±0.01**	**1.04 b ±0.10**	**0.95 b ±0.20**
Feed efficiency[4]	**0.61 a ±0.1**	**0.60 a ±0.10**	**0.57 a ±0.10**	**0.47 b±0.10**	**0.43b ±0.12**
HSI (%)[5]	**3.2 a ±0.1**	**2.97 a ±0.1**	**2.93 a ±0.12**	**2.71b ±0.01**	**2.56 c ±0.12**
Apparent Protein Digestibility (APD) [6]	**88.25 a ±0.3**	**87.39 a ±0.2**	**86.09 a ±0.1**	**73.16 b±0.2**	**65.32 c ±0.1**
PTP (g/dl) [7]	**5.21±0.10**	**5.20±0.12**	**5.15±0.10**	**5.03±0.12**	**5.01±0.10**
PA (g/dl) [8]	**2.15±0.11**	**2.17±0.11**	**2.17± 0.12**	**2.07±0.02**	**2.08±0.08**
PTG (g/dl) [9]	**3.06±.0.12**	**3.03±0.10**	**2.98±0.11**	**2.96±0.09**	**2.93±0.01**
Survival rate (%)[10]	**100**	**100**	**98**	**96**	**94**

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 ratio (FCR) = 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- ***Hepato-somatic index = 100 x liver wt / fish wt.***
6- ***Apparent protein digestibility, APD (%)***
7- ***Plasma Total Protein, PTP (g/dl)***
8- ***Plasma albumin, PA (g/dl)***
9- ***Plasma total globulins= plasma total protein- plasma albumin, PTG (g/dl)***
10- ***Survival rate =No of survive fish/total No. of fish at the beginning X100***

growth performance and feed utilization parameters.

Digestibility Study

Results of apparent protein digestibility (APD) were affected by the level of PPs in the diets which were decreased with the increasing level of PPs replacement in the diets as reported in Table 4. Results give evidence that varying feed acceptance may be a reason for this observation. However, at the end of the experiment, APD were 88.25, 87.39, 86.09 and 73.16% for groups of fish fed on FM, 25PPs, 50PPs, and 75PPs%, respectively. The lowest APD was found to be 62.32% in the group of fish fed on free fish meal diet (100%PPs).

Blood measurements

Results of blood measurements at the end of the experiment showed that there was no effect of the experimental diets on plasma total protein, plasma albumin and plasma total globulins of fish fed the experimental diets in comparison with the control diet (Table 4).

Body composition

Results of body composition presented in Table (5) showed that no statistical differences were observed with protein content for fish fed on groups FM, 25%PPs and 50%PPs but it was decreased significantly ($P \leq 0.05$) by the increasing levels of fishmeal replacement in diets. Partly or totally substitution of fishmeal by PPs decreased lipid content and ash content with group of fish fed on diets 75% and 100%PPs. However the moisture was increased with increasing level of plant protein substitution.

Hepato-somatic index

Hepato-somatic index decreased significantly ($P \leq 0.05$) with the increasing level of PPs in the experimental diets. However, at the end of the experiment, HSI was 3.2, 2.97, 2.93 and 2.71 % for groups of fish fed on FM, 25PPs, 50PPs, and 75PPs%, respectively. The lowest HSI was found to be 2.56 % in the group fed on free fish meal diet (100%PPs) as repotted in Table 4.

Table (5): ***Whole body composition (% fresh weight) of see bream (S. aurata) fingerlings fed the experimental diets.***

Chemical analysis	Initial	Final				
		FM	PPs/25	PPs/50	PPs/75	PPs/100
Moisture	70.50	59.91 [a]	60.44 [a]	60.75 [a]	63.50 [b]	64.33 [b]
Crude protein	14.25	17.56 [a]	17.50 [a]	17.56 [a]	17.34 [b]	16.90 [b]
Crude fat	10.5	15.62 [a]	15.70 [a]	15.77 [a]	14.00 [b]	13.90 [b]
Crude ash	4.75	6.91 [a]	6.36 [a]	5.92 [b]	5.16 [c]	4.87 [d]

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

Economy study

The economic evaluation showed that the incorporation of PPs in sea bream diets seemed to be economic and sharply reduced the feed cost of sea bream fingerlings diets as reported in Table 6. These results indicate that incorporation of PPs in Sea bream diets reduced the total feed costs. However, high replacing levels of fishmeal by PPs (75 and 100) adversely affected all the growth and feed utilization parameters (Table 4), but the incorporation of PPs in sea bream diets seemed to be economic as incorporation of PPs in the diets sharply reduced feed costs by 18.71, 29.50 and 38.13% for PPs25, PPs50 and PPs75 respectively. The survival rate was high for all experimental groups.

DISCUSSION

Results of the present study indicate that PPs (corn gluten and soybean meal) can replace 25% to 50% of fish meal protein in sea bream diets with no significant differences ($P \geq 0.05$) in growth performance compared to the

Table (6): Feed cost (L.E) for producing one Kg weight gain by sea bream (*S. aurata*) 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	6.56	100	0.00	1.64	10.76	100
PPs25	5.66	86.29	13.71	1.68	9.51	88.38
PPs50	4.77	72.71	27.29	1.89	9.02	83.83
PP75	3.96	60.36	39.64	2.13	8.43	78.35
PP100	3.12	47.56	52.44	2.31	7.21	67.01

The local market price were 8LE for fish meal, 2.50LE for gluten, 1.70LE for soybean meal, 1.00 LE for yellow corn, 9 LE for oil, 5 LE for Vit. & Min.

control. This conclusion is in agreement with Gomes *et al* (1995a & b) for rainbow trout. They reported that replacement of fishmeal by plant protein sources had no adverse effects on growth. The optimal rate of substitution found in the present research was closed with Lanari (2005), he reported that soybean meal can substitute up to 25% of total protein of the sea bass diets without any negative effect on growth performance. Higher value than reported in the present study was reported by Gallagher (1994) in diets for hybrid striped bass, where soybean meal substituted 44% of fish meal without evidencing a negative effect on the feed intake and he also reported that up to 75% of fishmeal protein can be replaced with soybean meal. Moreover, Sitja-Bobadilla *et al.*, (2005) reported that up to 75% of fishmeal protein can be replaced by plant protein sources for juvenile sea bream, which also is in agreement with the present study for sea bream fingerlings. In the recent years, significant amount of researches has been conducted on the replacement of FM by different PPs. 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 sea bass (*D.labrax*) (Kaushik *et al.*, 2004) and gilthead sea bream (*S.aurata*) (Pereira and Oliva-Teles, 2003 and Gómez-Requeni *et al.*, 2004), recent short-term studies have shown that at least 60-75% of FM can be replaced by mixture of PPs without compromising growth performance. In the present study, the effects of FM replacement were studied on growth performance and feed utilization. This scenario, a high level of FM replacement by (50-75PPs %) produced a slight reduction in growth performance. Concerning the results of feed utilization in terms of FCR, PER and FE in the present study, the same trend was showed with growth performance. These results of feed utilization related to apparent protein digestibility of diets used in the experiment which showed worst feed utilization of sea bream fed on diets containing high mixture of PPs (corn gluten meal and soybean meal) was possibly due to the low biological value of such based diets, which are in agreement with Robaina, *et al.,(* 1995), Boonyaratpalin *et al.*,(1998), Regost *et al.*,(1999), Lanari (2005), Sitja-Bobadilla *et al.* (2005), and Tibaldi, *et al.*,(2006). Regarding to digestibility, several investigations were conducted to evaluate using of PPs and it's digestibility by fish. These investigations allow presenting a consolidated, core discussion. In fish, protein digestibility is generally high ranging from 75% to 95% and the apparent digestible coefficient of proteins from fish meal is often higher than 90% in salmonids (NRC, 1993). Soybean meal contains various anti-nutritional factors such as the anti-trypsin and an anti chimotrypsin factors, lectine, oligosaccharides and a low level of methionine, corn gluten has also a low level of amino acid lysine reduces the protein digestibility and amino acid availability of these plant protein ingredients. Increasing temperature can increase digestibility of soybean meal from 45% to 75% (Smith, 1976). Soybean meal can substitute up to 90% of the fishmeal in extruded diets for rainbow trout without causing redaction in the growth rate and net protein utilization and poorer FCR especially with diets containing high levels of soybean meal. Corn gluten meal (CGM) is considered to have a good digestibility (NRC, 1993).Diet containing 20% of CGM meal had a very good digestibility, in accordance with the results of Morales *et al.*(1994) and Gomes *et al.* (1995 a) in rainbow trout fed diets containing about 20% corn gluten meal. In contrast, apparent digestible coefficient of diets with high levels of plant proteins was very low. In common carp, Pongmaneerat *et al.* (1993) observed that the apparent protein digestibility had to be near 94% in a diet without fish meal (corn gluten meal, soybean and meat meal). Moreover, the supplementation of amino acids to diets which containing high levels of PPs give better growth performance which was reported by Rodehutscord *et al.*(1995). They observed that fish meal could be completely replaced by a mixture of wheat gluten and crystalline amino acids without negative influences on growth of rainbow trout. Results of apparent protein digestibility in the present study recorded that the dietary inclusion of high levels of corn gluten and soybean meal in replacement of fish meal led to a significant decrease in protein digestibility which are in agreement with Lanari (2005), Tibaldi *et al.*(2006) and Sampaio-Oliveira and Cyrino(2008). The value of hepato-somatic index was found to be similar to that reported for sea bass by Ballestrazi *et al.,* (1994) and Dias *et a.* ,(1998), they reported that the values of HSI were 2–3% or above. Effect of the experimental diets on hepato–somatic index confirmed that the fish fed on diets containing high levels of corn gluten meal and soybean meal evidenced a significant ($P \leq 0.05$) decrement of the HSI in relation to the utilization of glycogen, stored as an energy source.The results are in agreement with Lanari (2005) and Sampaio-Oliveira and Cyrino(2008). Effects of the experimental diets on whole body protein concentration were very small with exception of fish diet containing FM, 25 and 50%PP which showed a significant difference ($P \leq 0.05$) compared to the other experimental diets (75 and 100%PP). Fish body fat content decreased with increasing level of

PPs substitution. The low percentage of fat stored with diets containing high level of PPs is due to the limited ingestion of the feed or to probable use of the body fat as energy source and may be also related to the carbohydrate levels and type of the diets. These results are in agreement with Lanari (2005), Tibaldi *et al.*(2006) and Sampaio-Oliveira and Cyrino (2008) for sea bass *D. labrax* and Peres and Oliva-Teles (2009) for sea bream *S. aurata*.Results of blood measurements showed no significant differences (P≥0.05) in plasma total protein, plasma albumin and plasma total globulins of fish fed the experimental diets in comparison with the control diet. These findings are in agreement with Soliman (2000) and Mohamed (2007), they noted that increasing the plasma total protein indicates the improvement of the nutritional value of the diet. 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 (6) 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 PPs in sea bream diets reduced the total feed costs. However, high replacing levels of fishmeal by PP (75 and 100%PP) adversely affected all the growth and feed utilization parameters (Table 4), but the incorporation of PPs in sea bream diets seemed to be economic as incorporation of PPs in the diets sharply reduced feed costs by 13.71, 27.29, 39.64 and 52.44% for 25PP, 50PP, 75PP and 100%, respectively. The reduction of feed costs was easily observed for the feed costs per Kg weight gain which decreased with increasing incorporation levels of PPs in agreement with Soltan (2005) for Nile tilapia and Eid and Mohamed (2007) for sea bass fingerlings.

CONCLUSION

From the aforementioned results, it could be concluded that incorporation of plant protein sources (corn gluten and soybean meal) can replace fish meal protein in sea bream fingerlings‘diets at levels of 25 and 50 PP% of fish meal protein under similar experimental conditions.

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تأثيرإحلال مسحوق السمك بمصادر بروتينية نباتية على أداء النمو وتحليل الجسم لإصبعيات سمك الدنيس

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أجريت هذه التجربة لدراسة تأثير الإحلال الكلى و الجزئي لبروتين مسحوق السمك بخليط من البروتينات النباتية (جلوتين الذرة وفول الصويا) على أداء النمو ، تحليل الجسم و الكفاءة الاقتصادية لاصبعيات أسماك الدنيس. تم إحلال مخلوط من البروتين النباتى (جلوتين الذرة وكسب فول الصويا) بدلاً من بروتين مسحوق السمك بنسب إحلال 25 و 50 و75 و100% فى علائق غذيت بها إصبعيات سمك الدنيس بمتوسط وزن 10 ± 0.2 جم لمدة 120 يوما. وقد وجد أنه لا توجد فروق معنوية بين مجموعات الأسماك التى غذيت على مخلوط من البروتين النباتى بنسب إحلال 25 و 50% مقارنة بالمجموعة التى غذيت على مسحوق السمك بمفرده وذلك فى معدل النمو النسبى والكفاءة الغذائية. كما وجد أنخفاض معامل الهضم الظاهرى للبروتين لإصبعيات أسماك الدنيس التى غذيت على علائق بنسب إحلال 75 و 100% من بروتين مسحوق السمك . كما وجد أنه يقل دليل الكبد البنكرياسى بزيادة نسب الإحلال بالمصادر النباتية. كذلك أظهرت قياسات الدم عدم و جود أى إختلافات معنوية فى البروتين و الألبيومين و الجلوبيولين الكلى لبلازما الدم بين مجموعات الأسماك التى غذيت على العلائق التجريبية . هذا وقد أظهرت نتائج التقييم الإقتصادى إنخفاض تكلفة التغذية اللازمة لإنتاج واحد كيلو جرام من الاسماك بازدياد مستوى الإحلال النباتى فى العلائق المختبرة.

ويستنتج من هذه الدراسة أنه بناء على النتائج المتحصل عليها لتاثير العلائق التجريبية على أداء النمو و التقييم الاقتصادى فإنه يمكن إحلال مخلوط من البروتين النباتى (جلوتين الذرة - كسب فول الصويا) بنسبة 25 و 50% محل بروتين مسحوق السمك فى علائق سمك الدنيس تحت ظروف مماثلة لظروف التجربة.