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Effect of different dietary protein-energy ratio on growth, feed utilization, body composition and haematological indices of European sea bass, *Dicentrarchus labrax* fingerlings

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ABSTRACT

This study was conducted to investigate the effect three dietary protein energy ratio on growth performance, feed utilization and haematological indices of European sea bass *Dicentrarchus labrax* fingerlings culture in net enclosures (hapa, 30 m^{-3} each) for 60 days. The experimental treatments were assigned in triplicate. Three test diets were formulated to contain three different protein levels (450, 500, and 550 g kg^{-1} diet) and three lipid levels (174, 160 and 150 g kg^{-1} diet) to provided three different dietary protein: energy ratio (P: E ratio: 20 , 23 and 25 mg CP kJ^{-1} GE g^{-1}, $P:E_{21}$, $P:E_{23}$ and $P:E_{25}$, respectively). A total of 180 European sea bass, *Dicentrarchus labrax* with an average initial body weight of 13.0 ± 0.5 g $fish^{-1}$ were randomly distributed into nine net enclosures measuring (3 × 8 ×1.25m each) at a stocking density of 20 fish per net enclosure. Over the 60-days feeding period, growth, feed utilization efficiency and survival (%) of *D. labrax* fingerlings was improved significantly ($P>0.05$) with increasing dietary protein energy ratio up to $P:E_{23}$ compared to $P:E_{25}$ diets. The same trend was observed for the best feed conversion ratio (FCR). No statistical difference ($P \geq 0.05$) was observed for the influence of dietary protein energy ratio on whole body proximate analysis of fish except for protein which recorded the highest values for fish fed $P:E_{23}$ diet. Mean red blood cell counts (RBCs), mean white blood cell counts (WBCs), hematocrit (Hct), hemoglobin (Hb), total plasma protein, total plasma globulin, plasma

sodium chloride and glucose of *D. labrax* fingerlings significantly ($P \geq 0.05$) increased for fish fed the diets $P:E_{25}$ compared to other experimental treatments. An opposite trend was observed for plasma cortisol, albumin, plasma aspartate aminotransferase (AST) and alanine aminotransferase (ALT) values. The obtained findings revealed that, the diet containing 500 g kg^{-1} protein and 160 g kg^{-1} lipid with dietary P: E ratio of 23 mg CP kJ GE g^{-1} is recommended to stimulate growth performance, nutrients utilization efficiency and haematological indices of *D. labrax* fingerlings

Keywords: *Dicentrarchus labrax*, protein, energy, lipid, haematological, growth

Introduction

European sea bass, *Dicentrarchus labrax* L. is an economically important euryhaline marine fish that frequently inhabits coastal waters of the Mediterranean Sea. European seabass is considered one of the most appreciated species of Mediterranean area and, fished or aquacultured, is important not only for local consumption but also for exportation. The fish presents a white flesh, mild taste and low-fat content. In Egypt, *Dicentrarchus labrax* is one of the most important commercial marine fish species (**El-Shebly, 2009**).

Besides the important role of protein for adequate growth and maintenance of fish, this nutrient is either responsible for most of the production cost of a formulated diet. The protein and energy content of a diet are closely related and there are several reports on the influence of both factors on growth and feed utilization of fish (**Ai *et al.*, 2004**). If the dietary energy content of a diet is not sufficient to meet the energy demand of a fish, or if low quality protein is used in diet formulation, the amino acids which compound the protein will be used as energy source and high amount of nitrogen will be excreted by deamination of the amino acids in excess. Thus, a low energy to protein ratio could reduce fish growth rates due to the increased metabolic demand of energy to excrete nitrogen and reduces the water quality which is of utmost importance for maintenance of ornamental fish in aquaria. On the other hand, a high energy to protein ratio could lead to increased lipid deposition on body carcass and reduce the nutrient intake leading to

deficiency on some nutrients and reduced disease resistance of fish (**Cho, 1990**).

Therefore, the use of proper energy to protein ratios for European sea bass is important when formulating low cost and eco-friendly fish diets. Several studies have been conducted to evaluate the adequate energy to protein ratio for many fishes (**Hernandez *et al*., 2001; Ai *et al*., 2004**). However, several factors could influence the determination of proper dietary protein to energy ratio, such as fish species and their natural feed habits, size of fish, diet formulation and the production system (**Ai *et al.*, 2004**).

Most researchers have reported optimal protein levels of 50% crude protein (CP) or more for growth of European sea bass juveniles and grow-out (**Alliot *et al*., 1974; Metailler *et a*l., 1981; Hidalgo and Alliot, 1988; Tibaldi *et al.*, 1991; Ballestrazzi *et al.*, 1994**). However, **Alliot *et al.* (1984)** did not obtain any differences for diets containing 45 or 60% CP. Results obtained in fingerlings are contradictory. **Alliot *et al.* (1979)** cited better growth with a control diet (containing 50% CP) and with 43 and 46% CP compared to diets containing 50 or 54% CP, whereas **Harpaz (1991)** reported better results with 58 % CP than 48% CP.

Dietary lipid content always needs to be considered, because low levels (5%) can give poor growth in European sea bass (**Alliot *et al.*, 1974**). When these minimal values are avoided, results usually improve, although in every case fat levels higher than 15% did not improve growth in European sea bass (**Metailler *et al.*, 1981**). In fact, lipid inclusion in a diet changes its energy value and may have some influence on its energy efficiency, as can be inferred from the work published by **Alliot *et al.* (1979). Pèrez *et al.* (1997)** reported that, the optimum growth was obtained for European sea bass with dietary lipid levels between 10 and 14%, whereas high (18%) and low (6%) levels gave a poorer response, although in the first case, the effect could be explained by the low dietary protein content.

Only a few laboratory studies have been considering the optimum dietary protein to energy ratio in European sea bass (**Metailler, *et al.* 1981; Pèrez *et al*.1997**). In Egypt, there is limited research on evaluation of optimum dietary protein to energy ratio under commercial production of *D. labrax* such as net enclosures specially; the relatively long fish rearing (12-18 months) and low fish survival are disadvantages to commercial culture of this species. Therefore, this study was conducted

to investigate the effect of three different dietary protein: energy ratio (P: E ratio: 20 , 23 and 25 mg CP kJ^{-1} GE g^{-1}) on growth performance, feed utilization and haematological indices of European sea bass *Dicentrarchus labrax* fingerlings culture in net enclosures (hapa, 30 m^{-3} each) for 60 days.

Materials and methods

Experimental Fish, diet and culture technique

A total of 180 European sea bass, D. labrax with an average initial body weight of 13.0 ± 0.5 g/fish were obtained from a private commercial fish farm (El- Shref farm, Wady Marriott, Alexandria), Egypt. Prior to the start of experiment, the fish were acclimated to the experimental conditions for one week in two indoors circular fiberglass tanks ($1m^3$). After acclimatization, the fish were randomly distributed into nine net enclosures measuring (3 × 8 ×1.25m each) representing three treatments (in triplicate) at a stocking density of 20 fish per net enclosure. Three test diets were formulated to contain three different protein levels (450, 500, and 550 g kg^{-1} diet) and three lipid levels (174, 160 and 150 g kg^{-1} diet) to provided three different dietary protein: energy ratio (P: E ratio: 21 , 23 and 25 mg CP kJ^{-1} GE g^{-1}, $P:E_{20}$, $P:E_{23}$ and $P:E_{25}$, respectively). The ingredients and proximate compositions of the experimental diets are shown in Table (1).

Experimental diets were prepared by mixing the dry ingredients of each diet were thoroughly mixed and 200 ml of water was added per kg diet thereafter, the mixture (ingredients and water) was blender to make a paste of each diet. pelleting of each diet was carried out by passing the blended mixture through laboratory pellet matching was a 1mm diameter matrix, the resulting wet pellet were dried at room temperature for two days. The diets were stored in plastic bags in refrigerator (-2°C) until use.

Fish were fed experimental diets six days a week for 60 days. The daily ration was divided into three equal amounts and offered three times a day (09.00, 12.00 and 15.00 h).

Water temperature, dissolved oxygen, pH, and ammonia were monitored weekly during the trial, to maintain water quality at optimum range for European sea bass fingerlings. Continuous aeration was maintained in each net enclosure using an electric air pumping. Water temperature ranged from 18.0 to 19.0 °C, dissolved oxygen (DO) from

6.00to 6.59 mg/L, pH from 7.0 to 7.5, ammonia (NH3) from 0.23 to 0.29 mg/L and a photoperiod regime (12:12 h light: dark).

Table (1): Composition and proximate analysis of the experimental diets (g kg^{-1} as a fed-basis)**.**

	Experimental diets		
Protein energy ratio (mg CP kJ-1GE g-1)	P:E21	P:E23	P:E25
Fish meal (68 % CP)	317	400	522
Soy bean meal (47% CP)	375.4	363	272
Corn gluten (60% CP)	90	100	90
Wheat medling (13% CP)	50	-	-
Soybean oil	55	29.2	20
Fish oil	50	40	30
Salt	45	45	45
Dicalciom phosphate	10	10	9
Premix[1]	2	2	2
Methionen	2	2	1.4
Choline chloride	1	1	1
Lysine	1	1	1
Vit C	0.6	0.6	0.6
Antytocsec	1	1	1
Chemical composition (%, dry matter basis)			
Dry matter (DM)	90.51	90.54	90.5
Crude protein (CP)	46.13	51.15	54.59
Ether extract (EE)	17.41	15.96	14.98
Nitrogen free extract (NFE)[2]	24.59	20.13	16.04
Crude fiber (CF)	2.24	1.81	1.62
Ash	9.63	10.95	12.77
Gross energy (GE; Mj/kg DM)[3]	22.38	22.15	21.84
P/E ratio (mg CP/J)	20.61	23.09	25.00

[1]Vitamin and mineral mixture (supplements per kg of the mixed feed): vitamin A, 4,500 IU; vitamin D3, 4,500 IU; vitamin E, 400 mg; vitamin B1, 30 mg; vitamin B2, 40 mg; vitamin B6, 40 mg; vitamin B12, 0.08 mg; vitamin K3, 15 mg; ascorbic acid, 750 mg; nicotinic acid, 300 mg; Ca-pantothenate, 100 mg; folic acid, 10 mg; biotin, 3 mg; inositol, 500 mg; p-amino benzoic acid, 200 mg; Ca, 2.1 g; Fe, 250 mg; Mn, 40 mg; Zn, 60 mg; I, 4 mg; Cu, 12 mg; Se, 0.3 mg; Co, 2 mg.

[2]NFE: calculated using the following equation: NFE = 100 (crude protein + ether extract + crude fiber + ash).

[3]Gross energy (GE) contents of diets were calculated according to gross caloric values of Brett (1973) using the values of 23.6, 39.5, and 17.2 kJ/g for crude protein, crude fat, and total carbohydrate, respectively.

Growth and feed utilization indices

The mean final body weight (FBW) in experimental treatment was determined by dividing the total fish weight in each net enclosure by the number of fish. Weight gain (WG), feed conversion ratio (FCR), specific growth rate (SGR) , protein efficiency ratio (PER), protein productive value (PPV), energy retention (ER) and condition factor (K) were calculated using the following equations, according to **Cho (1990)** and **Castell and Tiews (1980):**

WG = final body weight (g) - initial body weight (g).

FCR = feed intake (g)/weight gain (g).

SGR= 100× [(ln final body weight (g) - ln initial body weight (g))/ duration of feeding (day)].

PER = weight gain (g)/protein intake (g).

PPV = (protein gain (g)/protein intake (g))× 100.

ER = (energy gain (kJ)/energy intake (kJ)) ×100.

Survival (%) = 100 × (initial number of the fish/final number of fish).

$K = W / L3 \times 100$.

Where: W: fish weight (wet weight in g); L: fish length (in cm)

Carcass composition

At the beginning of the trial, a random pooled sample of 20 fish was collected, anaesthetized with t-amyl alcohol and sacrificed for determination of initial whole-body proximate composition. At the termination of the feeding trial, five fish were randomly selected from each replicate and anaesthetized with t-amyl alcohol, sacrificed and homogenized in a blender to determine the final whole-body proximate composition. The fish were pooled for each treatment, oven-dried at 105°C over night, grounded and stored at -20°C for subsequent analysis. The chemical composition of fish and diet samples was assessed according to procedures of **AOAC (2000).** Dry matter was determined after drying the samples in an oven (105°C) for 24 h. Ash was measured following incineration at 550°C for 12 h. Crude protein was determined by the micro-Kjeldahl method, with N%×6.25 (using a Kjeltec Auto Analyzer, Model VELP Scientifica, UDK 127, Usmate, Italy), and crude fat was assessed by Soxhlet extraction (Model VELP Scientifica, SER148) with diethyl ether (40–60°C).

Blood Sampling:

Blood samples were collected at the end of the experiment. Each of the experimental treatment was sampled once, with five fish/ net enclosure for hematological indices analysis and five fish/ net enclosure bled for plasma content analysis. The fish were anesthetized with t-amyl alcohol and the blood samples were taken by puncturing the caudal vessels. The collected blood was divided into two tubes, one containing heparin as anticoagulant agent for haematological assessment and the other was anticoagulant free for biochemical estimation. The haematological parameters are expressed in international units (SI).

The red blood cell counts (RBCs) were determined by using a Bürker counting chamber and Hayem solution. The findings and instructions published by **Blaxhall and Daisley (1973)** and **Hrubec *et al*. (2000)** were followed when the RBCs were determined. Hematocrit (Hct) was determined by using microhematocrit-heparinized capillary tubes and a microhematocrite centrifuge (10000 gfor 5 min). The values of Hct were determined within 30 min alter bleeding. Hemoglobin concentrations (Hb) were determined by the cyanhemoglobin method, at 540 nm. The total WBCs count was determined according to the method of **Stoskopf (1993)** and **Terry *et al*. (2000).** WBCs and Hb values were determined within 6 h after blood sampling.

Total plasma protein (g dL^{-1}) was determined using biuret method according to (**Doumas *et al.*, 1981**). Albumin (g dL^{-1}) was determined by the bromocresol green method according to **Reinhold (1953)** and globulin (g dL^{-1}) was calculated as the difference between total protein and albumin. Glucose (mg dL^{-1}), Sodium chloride (mEq/L) and Cortisol (P/moL) were determined according to (**Brown and Taylor, 1995**: **Gilles *et al*., 1997**).

Plasma aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities were assayed using the method of **Gella *et al.* (1985**). The principle reaction of the colorimetric determination of AST or ALT activity is based on the reaction of aspartate or alanine with ϙ-ketoglutaric acid to form oxaloacetate or pyruvate respectively. The oxaloacetate or pyruvate was measured by monitoring the concentration of oxaloacetate or pyruvate hydrazone formed with 2, 4-dinitrophenylhydrazine. The absorbance is read at a wavelength of 505 nm. The absorbance was then interpolated in the calibration curve.

Statistical analysis:

One-way ANOVA and **Duncan,(1955)** multiple range tests were calculated effects with a probability of $p<0.05$ were considered significant. The data of the experiments were statistically analyzed using GLM (general linear model) procedure according to Statistical Analysis System (**SAS 2004**). However, data are presented untransformed to facilitate comparisons. The relationship between hematological indices was tested using simple correlation analysis.

One of the major problems associated with the dietary protein utilization are the dietary energy levels and sources. **Shiau and Lan (1996)** reported that dietary protein requirements are closely related to dietary energy levels. Growth and metabolism are sustained by the energy generated from the catabolism of either dietary protein or non-protein energy sources. Without add alternative energy sources (carbohydrates and lipids) to meet energy demand in the diet, some of the dietary protein consumed will have to be degraded to support the energy demands for tissue synthesis and metabolism (**Hawkins and Bayne, 1991**). Efficient diets contain sufficient non-protein sources that are metabolized to meet general energy requirements, allowing an organism to direct the maximum level of available dietary protein to growth; this is known as the protein sparing effect (**Wilkinson 2003; Johnston, *et al*. 2003**). The effectiveness of the protein sparing effect of carbohydrates and lipids is related to the ratio of protein to energy ratio (P: E ratio) in the diet. However, excess protein in the diet will be metabolized by the fish as a source of energy, and nitrogen will be excreted as ammonia and could be inhibit fish growth (Lim and Persyn 1989). Therefore, the ratio of P: E in feeds for fish is an important consideration for the formulation of cost-effective and environment friendly diet (**Cortés-Jacinto, *et al*. 2003**).

Growth performance and feed utilization of seabass fed different dietary ratio of P: E are shown in Table (2). The final body weight (FBW), body weight gain (BWG) and specific growth rate (SGR) of *D. labrax* increased significantly ($P>0.05$) with increasing dietary protein energy ratio up to $P:E_{23}$ compared to $P:E_{25}$ diets. The same trend was observed for the best feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive values (PPV), and energy retention (ER).

Table (2) Growth performance and nutrient utilization of *D. labrax* fingerlings fed the different experimental diets for 60 days.

	Experimental treatments		
Protein energy ratio (mg CP kJ-1GE g-1)	P:E21	P:E23	P:E25
IBW(g fish-1)	13.38±0.10	13.55±0.76	13.63± 0.05
FBW (g fish-1)	19.50±0.47b	20.86±0.43a	18.55±0.14b
WG (g fish-1)	6.12±0.47b	7.31±0.43a	4.93±0.15c
Feed intake/ g fish-1	16.48±0.01	17.24±0.01	14.56±0.15
FCR	1.77±0.05b	1.60±0.05c	1.88±0.04a
SGR (% days)	1.00±0.50b	1.06±0.05a	0.76±0.03b
PER	1.27±0.06a	1.23±0.06a	1.00±0.02b
PPV (%)	18.03±0.01	18.12±0.02	18.07±0.01
ER (%)	17.74±0.06b	18.53±0.04a	16.53±0.11c
K	1.22±0.04	1.12±0.03	1.11±0.06
S %	100	100	100

Values are means ± SD of triplicate analyses. Means in the same row bearing different superscript differ significantly ($P \leq 0.05$).

IBW, initial body weight; FBW, Final body weight; WG, body weight gain ; FCR, feed conversion ratio; specific growth rate (SGR) , protein efficiency ratio (PER), protein productive value (PPV), energy retention (ER), condition factor (K) and Survival (S).

In the present work, growth increased when dietary gross energy content of diets was low, thus diet P:E_{23} containing 50% CP and 23 kJ g^{-1} GE, (15.96% EE) was better than diet P:E_{21} with 45% CP and 21 kJ g^{-1} GE, (17.41% EE). For the high protein levels (55% CP), higher gross energy content also seemed to decreased growth performance, hence results were worth with diet P:E_{25} containing 25kJ g^{-1}, GE (14.98% EE). This is probably because the dietary energy content of a diet is sufficient to meet the energy demand of a fish (Lee and Kim 2001), and the most of dietary protein (amino acids) was used to building new tissues, thus, balance energy to protein ratio could increased fish growth rates due to

the decreased metabolic demand of energy to excrete nitrogen. Therefore, the highest growth of sea bass was obtained with CP:GE ratios between 21.0 and 23.0 g kJ^{-1}, while higher values 25.0 g kJ^{-1}, led to poorer responses. This could explain by the high energy to protein ratio could lead to increased lipid deposition on body carcass and reduce the nutrient intake leading to deficiency on some nutrients and reduced disease resistance of fish (**Cho, 1990**). **Lovell (1989)** observed that when fish are fed a diet containing excess in protein, growth may be reduced or constant due to an imbalance of digestible energy/crude protein ratio and excessive fat deposition in the visceral cavity and tissue.

In the present study, with increasing dietary P: E ratio, a decreasing value of PER and PPV was observed. These results may have occurred because weight gain was related to the deposition of protein, and protein accretion is a balance between protein anabolism and catabolism (**Abdel-Tawwab *et al.*, 2010**). PER tended to decrease with increasing dietary protein levels in this study. **Dabrowski (1979)** reported that different patterns of changes in PER in relation to dietary protein and energy levels and found that the relationship between dietary protein and PER differs from species to species.

No statistical difference ($P \geq 0.05$) was observed for the influence of dietary protein energy ratio on whole body proximate analysis of fish except for protein which recorded the highest values for fish fed $P:E_{23}$ diet (Table 3). Crude protein content in whole body increased significantly with increasing dietary protein, as have been reported in other fish species **(Chai *et al.* 2013; Deng *et al.* 2013). Mathew *et al.*, (2015)** reported that no significant difference was observed in whole body proximate for tilapia fed different dietary protein levels.

Hematological parameters investigated are presented in Figures (1-8). Mean red blood cell counts (RBCs) and mean white blood cell counts (WBCs), (Fig. 1), hematocrit (Hct, Fig 2), hemoglobin (Hb, Fig 3), total plasma protein, globulin (Fig. 4) and plasma sodium chloride (Fig. 5) and glucose (Fig. 6) were significantly ($P \geq 0.05$) increased foe fish fed $P:E_{25}$ diet compared to either $P:E_{21}$ or $P:E_{23}$ diets . An opposite trend was observed for plasma cortisol (Fig. 7), AST and ALT values (Fig. 8). Blood parameters can be useful to help determine the health status of fish in response to dietary supplements (**Congleton and Wagner 2006; Buentello *et al.* 2007).** In the current study, contents of white blood cell (WBC), red blood cell (RBC), haematocrit and haemoglobin of seabass

were significantly affected by the P:E ratios, and the levels obtained for the haematological parameters were in accordance with those of healthy seabass as reported by **Abdel-Tawwab *et al.* (2010)** reported that increased dietary protein level can raise haemoglobin concentration and red blood cell count . Serum immunoglobulins are major components of the humoral immune system; in particular, immunoglobulin M (IgM) is the main immunoglobulin found in fish **(Sun *et al.* 2010).** Similar results were observed at for summer flounder, *Paralichthys dentatus* (Daniels and Gallagher, 2000), Nile tilapia **(Abdel-Tawwab *et al*. 2010)** and wuchang bream, *Megalobrama amblycephala* **(Habte-Tsion *et al.* 2013)** increased with dietary protein level and stinging catfish, *Heteropneustes fossilis* **(Farhat and Khan, 2014)** and Indian carp, *Catla catla* **(Zehra and Khan, 2015, 2016)** supplemented with amino acids.

Plasma protein tended to increase with increased dietary P:E ratios. Similar results were observed in European eel **(Suárez *et al*., 1995),** and Nile tilapia **(Abdel-Tawwab *et al*. 2010).**

Table (3) Whole-body proximate composition of *D. labrax* fingerlings fed the different experimental diets for 60 days.

	Experimental treatments		
Protein energy ratio (mg CP kJ-1GE g-1)	P:E21	P:E23	P:E25
Dry matter (DM, %)	27.90±0.34	28.57±0.52	28.2±0.42
Crude protein (CP, %)	50.95±0.52b	52.33±1.12ab	53.79±0.52a
Ether extract (EE, %)	27.83±0.40	29.17±1.78	29.21±0.12
Ash (%)	18.93±0.00	19.37±0.42	19.45±0.10
Gross energy (Mj/100g)	5.64±0.11	5.66±0.09	5.62±0.13

Values are means ± SD of triplicate analyses. Means in the same row bearing different superscript differ significantly ($P \leq 0.05$).

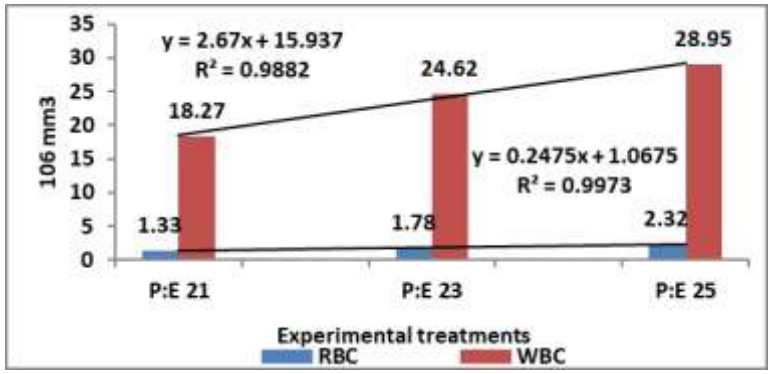

Fig. 1 Illustrated the effect of various dietary protein energy ratio on blood RBCs and WBCs content of European sea bass, *Dicentrarchus labrax* fingerlings.

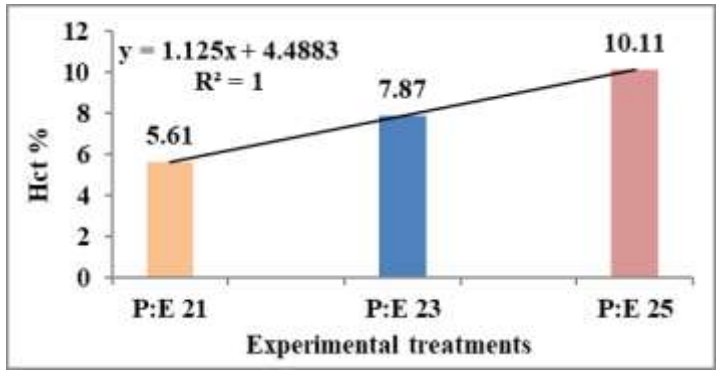

Fig. 2 Illustrated the effect of various dietary protein energy ratio on blood Hct% content of European sea bass, *Dicentrarchus labrax* fingerlings.

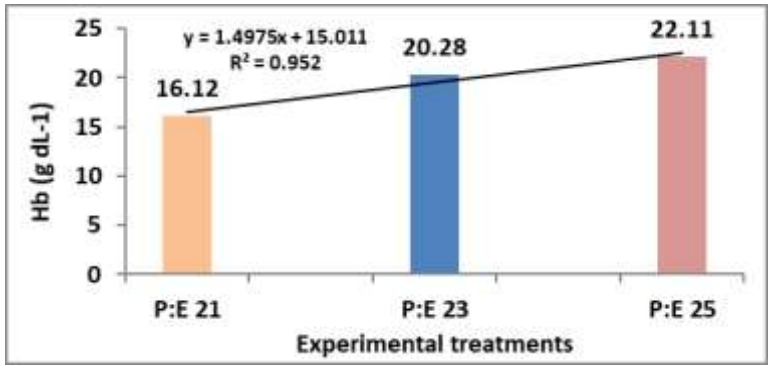

Fig. 3 Illustrated the effect of various dietary protein energy ratio on blood Hb content of European sea bass, *Dicentrarchus labrax* fingerlings.

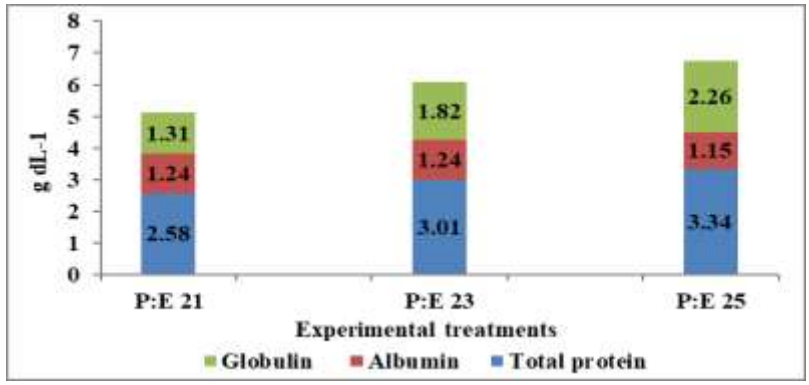

Fig. 4 Illustrated the effect of various dietary protein energy ratio on total plasma protein, albumin and globulin of European sea bass, *Dicentrarchus labrax* fingerlings.

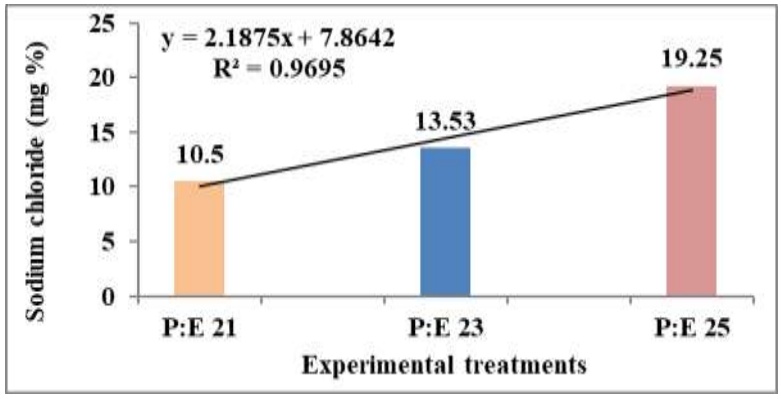

Fig. 5 Illustrated the effect of various dietary protein energy ratio plasma sodium chloride content of European sea bass, *Dicentrarchus labrax* fingerlings.

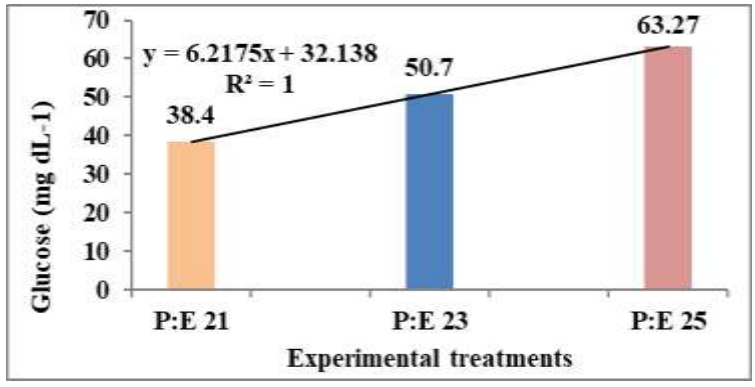

Fig. 6 Illustrated the effect of various dietary protein energy ratio on blood glucose content of European sea bass, *Dicentrarchus labrax* fingerlings.

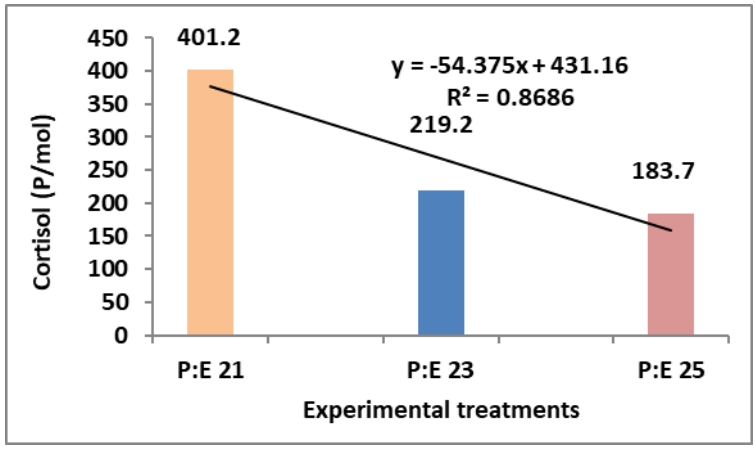

Fig. 7 Illustrated the effect of various dietary protein energy ratio on serum cortisol content of European sea bass, *Dicentrarchus labrax* fingerlings.

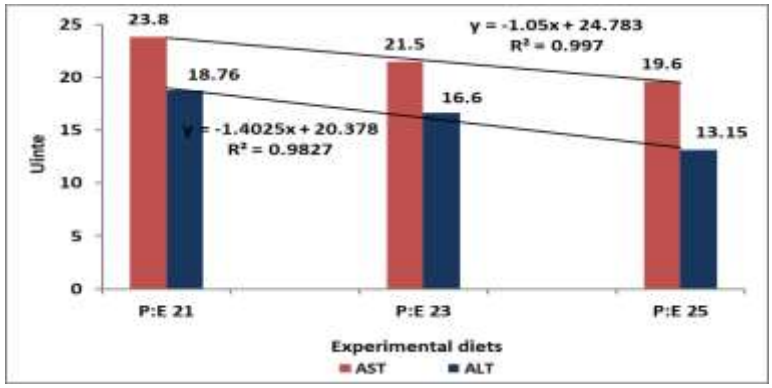

Fig. 8 Illustrated the effect of various dietary protein energy ratio on plasma AST and ALT content of European sea bass, *Dicentrarchus labrax* fingerlings.

Cortisol, AST, and ALT in seabass were significantly affected by dietary P:E ratios. **Metón *et al.*, (2003)** reported that the expression of key enzymes of intermediary metabolism is modulated by nutritional status in fish. The levels of amino acid-metabolizing enzymes excretion is reliable indicators of dietary protein availability. Metabolism of amino acids involves deamination and transamination reactions. In the present study, the highest hepatic enzymes AST, and ALT was observed when fish fed on P:E_{21} diet which may indicate the use of excess dietary amino acids for growth as well as substrate for gluconeogenesis, particularly for AST and ALT activities.

Glucose concentration is maintained within very narrow limits, regulated by hormonal control, even in fasting state, because glucose is the main source of energy for the central nervous system. In the present study, increased glucose in blood for fish fed P:E_{25} diet suggests the decreasing of gluconeogenesis cycle as a consequence of increased dietary protein level **(Metón *et al.* , 2003).**

Conclusion

The ratio of P: E in feeds for fish is an important consideration for the formulation of cost-effective and environment friendly diet. Over the 60-days feeding period, growth, feed utilization efficiency and survival (%) of *D. labrax* fingerlings was improved significantly (P>0.05) with increasing dietary protein energy ratio up to P:E_{23} compared to P:E_{25} diets. The obtained findings revealed that, the diet containing 500 g kg^{-1} protein and 160 g kg^{-1} lipid with dietary P: E ratio of 23 mg CP kJ GE g^{-1} is recommended to stimulate growth performance, nutrients utilization efficiency and haematological indices of *D. labrax* fingerlings

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تأثير أختلاف نسبة البروتين والطاقة على النمو والاستفادة من الغذاءوتكوين الجسم ، ومؤشرات الدم في إصبعيات أسماك القاروص البحر الأوروبي

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الملخص العربى

أجريت هذة الدراسة بأحدى المفرخات الخاصة بوادى مريوط – بالإسكندرية (مفرخ مدحت الشريف للأسماك البحرية) حيث أجريت التجربة بهدف دراسة تاثير كل من مستويات البروتين والطاقة على كفاءة النمو والاستفادة من الغذاء وتكوين الجسم ، ومؤشرات الدم في إصبعيات أسماك القاروص البحر الأوروبي.

تم إجراء تجربة عاملية (٣×٣) بإستخدام ٣ مستويات من البروتين (٤٥٠- ٥٠٠-٥٥٠ جم) مع ٣ مستويات من البروتين :الطاقة على النحوالتالى (٢١- ٢٣-٢٥ ك كالورى/ ١٠٠ جم علف) بمعدل تخزين ٢٠ سمكه بكل هابة وقد استمرت التجربة ٦٠ يوم بوزن ابتدائى (١٣ جم) وتمت التغذية حتى الشبع ٦أيام فى الاسبوع وقدمت العلائق ٣ مرات يوميا.

وقد أظهرت النتائج ما يلى:

أفضل معدلات تم الحصول عليها عند مستوى بروتين : طاقة (٢٣:٤٥) وكذلك أفضل كفاءة للاستفادة من الغذاء كانت عند نفس المستوى من البرويتن والطاقة.

وقد وجد أيضا تحسن مؤشرات الدم لاصبعيات اسماك القاروص الاوربى بزيادة مستوى البروتين والطاقة حيث سجلت أفضل النتائج عند مستوى برويتن: طاقة (٢٥:٥٥).

مما سبق نستنتج أن النظام الغذائي المحتوي على ٥٠٠ جم/كجم علف ، و ١٦٠ جم/ كجم علف من الدهون مع نسبة بروتين : طاقة بتركيز(٢٣ملجم/كجم علف) ادى الى تحسين معدلات اداء النمو والاستفادة من الغذاء ومؤشرات الدم لاصبعيات أسماك القاروص الاوربى.