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Effect of Different Protein Source on the Growth Performance and Body Composition of Seabream (*Sparus aurata* L.).

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ABSTRACT

Six experimental diets containing isonitrogenous (383 g kg^{-1}) and isocaloric (18.4 kJ g^{-1}) energy were formulated from fish meal (1), shrimp meal (2), soybean meal (3), fish and soybean meal (4), shrimp and soybean meal (5) and fish & shrimp meal (6). Results showed that no significant differences in FBW, DWG and SGR, were observed of fish fed diet contained sole source of fish meal protein and groups of fish fed diets contained 40 % FM and 20%SBM and group of fish fed on 30% FM and 27% SM. Also, had a significantly ($P \leq 0.05$) higher than the rest of experimental groups. 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 SBM. Therefore, it could be concluded that the SBM 20% can replace fishmeal protein in diets for sea bream fingerlings under similar experimental conditions.

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).

Aquaculture production of marine finfish is expected to continue to increase to meet the world's growing demand for seafood. Many types of marine finfish aquaculture use compounded diets that contain high concentrations of protein, which is often provided by fish meal derived from wild fisheries or by animal processing by-products obtained from the commercial fishing and livestock production industries. Currently, about 60 percent of the world supply of fish meal is used in aquatic animal feeds FAO (2011). Fish meal is an optimal protein source for fish feeds because of its nutritional value and high palatability to fish NRC (2011).

Fish meal contains high levels of dietary essential amino acids and essential fatty acids (omega-6 and omega-3 highly unsaturated fatty acids) that promote rapid growth. However, fish meal is a finite resource that has steadily increased in price in recent years and will continue to become increasingly expensive relative to other protein supplements in the ingredient market. Rising fish meal prices are driving efforts worldwide to identify economical alternatives to fish meal in marine fish diets. The reduction, or elimination, of fish meal from compounded diets can be expected to provide economic and environmental benefits by reducing feed costs for fish producers, while lessening fishing pressure on species harvested for fish meal production, many of which also serve as important resources in the marine food web (Lech and Reigh, 2012)

Most plant-based protein supplements are of interest as fish meal replacements because of their relatively low cost and widespread availability. Soybean is one of the most promising plant-based substitutes for fish meal because of its excellent amino acid composition, which provides the best dietary essential amino acid profile among commonly available plant products in the ingredient market. Among the soybean products available for use in compounded fish feeds is high-protein, de-hulled, solvent-extracted soybean meal produced by heat-treatment and oil-extraction of full-fat soybeans. High-protein soybean meal contains about 49 percent crude protein, which is more than three-quarters of the amount of protein in commonly available fish meals, and prices of high-protein soybean meal have been about one-third the price of fish meal in recent years (Muirhead 2011). Thus soybean meal is an affordable and readily available protein source for fish feeds (Gatlin, et al., 2011).

This study aims to decrease the quantity of animal protein required in the diet for good growth of sea bream and hence minimize the cost of artificial feed. It is considered essential to develop efficient for sea bream.

MATERIAL AND METHODS

Culture condition

The fingerlings *Sparus aurata* were collected from Lake Manzalah. They were transferred to Laboratory of National Institute of Oceanography and Fisheries, Suez branch.

The fish weight ranged 13.4 ± 0.59 g, The fish were distributed into 18 fiberglass tanks (1000- L) at a density of 50 fish per tank. The system was supplied with aerated filtered seawater, which was replaced every one week. Each tank was equipped with an air stone and an external stand pipe. Fish were acclimated for 15 days (gradual salinity change till adapted to the water of gulf) where fed on chopped trash fish prior to the commencement of the experimental period, and during that time, the fish were fed various diets differing in protein source. Feed quantity was always adjusted according to the increasing in the body weight of the fish. The experimental fishes were fed twice daily, about 3 % of the live body weight, except for the day before weighing (six days in the week). The experiment was dealt with feeding and rearing and feeding of fingerlings of *Sparus aurata* for five months.

Preparation of diets

Six diets were formulated from fish meal (1), shrimp meal (2), soybean meal (3), fish and soybean meal (4), shrimp and soybean meal (5) and fish & shrimp meal (6). Yellow corn; starch; cotton seed oil and vitamins and minerals premix was added to each diet (Table 1). The calculated indispensable amino acid concentration in the experimental diets (Table 2) met or exceeded the recommendation of Luquet & Sabaut (1974).

All diets were formulated to be isonitrogenous (383 g kg^{-1}) and isocaloric (18.4 kJ g^{-1}). In preparing diets, dry ingredients were first ground to small particle size (approximately 250 μm) in a Wiley mill. Ingredients were thoroughly mixed and pelleted, freeze dried and stored at -20°C until use.

Water quality

Water quality parameters (temperature, dissolved oxygen, pH, ammonia, nitrate and nitrite) were monitored to ensure water quality remained well within limits recommended for sea bass. Water temperature and dissolved oxygen were measured every other day using an YSI Model 58 oxygen meter (Yellow Springs Instruments, Yellow Springs, OH). Ammonia and nitrite were measured at wkly intervals. Alkalinity was monitored twice weekly using the titration methods of Golterman *et al*. (1978). The pH was monitored twice weekly using an electronic pH meter (pH pen Fisher Scientific, Cincinnati, OH). The sampling was performed between 07:00 and 08:00 hours.

Chemical and statistical analysis

Proximate analysis of gilthead seabream (whole-body) and the experimental diets was conducted by standard methods (AOAC 2002). Dry matter content of diets and whole-body of gilthead seabream were determined by 24-hr oven drying at 100°C. Crude protein, lipid, and fiber contents of samples were determined by the National Institute of Oceanography and Fisheries Laboratory fish Nutrition. Ash content was measured by incineration at 600°C in a muffle furnace. Gross energy was determined by bomb calorimetric (Ballistic bomb calorimeter, Gallenkamp, England).

Calculations of growth parameters were conducted according to Cho & Kaushik (1985). Data were analyzed by analysis of variance (ANOVA) using the SAS ANOVA procedure (Statistical Analysis System 1988). Duncan's multiple range tests was used to compare differences among individual means. Treatment effects were considered significant at $P < 0.05$. All percentages and ratio were transformed to arcsine values prior to analysis (Zar 1984).

Table 1: Ingredients and proximate chemical composition of diets fed to Sea bream (*Sparus aurata*).

Ingredients (%)	Diets					
	1	2	3	4	5	6
Fish meal (66% CP)	55	--	--	40	--	30
Shrimp meal (60% CP)	--	60	--	--	45	28
Soybean meal (48% CP)	--	--	77	20	20	--
Yellow cornmeal	24	24	12	24	24	24
Starch	10	5	--	5	-	7
Oil	9	9	9	9	9	9
Vitamin & Min. premix[1]	2	2	2	2	2	2
Proximate chemical composition (%)[2]						
Moisture	9.19	9.46	9.25	9.32	9.51	9.36
Crude protein	38.3	38.5	38.3	38.4	38.2	38.2
Ether extract	12.67	12.81	12.65	12.92	12.36	12.4
Crude fiber	4.87	4.1	4.6	4.92	4.64	4.62
Ash	8.68	8.24	8.8	8.33	8.25	8.27
NFE[3]	26.29	26.89	26.4	26.11	27.04	27.15
Gross energy (kcal/g^{-1} diet)	4.45	4.49	4.45	4.46	4.44	4.44
P/E ratio[4]	1:0.73	1:0.73	1:0.73	1:0.73	1:0.73	1:0.73

[1]Premix supplied the following vitamins and minerals (according to Xie, et. al (1997).
[2] Values represent the mean of three sample replicates.
[3] Nitrogen free extract (NFE) = {100 - (moisture+ crude protein + crude fat + ash + crude fiber)}
[4] P/E ratio = Protein energy ratio

Table 2: Amino acid content in the diets fed to Sea bream (*Sparus aurata*) (g.100 g^{-1}diet).

Amino acid	Required[1]	Diets					
		1	2	3	4	5	6
		Indispensable amino acid*					
Arginine	1.7	2.16	2.19	2.37	2.21	2.23	2.17
Histidine		0.86	0.65	0.86	0.85	0.7	0.76
Isoleucine		1.66	1.1	1.6	1.64	1.51	1.3
Leucine		2.97	3.03	2.74	2.89	2.93	3.1
Lysine	1.7	2.46	2.48	2.01	2.49	2.36	2.57
Methionine	1.4	1.0	1.09	0.63	1.04	0.9	1.04
Phenylalanine		1.45	1.63	1.69	1.51	1.63	1.54
Threonine		1.46	1.5	1.33	1.43	1.44	1.48
Tryptophan	0.4	0.38	0.24	0.5	0.41	0.31	0.31
Valine		1.88	1.78	1.63	1.8	1.71	1.83
		Dispensable amino acid					
Cystine		0.36	0.36	0.61	0.42	0.46	0.39
Tyrosine		1.16	1.16	1.08	1.04	1.34	1.3
Serine		1.35	1.35	1.7	1.13	1.43	1.83

*Data obtained from the National Research Council (1993).

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Table 3: Growth performances and nutrient utilization of Sea bream (*Sparus aurata*).fed the experimental diets

Parameters	Diets					
	1	2	3	4	5	6
IBW[1]	13.7±0.8	13.5±0.5	13.3±0.4	13.0±0.4	13.6±0.4	13.2±0.3
FBW[2]	90.4±5.0^{ab}	70.4±4.3^{cd}	39.5±3.9^{e}	92.0±6.1^{a}	65.4±4.2^{d}	82.9±4.2^{b}
ADG[3]	0.6±0.04^{a}	0.38±0.03^{c}	0.2±0.02^{d}	0.6±0.04^{a}	0.3±0.03^{c}	0.5±0.03^{b}
SGR (%/day)[4]	1.3±0.01^{a}	1.1±0.02^{c}	0.7±0.03^{e}	1.3±0.01^{a}	1.1±0.03^{c}	1.2±0.02^{b}
FI (g fish^{-1})[5]	139.8±6.0^{b}	120.5±5.8^{c}	67.6±3.1^{d}	146.4±7.2^{b}	119.8±4.3^{c}	168.3±8.1^{a}
FCR (FI/WG)[6]	1.8±0.04^{a}	2.1±0.05^{b}	2.6±0.19^{c}	1.9±0.04^{a}	2.3±0.09^{b}	2.3±0.21^{b}
FER (%)[7]	54.7±1.2^{a}	47.1±1.1^{b}	39.1±2.8^{d}	53.9±1.1^{a}	43.2±1.6^{c}	41..0±0.7^{c}
PER[8]	1.43±0.04^{a}	1.23±0.03^{b}	1.02±0.1^{c}	1.41±0.03^{a}	1.13±0.04^{c}	1.07±0.02^{b}
Survival (%)	95.0±2.0^{b}	75.0±3.0^{c}	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}

Values are mean± standard deviation. Values in the same row with same superscripts are not significantly different (P≥0.05).

[1] IBW=Initial body weight

[2] FBW=final body weight.

[3] ADG=Average daily gain=weight gain/150

[4] SGR, specific growth rate= (Ln FBW-Ln IBW) /150x100.

[5]. FI= feed intake.

[6] FCR, feed conversion ratio=dry feed fed/ body weight gain.

7 FER, feed efficiency ratio= body weight gain/ dry feed fed x 100

[8] PER, protein efficiency ratio= final body weight gain/protein intake.

Table 4: Whole body composition (% wet weight basis) of fish at the beginning and end of experiment

Parameters	At beginning	At end of experiment					
		Diets					
		1	2	3	4	5	6
Moisture	73.2±0.8	70.0±0.4^{c}	71.0±0.5^{b}	73.2±0.3^{a}	70.0±1.3^{c}	73.0±0.2^{a}	70.0±0.4^{c}
Crude protein	13.51±0.4	19.5±0.3^{b}	17.9±0.3^{d}	14.7±0.1^{f}	20.1±0.5^{a}	16.1±0.1^{e}	19.0±0.3^{c}
Crude fat	2.76±0.1	5.5±0.1^{a}	4.4±0.1^{d}	4.3±0.2^{e}	4.9±0.2^{b}	4.8±0.1^{b}	4.7±0.1^{c}
Ash	2.14±0.1	3.0±0.1^{a}	2.8±0.1^{b}	2.3±0.1^{d}	2.7±0.1^{b}	2.4±0.1^{c}	2.2±0.03^{d}
Energy (kcal/g)	129.6±4.0	171.9±2.3^{a}	169.7±3.0^{a}	141.8±0.9^{b}	177.7±4.1^{a}	153.5±1.1^{b}	171.3±2.3^{a}

Values are mean± standard deviation. Values in the same row with same superscripts are not significantly different (P ≥0.05).

Table 5: Economic information for Seabream.

Items	Diets					
	1	2	3	4	5	6
Food cost kg diet (LE)	1.56	1.78	1.27	1.28	1.35	1.62
No. fish stocked/ m3	50	50	50	50	50	50
No fish harvested m3	48	37	50	50	50	50
Harvested (kgm-1)	4.34	2.28	1.98	4.6	3.27	4.14
Food used(kg/m-1)	6.71	4.46	3.38	7.32	5.99	8.42
Fingerling cost (LE)1	25	25	25	25	25	25
Food cost 2	10.47	7.94	4.29	9.37	8.09	13.64
Total cost (LE)	35.47	32.94	29.29	34.37	33.09	38.64
Value of harvest (35 LE. kg-1)	--	--	--	--	--	--
Net profit (LE)	151.9	79.8	69.3	161.0	114.5	144.9
	116.432	46.86	40.01	126.63	81.41	106.3

[1]LE= Lever Egyptian, one Dollar equal 6.12 LE.

[2] Feed cost of 1 kg ingredients used were 6 LE for fish meal, 23.9 LE for soybean meal, 1.75 LE for yellow corn meal, and 6.5 LE for soybean oil, 5.0 LE vitamin and minerals, ingredient price at start of 2012.

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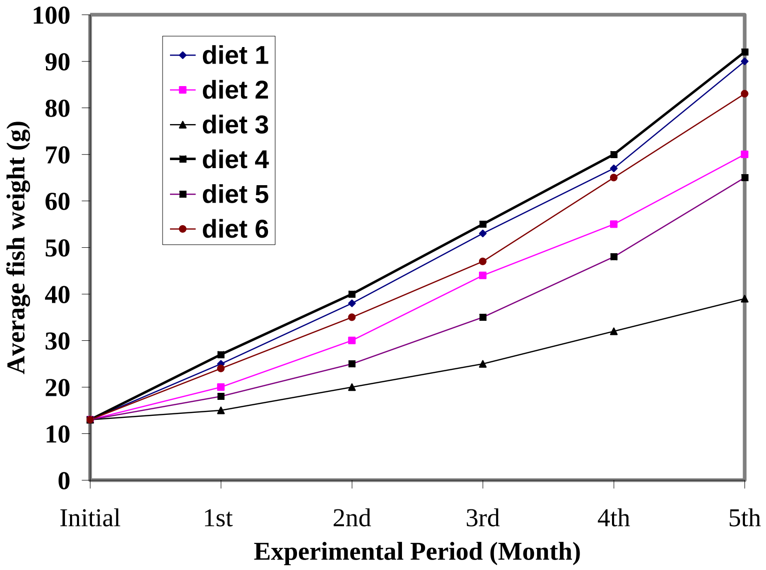
Figure 1: Effect of different protein sources on growth of gilthead sea bream (*Sparus aurata L.*).



RESULTS

Water quality

The water temperature ranged from 26.8±0.8̊ C dissolved oxygen 6.2±0.4 mgl^{-1}; pH 7.8±0.6; ammonia 0.01±0.04 mgl^{-1}; nitrite 0.1±0.05 mgl^{-1}; nitrate 1.5±.2 mgl^{-1}; salinity 39.0±1.26 mgl^{-1}. There were no significant different in the water parameters during the whole experimental period. The water quality parameters were found within the acceptable range for s gilthead seabream growth.

Growth performance

The growth performance of gilthead sea bream *(Sparus aurata)* fingerlings which fed different diets is shown in Table 3. Initial average body weight (13.3±0.59 g) of sea bream fingerlings fed the experimental diets at the start did not differ significantly, indicating that groups were homogenous. At the end of growth experimental period (150 days), the group of fish fed on fish meal diet as a sole source of protein and groups of fish fed diets contained 40 % FM and 20%SBM and group of fish fed on 30% FM and 28% SM had a significantly ($P \leq 0.05$) higher ABW (Fig 1) and DWG than the rest of experimental groups. Whereas the lowest body weight BW (39.5g) was achieved by group of fish fed on diet containing 75% SBM (FM was totally replaced by SBM). On the other hand, the groups of fish fed on 40% SM and 20% SBM had moderate body weight gain. However, at the end of the experiment, SGR values were 1.3, 1.3 and 1.2 for group of fish fed on FM, 55, 40 and 28%, respectively. The lowest SGR was found to be 1.72%/ d in the group fed on free fish meal diet (100%SBM).

Results of feed utilization in terms of FCR, PER and FE are presented in Table 3. Averages of feed conversion ratio (FCR) of the FM, 55, 40 and 28% groups were found to be 1.8, 1.9 and 2.3, respectively. These results indicated that the best ($P \leq 0.05$) FCR recorded were obtained by the diets contained FM 55% followed by 40 and 28%. The worst FCR was observed by diet 100% SBM (plant protein sources). The same trend was reported with protein efficiency ratio (PER) which was found to be 1.67, 1.67, and 1.27 respectively. Also, the results of feed efficiency (FE) followed the same trend as FCR and PER which were found to be 54.7 and 53.9 for diets FM and 55% SBM and 0.40 for diet 20% SBM. Results also revealed that, the plant protein sources (soybean meal) could replace up to 36% of fishmeal protein in growing sea bream fingerlings diets without any adverse effects on growth performance and feed utilization parameters.

Feed intake of fish fed the different diets showed the lowest values were associated with diet 3, followed by diets 2 and 5. Significant differences in feed intake were found in diet 1 compared with diet 6, which ingested at higher amounts (Table 3). The protein utilization (PER) in fish fed the experimental diets were significantly different (Table 3).

Whole body composition

Results of whole body composition presented in Table (4) showed that statistical differences were observed with protein content for fish fed on groups FM, 20% SBM but it was decreased significantly (P≤0.05) by the 100 replacement of fishmeal in diet (3). Also, totally substitution of fishmeal by SBM decreased lipid content and ash content with group of fish fed on diet contained 76% SBM. However the moisture was increased with increasing level of SBM substitution.

Economy study

The economic evaluation showed that the incorporation of SBM in sea bream diets seemed to be economic and sharply reduced the feed cost of sea bream fingerlings diets as reported in Table 5. These results indicate that incorporation of SBM in Sea bream diets reduced the total feed costs. However, high replacing levels of fishmeal by SBM (100%) adversely affected all the growth and feed utilization parameters (Table 3), but the incorporation of SBM in sea bream diets seemed to be economic as incorporation of SBM in the diets sharply reduced feed costs by 10.51 and 59.03% for SBM 20 and SBM 76 respectively. From the economic information it can be concluded that the highest net profit (Lever Egyptian) was achieved at fish fed on diet 4 which contained 40% fish meal with 20% soybean meal. This indicated that, this diet was economically superior to fish meal diets. The survival rate was high for all experimental groups expect diets (1 & 2) survival rate were 95 & 75% and significant different from other experimental diets.

DISCUSSION

Reduction of protein content can be achieved by increasing the energy supplied by other constituents of the diet like fat and carbohydrate. However the inclusion of high levels of different energy sources in feeds for aquaculture may reduce growth by reducing feed intake and as a consequence the total protein intake (Fountoulaki et al. 2005). The protein sparing effect of (Johnsen et al., 1993; Weatherup et al., 1997), red sea bream (Takeuchi et al., 1991), striped bass (Nematipour et al., 1992) and sea bream (Vergara et al., 1996; Company et al., 1999a) has been achieved by improvements in growth and protein efficiency. Nevertheless some other researchers did not find any protein sparing effect in sea bass and sea bream (Lanari et al., 1998; Peres & Oliva Teles 1999; Company et al., 1999b)

In our experiment we formulated diets having crude protein 38.3% according to R SA et al. (2006). They reported that protein requirements of White Sea bream fingerling and juveniles seem to be satisfied with dietary inclusion levels of 38% while lipids apparently do not have a protein sparing effects.

Very limited information is available on the use of soybean meal in the diets of sea bream and sea bass. Moreover, it is difficult to assess the nutritional value of soybean meal for these species because their quantitative requirements for most essential amino acids are practically unknown. However, soybean meal is generally included in both experimental and practical diets of these species. El-Sayed (1994) reported that soybean meal heated for 10 mm at 100 °C could be used as a replacement of 25 % fish meal protein in diets of silver sea bream fingerlings without affecting their growth and feed efficiency. Kissil et al. (1983) included 35% and 45% of soybean meal in combination with 15 % fish meal and 10 % meat and poultry meal in experimental diets to determine the protein to energy requirements of gilthead sea bream. They found that a diet containing 45% soybean meal with 5% capelin oil provided the best growth performance. In our experiment we used 20% soybean meal in combination with 40 fish meal provided best growth performance than other experimental diets.

Results of the current study suggest that replacement of fish meal with of SBM or SM (Shrimp meal) is feasible for gilthead sea bream, but factors other than the amino acid profile of these ingredients affect fish performance at different levels of soybean-product inclusion. The significantly lower feed intake of fish fed diet (3) was a primary cause of the poor weight gain of fish in this treatment group due to reduced nutrient intake relative to fish fed the other diets (Table 3). It is possible that one of the factors affecting feed intake is the attractiveness or palatability of soybean products. Feed intake data suggest that a diet (3) composed primarily of SBM (75 percent), corn meal was not as attractive and/or palatable as diets of similar composition and nutritional value that contained 20 percent SBM and reduced quantities of SM (Shrimp meal) (40 percent of diet). Why this would be the case is not readily apparent. However, the nutritional equivalence — i.e., amino acid (Table 2) and energy content (Table 1) - among diets suggests that nutrient deficiencies were unlikely to be the cause. There is no evidence from previous research conducted in this laboratory, or from the literature, to suggest that SBM in prepared diets is attractive to gilthead sea bream, but it is possible that SM could be more attractive than SBM, such that replacement of 40 percent SBM in the diet 5 with SM significantly increased feed intake to a level differed significantly (*P*>0.05) from that of fish fed the diet 3 (Table 3).

Daily weight gain, FCR, SGR, and PER did not differ significantly among gilthead sea bream fed the diets, 1, 4 and 6, indicating that a 40 percent protein, fish-meal- diet containing 200 g/kg (20 percent) of SBM produced growth performance of gilthead sea bream equivalent to a similar diet (1) containing 55 percent (550 g/kg) menhaden fish meal.

Studies with other marine fish species have shown reduced growth of fish fed diets that contained SBM as a major protein source. Kissil et al. (2000) reported that increased levels of SBM and phytic acid in diets for gilthead sea bream caused reduced feed intake and weight gain due to low diet palatability. Deng et al. (2006) improved the palatability of soy-based diets for Japanese flounder by incorporating 0.5 percent taurine as a feeding stimulant, and reduced phytic acid content by adding phytase at a concentration of 750 FTU/kg diet.

Zhao et al. (2009) completely replaced fish meal with SBM in Nile tilapia diets by increasing feeding frequency. Nile tilapia fed a soybean-based diet six times per day exhibited feed intake and weight gain not different from that of fish fed a fish-meal based diet twice per day. Walker et al. (2010) reported no negative effects of SBM inclusion level on growth or feed intake of Atlantic cod fed FMF diets. However, hydrolyzed fish protein concentrate and blood meal, which are likely feeding stimulants, also were included in all diets. Burr et al. (2012) replaced up to 82 percent of fish meal in diets for 20-g rainbow trout with a soy-based protein blend, with no negative effects on growth. A similar plant-protein blend depressed growth of 6-g Atlantic salmon when used to replace 50 percent of dietary fish meal, but growth of late-stage juvenile Atlantic salmon (30-g or larger) was unaffected by complete replacement of fish meal with a blend of corn protein concentrate, SPC and supplemental amino acids Burr et al. (2012).

Soybean products are among the most promising replacements for fish meal in aqua feeds. However, to be effective, FMF (fish meal free) diets must be consumed in quantities sufficient to support rapid fish growth and cost-efficient production. Development of nutritious, palatable, FMF diets for gilthead sea bream, and other fishes, will require the continued identification and testing of new alternatives to fish meal.

Murai et al. (1982) found that supplementing soybean meal diets with either coated or uncoated methionine significantly improved the growth and feed efficiency of fingerling channel catfish. Also, El-Saidy & Gaber (2002 & 2003) completely replaced fish meal with SBM in Nile tilapia diets by supplementing dietary l-lysine, improved growth rate and not different significantly from that of fish fed a fish-meal based diet. Leibowitz (1981) showed that when energy and phosphorus requirements were met and when fish was fed to satiation; soybean meal could replace most of the menhaden fish meal in practical diets of catfish. At a lower feeding rate, however, the growth of fish was slightly reduced unless 6 % of fish meal was added to the diet (Murray, 1982).

Published data on nutrient availability in feedstuffs is not only species-specific, but also diet-specific. Digestibility/nutrient availability is a function not only of the chemical composition of a feedstuff itself, but also of the chemical and physical composition of the larger diet of which it is a part. Thus, reference diet composition may be another significant factor that researchers should consider more closely when measuring nutrient digestibility/availability in feedstuffs. Because the nutrient availability of an ingredient can vary among different diet formulations, the ingredient/chemical composition of reference diets used to generate digestibility data for practical feed formulation for applying the composition of the production diets in which the data will be used, to ensure that nutrient availability coefficients are accurate in the intended application.

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 SBM in sea bream diets reduced the total feed costs. However, high replacing levels of fishmeal by SBM (100% SBM) adversely affected all the growth and feed utilization parameters (Table 3), but the incorporation of SBM in sea bream diets seemed to be economic as incorporation of SBM in the diets sharply reduced feed costs by 10.51 and 59.03% for 20 SBM and 76 SBM respectively. The reduction of feed costs was easily observed for the feed costs per m^3 weight gain which decreased with increasing incorporation levels of SBM in agreement Gaber (2005) for Nile tilapia and Eid & Mohamed (2007) for sea bass fingerlings.

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