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Protein and Energy Maintenance and Maximum Growth Requirements for Sea Bass (*Decentrarshus laborax*) Larvae Using Different Feeding Rates

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ABSTRACT

The effect of feeding rates(5, 10, 15, 20, 25 and 30%) was studied on growth performance body composition and feed utilization of sea bass fry in salt water 30 ppt and temperature 21.8ºC±0.35 for 7 weeks. Protein and energy requirements for maintenance and maximum growth were also determined. Fish were fed on six basal diets containing 45% crude protein and 300kcal/ 100g diet. Sea bass fry of initial BW ± SE (0.08 g ± 0.00) were stocked at the rate of 30 fish per aquarium. Fish were fed 3 times daily 6 days per week; the amount was adjusted every two weeks. Weight gain and final body weight (FBW) of sea bass increased significantly with increasing dietary feeding rate up to 20% with no differences among 20, 25% and 30%. The best growth rate and specific growth rate was observed with 20% feeding rate and no significant differences were found among 20, 25 and 30% feeding rates. The body weight of sea bass increased by increasing protein and energy intake in the diet (22 – 90 mg protein / 1g BW daily and 150 – 600 cal grosses energy / 1g BW daily). The increase in body protein and energy with the increase in protein and energy intake could be expressed by the equation: Y = 6.21x – 22.8 and Y = 0.93x – 22.8 for protein and energy, respectively. From the regression analysis, maintenance requirements could be calculated at Y= zero. It could be calculated in the range of 3.67–3.83 mg protein/ and 24.49–31.79 cal gross energy /1g of the fish BW daily were the maintenance requirements of sea bass (0.08g IBW). The result indicates that the best feeding rate was found at 20% BW for sea bass 0.08g IBW. Thus, 90mg protein and 600cal gross energy / g BW daily could be recommended as the maximum growth requirements for sea bass larvae. Also, from the same data, it could be recommended that sea bass larvae (0.08g initial BW) require 3.75mg protein / g BW and 28.14 cal gross energy /g BW daily as maintenance requirements.

Keywords: Sea bass (*Dicentrarchus labrax*), feeding rates, protein / energy requirement.

INTRODUCTION

The European sea bass (*Dicentrarchus labrax*, Linnaeus, 1758), being a member of the recently revised family of Moronidae. It was the first marine non salmonid species to be commercially cultured in Europe and at present is an important commercial fish widely cultured in Mediterranean areas. Greece, Turkey, Italy, Spain, France and Egypt are now the biggest producers (Viale *et al*., 2006).The catch of sea bass (*Dicentrarchus labrax*) in Egypt from the Mediterranean has fluctuated between 266 tons in 1991and 559 tons in 1998 (El-shebly, 2009).

The European sea bass are eurythermic (2-32ºc) (Barnabe 1990 and EFSA. 2008). The common (or European) sea bass *Dicentrarchus labrax* L. (Teleost, Perciformes, Moronidea) is a marine teleost of great economic importance in the Mediterranean area able to survive under various salinity conditions. It is euryhaline species, (5- 60 ppt) (Jensen *et al*., 1998). Larvae of sea bass tolerate low salinities (5-6 ppt) and display better growth performance at (10-20 ppt) (Orhant, 2002). Production of these species is nowadays a well- controlled process, but knowledge of their nutritional requirements is still very limited (Oliva, 2000).

Fish feeding is one of the most important factors in commercial fish farming because feeding regime may have consequences on both growth efficiency and feed wastage (Tsevis *et al*., 1992 and Azzaydi *et al*., 2000). There have also been feeding trials for larvae, juveniles, and sub-adults (Berlinsky *et al.*, 2000; Copeland *et al*., 2002 and 2003; Marek *et al*., 2002; Cotton and Walker, 2004; Alam *et al*., 2007; Rezek *et al.*, 2007 and Woolridge *et al*., 2007) of black sea bass. One of the factors affecting the dietary protein to energy ratios might be the use of fish of different weights, as protein requirements decrease with increasing fish size (Page and Andrews, 1973; Kaushik and Luquet, 1984 and Masser *et al*., 1991). As protein is the main costly item for culture of this carnivorous marine fish; so, many researchers have attention in respect of protein requirement (kikuchi *et al*., 1992; Kim *et al*., 2002 and Lee *et al*., 2002).

However, more studies are still needed on larval nutrient requirements (Planas and Cunha, 1998), since the maximum capacities of lipids and HUFA for fish larvae are not yet known. As feed is one of the principle costs in fish production, formulation must be based on sound knowledge of nutritional requirements for it to be economical (Sanver, 2005).

Moreover, knowledge of the optimum feeding rate is important not only for promoting best growth and feed efficiency, but also for preventing water quality deterioration as a result of excess feeding (Ng *et al*., 2000; Mihelakakis *et al*., 2002 and Webster *et al*., 2002). In this context, it is useful to know the optimum feeding rate of the cultured species and how feed efficiency, feed consumption and composition of flesh are affected by it.

Studies on European sea bass have been directed towards establishing its feeding rhythms (Sa´nchez-Va´zquez *et al*., 1998 and Azzaydi *et al*., 2000), meal frequency (Hidalgo *et al*., 1987 and Tsevis *et al.,* 1992) and growth performance in freshwater (Harpaz, 1991 and Eroldogan, 2003). There is no study available focusing the optimization of requirements for European sea bass (Peres and Oliva-Teles, 2006). Currently, there is no published information on the effects of feeding rate on growth of European sea bass fingerlings. It is necessary to have a better understanding of the optimum feeding rates of this species (Eroldogon *et al*., 2004).

MATERIALS AND METHODS

This study was carried out in the Marine Fish Laboratory (MFL), Faculty of Agriculture (Saba-Basha); Alexandria University, Egypt.

Experimental procedure

Fish were obtained from El- Meadia Fishing Port in March from the Mediterranean Sea. Fish were acclimated in glass aquaria for 15 days on the experimental diets and environmental conditions before experiment start. Aquaria contained sea water transferred from the sea (30 ppt) and with supplementary aeration contenusly. Fecal matter was removed by siphoning the water from the bottom of each aquarium one hour before giving the diet. All fish in each aquarium were weighed at the beginning of experiment and biweekly. Pooled sample of fifty handred fish of sea bass were killed at the beginning of each experiment and kept frozen for further chemical analysis. At the end of the experiment, 15 to 20 fish were taken randomly from each aquarium, killed and dried at 70°C for about 48 hours for final chemical analysis.

Sea water supply system

The sea water supply system consists of three components; the sea water supplies line, the sedimentation and disinfection facilities and the water storage tanks.

Diets formulation and preparation

Diets were formulated from commercial ingredients of fish meal (FM), wheat flour, wheat bran, shrimp meal, soybean meal (SBM), yellow corn, vit and mineral mixture, fish oil, ascorbic acid and carboxy methyl cellulose (CMC). Diets composition and chemical analysis during the study are shown in Table (1). Diets were prepared as follow: Dry ingredients were passed through a sieve (0.6 mm diameter hole) before mixing into the diets. Oil was emulsified with equal amount of water using 0.7 % phosphatedyl choline (lecithin) according to El-Dhhar and El-Shazly (1993), and added to the diets of the experiments. Mixtures were homogenized in a feed mixer model SNFGA (Kitchen aid St. Joseph, M 149085 USA). Boiling water then blended to the mixtures at the rate of 50% for pelleting.

An autoclave was used to heat the diets for 20 min after adding boiling water at a maximum pressure of 1.2 kg/ cm^2 G. Vitamins and minerals mixture was added to the diets after heat treatments. Aquaria management, heat treating of the diet and exogenous zymogene addition were made according to El-Dahhar (1999a).

Experimental Design

This experiment was designed to study the effect of feeding rates(5, 10, 15, 20, 25 and 30%) on growth performance, body composition and feed utilization of sea bass fry in 18 glass aquaria in salt water 30 ppt and temperature 21.8ºC±0.35 for 7 weeks. Protein and energy

Table 1: Composition and chemical analysis of the test diets used in the first experiment (feeding rates) different to feed sea bass (initial body weight 0.08).

Protein level (%)	45%
Energy level(Kcal/100g diet)	300
Ingredients (%)	
Wheat flour	0
Shrimp meal	25
Wheat bran	0
Soybean meal	20
Yellow corn	0.8
Fish meal	40
Fish oil	10
CMC[1]	3
Vit&Min.Mix[2]	0.8
Ascorbic acid	0.4
Proximate analysis (%)	
Moisture	9.32
Crude protein	45.07
Crude lipid	12
Crude fiber	4.02
Carbohydrate (NFE)[3]	
Crude ash	9.99
*Gross Energy(GE)and	448.41
(ME) Kcal/100g diet	(300)

1-Carboxy methyl cellulose.

2-vitamin and mineral mixture/kg premix: vitamin A, 4.8 million IU; D 3, 0.8 million IU; E 4g; K, 0.8g; B1 0.4g; riboflavin, 1.6g; B6, 0.6g; B12, 4mg; pantothinic acid, 4g; nicotinic acid, 8g; folic acid, 0.4g; biotin, 20 mg; choline chloride, 200 g; Cu, 4g; I, 0.4g; Iron, 12g; Mn, 22g; Zn, 22 g; selenium, 0.4 g.

3-NFE is nitrogen free extract = 100-(cp+cl+cf+ash).

2% Zymogene® was added to each diet according to El-Dahhar (1999a)

** gross energy (ge) content was calculated by using the factors 5.65, 9.4 and 4.1 kcal/g for protein, ether extract and carbohydrate, respectively (Jobling, 1983).*

requirements for maintenance and maximum growth were also determined. Fish were fed on six basal diet containing 45% crude protein and 300kcal/ 100g diet. Sea bass fry of initial BW ± SE (0.08 g ± 0.00) were stocked at the rate of 30 fish per aquarium (40* 60*100cm). Fish were fed 3 times daily at 9.00, am and 12.00 and 16.00 Pm 6 days per week in the amount adjusted every two weeks.

The whole population was weighed every two weeks. Fecal matter was removed by siphoning the water from the. Mortality was recorded daily. Fecal matter was removed by siphoning the water from the bottom of each aquarium one hour before giving the diet.

Chemical and statistical analyses

Crude protein (total-N x 6.25) and total lipid contents of the test diets and whole bodies were determined using the Kjeldahl method and ether-extraction method, respectively. Ash and moisture contents were analyzed following the Association of Official Analytical Chemists (AOAC, 1995) using two replicate samples for each determination. Probability of 0.05 was considered significant. The analysis of variance (ANOVA) test was mad according to Snedecor and Cochran (1981).

RESULTS

Growth performance

Feeding sea bass on a diet containing 45% crude protein and 300 kcal ME / 100g diet at six incremental feeding rates (5, 10, 15, 20, 25, 30%)of body weight (BW)) daily in this experiment, resulted in a linear increase in BW gain, $r^2 = 0.99$ (Figures 1and 2 and Table 2).The linear increase of the growth was observed with increasing feed intake up to 90 mg protein and 600 kcal ME energy /g BW daily. The relationships between BW gain (y) and the increase of protein and energy intake(X) could be expressed by the equations $Y= 6.21x – 22.8$ (Fig.1) and $Y= 0.93x – 22.8$ (Fig. 2) for protein and ME, respectively. Maintenance requirements calculated from these equations (as BW gain = zero) of sea bass (0.08g initial BW) / g of their body weight daily were found to be 3.67mg protein and 24.49cal gross energy / g BW daily.

The results showed that BW of sea bass significantly increased with increasing feeding rate up to 20 % BW daily at the end of the experimental period. Net energy of sea bass increased linearly with the increase in feeding rate up to 90 mg protein and 600 cal gross energy / g BW daily (Table 2). The increase in body protein and energy (Y) with the increase in protein and energy intake (X) could be expressed by the equations $Y=1.024x – 3.92$; $r^2 = 0.989$ for protein (Fig.1) and $Y=1.291x – 41.037$; $R^2 = 0.991$ for energy (Fig.2) (Table2).

From the regression analysis, maintenance requirements could be calculated at Y= zero. It could be calculated as 3.83mg protein and 31.79cal gross energy of sea bass (0.08g BW) / g of the fish BW daily. Also, from the mathematical models, maintenance requirements of sea bass (0.08 g initial BW) could be estimated. They were found to be 3.83 –3.67mg protein / g BW. d^{-1} and 31.79–24.49cal gross energy / g BW. d^{-1}. Thus, It could be recommended that the sea bass larvae of 0.08g initial BW require 3.75mg protein / g BW and 28.14cal gross energy / g BW daily as maintenance requirement. Also, from the same data, 90mg protein and 600cal gross energy / g BW daily could be recommended as the maximum growth requirements for the same sea bass fry. Final body weight (FBW) and survival of sea bass (0.08g initial BW) increased significantly ($P < 0.05$) with increasing feeding rate up to 20 % of the total biomass daily (Table 2 and Fig 3). However, the increase of these criteria as feeding rate increased beyond 20% was not significant ($P > 0.05$). Data of offered feed, weight gain (WG), feed conversion ratio

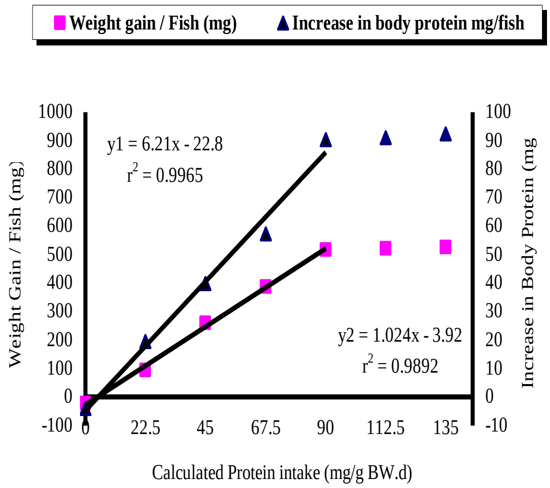

Fig. (1): Effect of increasing levels of calculated protein intake (mg / g BW .d) on sea bass gain and change in body protein (mg). Each symbol represents the mean of three observations.

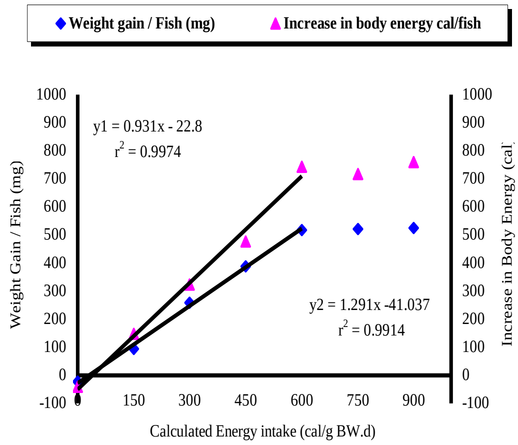

Fig. (2): Effect of increasing levels of calculated energy intake (cal/g BW .d) on sea bass gain and change in body energy (kcal). Each symbol represents the mean of three observations.

Table 2. Protein intake mg/g (BW), gross energy intake cal/g BW, mean ± standard error (SE) of final body weight and survival of sea bass (Decentrarshus laborax) (0.08g initial BW) fed at six feeding rates (5, 10, 15, 20, 25 and 30%) for seven weeks.

Feeding rates	Weight gain	Gain of body protein	Gain of body energy	Nutrients Intake g BW		Final weight	Survival
(%of BW)	(mg/ fish)	(mg /fish)	(cal/ fish)	Protein (mg)	(Energy (cal) g/fish)	(g/fish)	(%)
5%	95	19.45	148.44	22.5	150	0.175d ± 0.007	66.66c ± 0.409
10%	259.33	39.76	322.95	45	300	0.339c ± 0.008	70.00bc ± 0.709
15%	387.66	57.25	477.18	67.5	450	0.468b ± 0.002	71.66b ± 0.409
20%	518	90.47	742.62	90	600	0.598a ± 0.010	85.00a ± 0.709
25%	520.66	91.11	718.02	112.5	750	0.601a ± 0.010	83.33a ± 0.818
30%	525.66	92.5	760.49	135	900	0.606a ± 0.007	86.66a ± 0.409

- ***Means in the same column not sharing the same letter are significantly different P < 0.05.***

(FCR) and specific growth rate (SGR) are shown in Table (3). Offered feed of sea bass increased significantly ($P < 0.05$) with the increase of feeding rate. It was found to be (0.30 ± 0.01, 0.62 ± 0.02, 1.13 ± 0.02, 1.78 ± 0.03, 2.26 ± 0.06 and 2.56 ± 0.09 g/fish) for the fish fed 5, 10,15,20,25 and 30% BW daily, respectively in (Table 3). Also, feed conversion ratio (FCR) decreased significantly from 2.37 ± 0.054 to 4.87 ± 0.113 with increasing feeding rates from 10 to 30% of BW daily and improved significantly ($P < 0.05$) (Table3 and Fig 4).

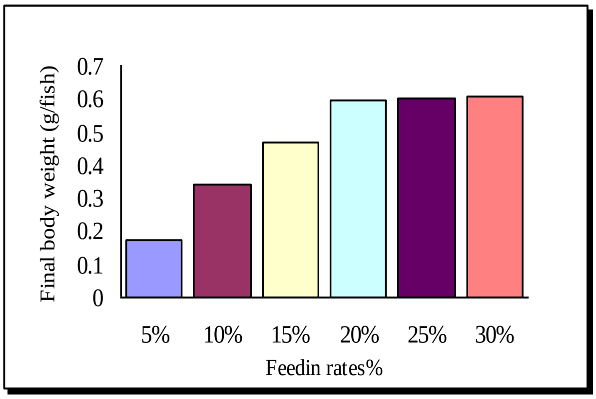

Figure (3): Final body weight of sea bass (Decentrarshus laborax) (0.08g initial BW) fed at six feeding rates (5, 10, 15, 20, 25 and 30%) for seven weeks.

Table 3. Mean ± standard error (SE) of offered feed, weight gain, feed conversion ratio (FCR) and specific growth rate (SGR) of sea bass (Decentrarshus laborax) (0.08g initial BW) fed at six feeding rates (5, 10, 15, 20, 25 and 30%) for seven weeks in the first experiment.

Feeding rates (%of BW)	Offered feed (g)	Weight Gain (g/fish)	feed conversion Ratio(FCR)	SGR % (%/d)
5%	0.30g ± 0.01	0.095d ± 0.006	3.18g ± 0.042	1.86d ± 0.065
10%	0.62f ± 0.02	0.259c ± 0.007	2.37f ± 0.054	3.44c ± 0.056
15%	1.13d ± 0.02	0.388b ± 0.001	2.98d ± 0.042	4.20b ± 0.011
20%	1.78c ± 0.03	0.518a ± 0.010	3.44c ± 0.062	4.79a ± 0.041
25%	2.26b ± 0.06	0.521a ± 0.011	4.35b ± 0.196	4.81a ± 0.043
30%	2.56a ± 0.09	0.525a ± 0.007	4.87a ± 0.113	4.58a ± 0.206

Means in the same column not sharing the same letter are significantly different P < 0.05.

Weight gain (WG) and specific growth rate (SGR) of sea bass (0.08g initial BW) increased significantly (P<0.05) by increasing feeding rate up to 20 % of the total biomass daily (Table 3). On the other hand, increasing the feeding rate from 20 to 30 % did not affect any additional increase in WG and SGR of sea bass (Table 3).

Body composition

Table 4 shows that body composition of sea bass (*Decentrarshus laborax*) larvae was affected by increasing feeding rate. Moisture content of sea bass decreased with increasing feeding rates. The highest moisture content was found to be 78.17 ± 0.01 % for the fish maintained at 5 % feeding rates, while the lowest was 75.33 ± 0.008 % for 30 % daily feeding rate. Protein content of sea bass increased with increasing feeding rates from 5 to 30 %. There was a positive significant (P<0.05) effect of feeding rates on protein content of the fish body. Also, lipid contents of sea bass increased significantly (P< 0.05) with increasing feeding rate up to 20% BW.

Protein and energy utilization

Values of protein efficiency ratio (PER), protein productive value (PPV %), energy retention (ER %) are shown in Table 5. PER (body weight gain / protein fed) of sea bass decreased significantly (P < 0.05) (Table 5) as

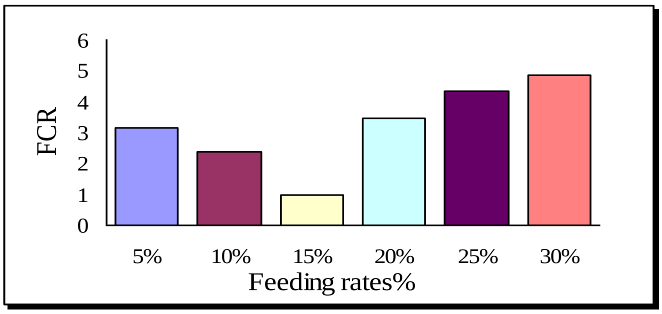

Figure (4): ***Feed conversion ratio (FCR) of sea bass (Decentrarshus laborax) (0.08g initial BW) fed at six feeding rates (5, 10, 15, 20, 25 and 30%) for seven weeks.***

Table (4). Mean ± standard error (SE) of moisture, protein and lipid content dry mater bais in the carcass of sea bass (Decentrarshus laborax) (0.08g initial weight) fed at six feeding rates (5, 10, 15, 20, 25 and 30%)) for seven weeks.

Feeding rates (% of BW)	Moisture%	Protein%	Lipid%
Initial	80.02 ± 0.041	11.43 ± 0.062	1.73 ± 0.031
5%	78.17a ± 0.011	11.61e ± 0.023	3.067d± 0.022
10%	77.89b ± 0.011	11.96d ± 0.053	3.463c ± 0.022
15%	77.36c ± 0.011	12.43c ± 0.103	3.700b ± 0.014
20%	75.61d ± 0.017	15.28b ± 0.054	4.293a ± 0.022
25%	75.40e ± 0.010	15.31ab ± 0.063	4.267b ± 0.008
30%	75.33f ± 0.007	15.43a ± 0.021	4.287ab ± 0.022

**** Means in the same column not sharing the same letter are significantly different P < 0.05.***

feeding rates increased. Also, PPV% (100 gained protein/protein fed) and ER% (100 retained energy/energy fed) of sea bass of 0.08g initial BW decreased significantly (P < 0.05) as feeding rates increased Table (5).

DISCUSSION

This study was carried out to investigate the effect of different feeding rates, on performance, feed utilization and body composition of sea bass (*Dicentrarchus labrax*). The requirements of protein and energy for maintenance and maximum growth were also determined. Despite of the commercial importance and rapid expansion of and sea bass aquaculture, very little is known about the nutritional requirements of this species. However, based on the information available, nutritional requirements of fish do not vary greatly among species (Lovell, 1989). There is no published information on the effects of feeding rate on growth of European sea bass fingerlings. It is necessary to have a better understanding of the optimum feeding rates of this species (Eroldogan *et al*., 2004).

Currently, little information exists regarding the nutritional demands of fry sea bass, studies have been conducted with other carnivorous marine species such as mutton snapper, *Lutjanus analis* (Watanabe *et al.,* 2001); drum, *Nibea miichthioides* (Wang *et al*., 2006a and b); black sea bass, *Centropristis striata* (Rezek *et al*., 2005 and 2007) (Thoman *et al.*, 1999); sea bass, family Serranidae (Borlongan and Parazo, 1991; Catacutan and Coloso, 1995; Company *et al*., 1999a and b; Russel *et al., 1986*; and Lanari *et al*., 1999 and 2002; Perez *and Oliva-Teles* 1997, 2005 and 2006); Japanese flounder, (*Paralichthys olivaceus* (Kikuchi, 1999); yellowtail, *Seriola quinqueradiata* (Masumoto *et al.,* 1996) and hybrid striped bass, *Morone* sp. (Nematipour *et al.,* 1992a and b and Gaylord and Gatlin, 2000).

Table 5. ***Mean ± standard error (SE) of protein efficiency ratio (PER), protein productive value (PPV %) and energy retention (ER %) of sea bass (Decentrarshus laborax) (0.08 g initial weight) fed at six feeding rates (5, 10, 15, 20, 25 and 30%)) for seven weeks.***

Feeding rates (%of BW)	PER	PPV %	ER %
5%	0.70b ± 0.017	14.28a ± 0.26	16.39b ± 0.26
10%	0.91a ± 0.022	13.86a ± 1.47	17.51a ± 1.47
15%	0.75c ± 0.003	11.11b ± 0.46	13.75c ± 0.46
20%	0.64d ± 0.012	11.15b ± 0.91	13.91c ± 0.91
25%	0.50e ± 0.008	8.73c ± 0.87	10.58d ± 0.87
30%	0.45f ± 0.014	7.88d ± 0.42	9.92d ± 0.42

**** Means in the same column not sharing the same letter are significantly different P < 0.05.***
PER = gain/protein fed
PPV% = 100 gained protein/protein fed.
ER% = 100 gained Energy/energy fed.

In the present study, we investigate the effect of feeding rates (%BW) of the sea bass *D. labrax* to determine protein and energy requirements for maintenance and maximum growth. The best growth of sea bass with an initial BW of 0.08 g was obtained with 20% feeding rates. Also, FBW, SGR and WG increased with increasing feeding rate up to 20% in experiment1 (Table 3). There were significant differences ($P < 0.05$) in WG with increasing feeding rates. This corresponds to an energy content of 300 kcal / 100g feed with 45% protein. Studies with several fish species have revealed that with increasing feeding rate, the growth increases at higher ration levels and decreases at lower ration levels (De Silva *et al*., 1986; Hung and Lutes, 1987; Xiao-Jun and Ruyung, 1992; Adebayo *et al*., 2000; Ng *et al*., 2000; and Mihelakakis *et al.*, 2002). The increase in growth of European sea bass with increasing feeding rate obtained in the current study agrees with the results reported by the researchers cited above. A comparison between results of protein and energy maintenance and maximum growth requirements of some fish species is shown in (Table 6). Some differences among results were found to be different fish species and different experimental conditions, e.g. fish size, feeding rate, rearing temperature and others. The smaller fish required more than larger fish due to the higher metabolic rate (Halver, 1988)

Table 6: *Comparison between results of maintenance and maximum growth requirements of some fish species.*

Fish species	Body weight (g)	Water Temp. (°C)	Maintenance Requirements		Maximum Growth Requirements		Dietary Protein Level (%)	Author(s)
			Protein mg/g BW	Energy cal/g BW	Protein mg/g BW	Energy cal/g BW		
Sea bass	0.08	21.8	3.75	2814	90mg/g	600	45	The present study
European (sea bass)	22	25	1.15	13.56				Peres *et al.*,(2005)
Florida pompano	6.3	22	0.23 g/fish	8.6 Kj/fish				Riche, (2009)
Striped mullet	0.19	24.5	3.9	30.2	34	345.6	38	El-Dahhar, (2000a)
Striped mullet	0.2	24.5			26.3	382.7	26	El-Dahhar, (2000a)
Grey mullet	2.5	23.3			13.5	215.3	25.5	Alexis and Papaparaskeva, -Papoutsoglou, 1986.
Grey mullet	12.7	24			5.8	190.3	15	Papoutsoglou and Alexis, 1986.
Red Tilapia	1	24.3		73				Hepher *et al.*, 1983.
Red Tilapia	1	20.9		51				Hepher *et al*., 1983.
Red Tilapia	11.4	20	3.7		42		28.2	Zonneveld& Fadholi, 1991.
Hybrid Tilapia	2.9	26	4.2		11.9		24	Shiau & Huang, 1989.
Nile Tilapia	0.2	27.5	10	106.9	48		39.6	El-Dahhar, 1993b.
Nile Tilapia	0.63	27	7	76.5	32		32	El-Dahhar *et al,* 1999b.
Nile Tilapia	0.76	27			30.6		24	El-Dahhar *et a*l, 1999b.
Nile Tilapia	1	27.5	8.6		36		30.2	El-Dahhar, 1994.
Nile Tilapia	3.6	27			25.8		20	El-Dahhar, 2000.
Nile Tilapia	6.3	27.5	4.3		17.5		34.9	El-Dahhar, 1993b.
Nile Tilapia	9.6	27.5	3.6		13.3		26.6	El-Dahhar, 1994.

Some differences among the results were found to be due to different fish species and Also, Eroldogan *et al*. (2004) found that weight gain and specific growth rate (SGR) of sea bass (*Dicentrarchus labrax*) (initial weight of 2.6g) were highest at ration 4.0% BW/day. Tsevis *et al*. (1992) stated that optimum feeding level, which gave the highest growth in European sea bass fingerlings (60 g), was 3.2% BW /day at two meals. This is in consistent with the findings of Ballestrazzi *et al.* (1998) who observed that 1.06% BW /day was an optimum feeding rate for 78 g European sea bass juveniles.

On the other hand, Eroldogan (2003) stated that daily feeding level for European sea bass having 30 g initial average body weight, cultured in FW, was as low as 1.0–2.5% BW/ day was adequate for the fish of this size. The discrepancies between the results of our study and the recent study and the findings of others could be explained by size and/or age differences of fish and experimental conditions such as stocking rate, feeding regimes or water quality (Brett, 1979; Webster *et al*., 2002 and Fiogbe´ and Kestemont, 2003).

For instance, Hung *et al*. (1993a and b) observed that optimum feeding rate for striped bass fingerlings (initial body weight 38 g) was 1.0–1.5% bw/ day at 19 ºC. In similar size, optimum feeding rate was suggested to be 2.0 BW /day for the same species (>27 g) kept at 21 ºC by Piper *et al*. (1982). A feeding rate of 4.0% BW /day for gilthead sea bream at 3-g initial average weight at 22ºC but 6.0% bw /day at 1-g initial average weight at 20 ºC was suggested to be optimal (Kalogeropoulos *et al*., 1992 and Alexis *et al*., 1999).

In the present study, at the first experiment, the best growth of sea bass with an initial BW of 0.08 g was obtained with 20% feeding rates, this feeding rate was considered lower than that reported by Ding *et al*, (2003). They reported the optimum feeding rates of white sturgeon larvae to be 26% at (initial BW 49 mg/fish). Also, (Ding *et al*, 2003) found that the optimum feeding rates of white sturgeon larvae to be 13% at (initial BW 94 mg/fish). Growth response decreased with decreasing feedings levels, but only at 2.5 g feed/kg$^{0.8}$/d ($P < 0.01$) of juveniles Blackspot sea bream (Ozorio *et al.*, 2009). Also, body lipid content increased with increasing feeding rates up to 20%. Also, the body protein content was increased with increasing feeding rates for sea bass (0.08g initial BW). Whereas, the body moisture content of the fish decreased with increasing feeding rate (Table 4).

The proximate composition of fillet (Webster *et al.*, 2002), whole of body and carcass (Hung *et al*., 1993a and b; Jobling, 1994; Ng *et al*., 2000 and Mihelakakis *et al.*, 2002) is affected by feeding rate. Generally, under suboptimal feeding conditions, fish retain more protein in the muscle (Austreng *et al*., 1987; Storebakken and Austreng, 1987; Hung *et al*., 1993a and b and Ng *et al*., 2000); however, body lipid is reduced when the feeding rate is lowered (Mihelakakis *et al*., 2002 and Van Ham *et al*., 2003). Ng *et al*. (2000) in tropical Bagri catfish (up to 3.0% BW /day) and Hung *et al*. (1993a and b) in striped bass (above 0.5 % BW/day) also observed that carcass and body lipid content of the fish increased with the increasing feeding rate. This situation has already been demonstrated with sea bass by Hidalgo *et al*. (1987), in which case, an increase in feeding rate from 0.74% to 1.45% BW/day caused a rise in the lipid content of the fingerlings at 15 ºC, whereas no significant effect of ration on the lipid content (1.0% to 2.6% BW/day) was detected at 20 ºC.

These relatively low protein requirements are recompanied by low values of PER, PPV and ER. This was also found by El-Dahhar (2000a).These values are known to affect by energy content of the diet in the form of fat. The maximum values of PER and PPV observed are lower than those observed for rainbow trout fed diets with low or high energy content (Takeuchi *et al*., 1978). PER and PPV decreased with increasing feeding rates for sea bass in this work. This was also found by Ozorio *et al*. (2009), who found that net protein utilization decreased with each increase in feeding level for sea bream juveniles *Pagellus bogaraveo* (initial weight = 64 g).

In the present study, body weight gain, body protein and energy of fry sea bass (0.08g initial BW) increased linearly as protein and energy intake increased (r^2=0.99). The suggested daily consumption for fish of 0.08 g initial BW was 3.83 – 3.67 mg/fish/day and 24.49 –31.79 cal/fish/day for protein and energy, respectively as maintenance requirement. The protein requirements of fish have been reported to vary with species, fish size, water temperature, salinity, protein quality, non-protein energy, feed allowance, stocking density and availability of natural foods (NRC, 1983).

Lupatsch *et al.* (2001a and b) calculated the digestible protein and energy requirements for gilthead sea bream in terms of daily consumption to avoid differences due to different feeding levels. The suggested daily consumption for fish of 10 g was 0.13 g/fish/day and 4.55 kJ/fish/day for protein and energy, respectively. On the other hand, calculated the digestible protein and energy requirements for Indian major carp, *Labeo rohita*, of 0.55g was 2.6–2.8 g protein and 23.49–25.31 kcal energy per 100 g of the diet per day is optimum for growth and efficient feed utilization of *Labeo rohita* different experimental conditions, e.g. fish size, feeding rate, rearing temperature and others. The smaller fish required more than larger fish due to their higher metabolic rate (Halver, 1988). El-Dahhar (1993 and 1994) and El- Dahhar *et al*., (1999a and 2000a) stated that at the same temperature, increasing fish size decreased maintenance and maximum growth requirements for both protein and energy.

Likewise, El-Dahhar (2000a) found that the protein and energy requirements of striped mullet (*Mugil cephalus*) larvae (0.195g initial BW) were 3.6 – 4.2 mg protein / (g BW/ d) and 24.6 – 35.8 cal gross energy / (g BW/d). This result agrees with that reported by the present study of sea bass larvae (0.08 g initial BW). On the other hand, Fournier *et al*. (2002) recalculation of N requirement for maintenance expressed as per average body weight per d for turbot was 470 mg/kg average body weight/d (y = 226·73 + 0·4823x).; a value considerably higher than that of 250 mg N/kg per d, reported for plaice, another flatfish, by Cowey *et al*. (1972) and of other data on endogenous N excretion levels measured by Birkett (1969) and Jobling (1981). N requirement for unit N gain of rainbow trout and turbot are similar. The slope of the curve relating N intake and N gain was 0·46 in turbot and 0·44 in rainbow trout. This observation confirms the higher N retention efficiency in turbot compared with other farmed fish as already suggested by Caceres-Martinez *et al.* (1984); Dreanno (1994) and Dosdat *et al.* (1995). Although N needs for maintenance of rainbow trout and sea bass were similar, the higher N requirement for unit protein accretion of sea bass (0·404 v. 0·365 g/g protein gain) could explain its higher dietary protein needs (Hidalgo and Alliot, 1988; Dias *et al.* 1998 and Peres and Oliva-Teles, 1999a and b). Data obtained here on the protein requirements of gilthead sea bream are in accordance with those reported by Santinha *et al.* (1996).

For sea bream, the required energy intake is calculated as DE maint = 50.8 kJ /BW $(kg)^{-0.82}$ /day. Accordingly, digestible energy maintenance (DE maint**)** for sea bass is calculated as 45.4 kJ/BW $(kg)^{-0.80}$ /day. The efficiencies of utilization of DE for growth were determined as kDEg = 0.67 and 0.69 for sea bream and sea bass, respectively. The reciprocal values 1.50 and 1.44 are a measure for the requirement (as kJ DE) to deposit one unit of energy (kJ). Maintenance requirement for protein can be calculated as digestible protein maintenance (DPmaint=0.61g/BW (kg)$^{0.70}$ /day). (http// resources. Ciheam.org/om/pdf/e 63).

Likewise, Peres and Oliva-Teles (2005) reported that maintenance energy and protein requirements were estimated to be 56.8 kJ DE/kg/day and 1.15 g DP/kg/day, respectively for juvenile European sea bass reared at 25 °C (IBW = 22 g). On the other hand, Riche (2009) found that digestible energy (DE) intake was 4.2–13.0 kJ/fish/d, and digestible protein (DP) intake was 0.13–0.32 g/fish/d for juvenile Florida pompano (6.3 ± 0.50 g).

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حساب الاحتياجات الحافظة والانتاجية من البروتين والطاقة ليرقات أسماك القاروص باستخدام معدلات تغذية مختلفة

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أجريت هذه الدراسة في كلية الزراعة (سابا باشا) جامعة الإسكندرية في هذه الدراسة تم تقدير الاحتياجات الحافظة والانتاجية لصغار أسماك القاروص (متوسط الوزن الابتدائى 0.08 جم) وذلك بتغذيتها على ستة معدلات تغذية (5 ، 10 ،15 ، 25 ، 20 ، 30 %) باستخدام علف يحتوى على 45% بروتين و 300ك كالورى بعد فترة أقلمة أسبوعين بكل حوض 30 سمكة، ،وكانت مدة التجربة 7 أسابيع وتقدم العلائق 3 مرات يوميا خلال 6 أيام أسبوعيا ويتم وزن الأسماك كل أسبوعين.

وقد أظهرت النتائج ما يلي :

1-الأسماك التى تم تغذيتها على معدل تغذية 5% من وزن الجسم كان نموها ضئيلا جدا و ارتفعت فيها نسبة النفوق.

2-زيادة معدل التغذية من 5% حتى 20% أدى الى زيادة معنوية فى وزن الجسم النهائى ،ولا يوجد اختلاف معنوى بين معدلات (20%, 25, 30 %).

3-لوحظ زيادة معنوية فى معدل النمو النوعى بزيادة معدلات التغذية ولا يوجد اختلاف معنوى بين معدلات التغذية(20, 25, 30 %) .

4-وقد لوحظ أن وزن الجسم لأسماك القاروص يزيد زيادة مطردة بزيادة البروتين والطاقة المأخوذة من19.45 إلى 90 مجم بروتين ومن 148.44 إلى 742.62 كالورى طاقة كلية / 1 جم من وزن الأسماك يوميا ،وما زاد عن ذلك من البروتين أو الطاقة فى العليقة لم يكن له نفس التأثير المطرد.

٨-أمكن حساب الاحتياجات الحافظة من المعادلات الرياضية وذلك باعتبار الزيادة فى الوزن أو فى بروتين الجسم أو طاقة الجسم = صفر.

نستنتج من هذه التجربة ما يلى:

١- أن أفضل معدل تغذية لصغار أسماك القاروص ذات وزن ابتدائى 0.08 جم هى 20% من وزن الجسم.

٢- أن الاحتياجات الحافظة لأسماك القاروص ذات وزن ابتدائى 0.08 جم هى3.67 -3.83 مجم بروتين و24.49- 31.79 كالورى طاقة كلية/1جم من وزن الأسماك يوميا. وفى المتوسط هى 3.75 مجم بروتين 28.14 كالورى طاقة كلية / جم من وزن الجسم يوميا كاحتياجات حافظة ليرقات أسماك القاروص بوزن ابتدائى 0.08 جم.

٣- أن نسبة90.47 مجم بروتين و 742,62 كالورى طاقة كلية / 1 جم من وزن الأسماك يوميا يمكن أن يوصى بها لأسماك القاروص ذات وزن ابتدائى 0.08 جم لأعلى معدل نمو.