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EFFECT OF FISH MEAL TYPE AND ITS PERCENTAGE IN DIET ON GROWTH PERFORMANCE, FEED UTILIZATION AND BODY CHEMICAL COMPOSITION OF EUROPEAN EEL (*ANGUILLA ANGUILLA*).

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SUMMARY

The present study was carried out at the Fish Research Unit at Department of Animal Production, Faculty of Agriculture, Fayoum University, Egypt from April to July 2012.

Eels were divided into 4 groups. Each treatment (different fish meal as a protein source (Herring or Yemen), and different ratio addition (60 or 80%) was replicated and 40 fry (average weight of 5.75 g± 0.02 /40 fry) per aquaria were used.

Four experimental diets were formulated to be isonitrogenous and isocaloric and contain 50.5% crude protein and 4.620 Kcal/g GE. The results cleared that the Herring and Yemen fish meal (FM) recorded highest values in eel final weight, weight gain, daily gain, specific growth rate and survival rate at level 80% than other treatment. The growth performance parameters of eels measured improved as FM protein level % in the diet increased. There is no significant benefit for growth improvement of eel between fish meal type at the same level 80%.

Herring and Yemen fish meal recorded best values in eel feed conversion ratio, and highest values of protein efficiency ratio, and energy productive value at level 80% than other treatment. There is no significant benefit for protein productive value and energy efficiency ratio of eel between fish meal type.

Significant differences observed between CP%, GE content and EE but no differences between DM and ash. CP% decreased with Herring and Yemen fish meal at 80% and no differences between them and differs than Herring fish meal and Yemen fish meal at 60%.

Yemen fishmeal recorded top level of profit rate and higher economic value as a result difference in growth with cheap price when comparing sales prices according to the sizes of fries.

Keywords: *European eel, growth performance, feed utilization and body chemical composition.*

INTRODUCTION

Freshwater eels are very valuable fish species. Eel meat is much appreciated around the world, principally in Asian and European countries, where it is considered a delicacy and a very healthy food product (Sinha and Jones, 1975; Heinsbroek, 1991; Coello *et al*., 1999; Ottolenghi *et al*., 2004). Currently the global eel market trades around 270 000 ton a year valued at over US$1.2 billion (FAO, 2010). Over 97% of worldwide eel production is based on farming of the European eel and the Japanese eel (FAO, 2010).

Among the many aquaculture species, eels appear to have a strong potential for further development in Asia**.** Eels are highly valued cultured species because of their high market price, high yield, high survival rate, and well-studied pathology. Liao *et al.* (2002) reported that the Japanese eel (*Anguilla japonica*) and the European eel (*Anguilla anguilla*) of the 19 *Anguilla* species, are the most important in East Asia (mainly Japan, Taiwan, and China) and Europe (mainly Italy and the Netherlands**).**

Eels are mostly carnivores and hence the feed consists of mostly animal products or byproducts. It consists of mainly fish meal, prawn meal, shell fish meal, worm meal, silk worm pupae meal, meat meal, crab meal, frog meal, insect meal, blood meal etc. The ideal is to feed scrub fish (fishes that are not consumed by human beings or very cheap types of fishes like raw sardines and mackerels). Of course now-a-days feeding raw fish is not at all feasible due to high cost of feeding (Chandy, 2002).

Starter feeding of eels on to artificial feed (weaning) is one of the key aspects of rearing eels (Heinsbroek, 1991; and Degani and Gallagher, 1995). Non-acceptance of the feed can lead to mortality and retarded growth, and therefore affects the overall production. The protocol used for weaning glass eel onto pelleted feeds has undergone many changes over the years (Heinsbroek, 1991).

Fish meal is the protein source traditionally used in aquaculture diets, yet it is limited and expensive resource (Tomas *et al.*, 2005). Alternate protein sources can lower the cost of aquaculture diets, reduce the amount of wild fish used as protein, and potentially reduce the nutrient levels in effluent waste. However, for most species, there is a limit to how much fish meal can be replaced by alternative protein sources without negatively affecting the fish (Catacutan and Pagador, 2004).

The composition of the dry feeds is calculated not only in quantitative and energy terms but also in qualitative terms (e.g. essential amino acids, essential fatty acids, vitamins) (Halver and Hardy, 2002). Likewise, eel aquaculture must consider not only the performance of the diets in terms of food conversion efficiencies and growth rate, but also product quality. The concentration of body fat and its composition (fatty acid profile) are among the main factors that define the flesh texture, flavor and aroma of the eel product (Fjellanger *et al*., 2001). The development of commercial pelleted feeds focusing on fish flesh quality assists in the successful marketing of the product (Ottolenghi *et al*., 2004).

The daily feeding rate of formulated feed at a water temperature of 25°C is 6 to 8 percent of the total wet body weight for glass eel and small-sized eels, and 2 to 3 percent for bigger sizes. For fresh fish feed, the feeding rate at 25°C is 20 to 30 percent of the total wet weight of glass eels and small-sized eels, and about 10 percent for bigger eels. Fish can eat a lot of feed during the warm season, but should be fed rather less than satiation for best food conversion efficiency, which for dry feeds should be 2–2.5:1 (weight of food fed: weight of fish growth).

The fishermen collects eels fry at the beginning of the spawning season on the shore of the Mediterranean sea in the natural assembly centers and some them incubation fries even increase in weight to sell it a higher price than selling small

The aim of the present study is to find inexpensive diet without prejudice to the growth rates in order to increase economic efficiency by using different fish meal.

MATERIALS AND METHODS

The present study was carried out at the Fish Research Unit established at the Department of Animal Production, Faculty of Agriculture, Fayoum University, Egypt from April to July 2012, a proximally 90 days

Eight aquaria; each aquarium could carry 115 L of dechlorinated tap water. Each treatment was represented in two aquaria; the number of fish/each aquarium was 40 fish, water was constantly aerated with micro porous stones and a mini air pump. It was siphoned each three days and aquarium water exchanged every siphoning was 30:40% all the experimental period. Black plastic kept around each aquarium to provide condition of darkness. Uneaten food and faces were removed from aquarium daily; values of water quality parameter were recorded through the experiment.

Experimental fish

European eel fry were obtained from seed collection center of the General Authority for Fish Resources Development Egypt, Alexandria. Fry transferred to fish nutrition laboratory, Faculty of Agriculture, Fayoum University, Egypt, and acclimated to the experimental system for a week (Engin and Carter 2001 and 2002). During acclimatization, eels were fed on a diet consisting of FM (Herring), poached eggs, and Silversides fish. After the period eels were divided into 4 groups. Each treatment (different fish meal as a protein source (Herring or Yemen), and different ratio addition (60 or 80%)) was replicated and 40 fish (average weight of 5.75 g. ± 0.02/40 fish) per aquaria were used.

Diet formulation and preparation

Four experimental diets were formulated to be isonitrogenous (using soybean meal) and isocaloric (using yellow corn) and contain 50.5% crude protein and 4.620 Kcal/g GE. Diet was prepared by mixing the dry ingredients by hand followed by the oil addition. Water (50 g /kg) was added before pelleting using laboratory pellet mill, after drying the pellets were broken up sieved into the proper pellets size in the freezer until utilization. The experimental diets were formulated to contain different fish meal type

(Herring fish meal 72% CP, Yemen fish meal 60% CP) and different ratio (80 and 60%). Diet chemical composition is shown in Table (1). Fish were fed twice daily from 9:00 to 10:00 and 16:00 to 17:00 hours and fed with a rate 20% of body weight per day for the first 53 day, 15% for another 30 day and 10% for the last 22 day.

Growth and feed utilization parameters:

Growth parameters were initial weight (IW), final weight (FW), average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR), feed conversion ratio (FCR), feed intake(FI), survival rate (SR), protein efficiency ratio (PER), protein productive value (PPV), energy efficiency ratio (EER), and energy productive value (EPV) were calculated.

Analytical Procedure:

Experimental diets were analyzed for their proximate composition in triplicates following the methods described by AOAC (1995). The gross energy (GE) content of the tested diets were calculated using values of 5.65, 9.44 and 4.11 Kcal for protein, fat and carbohydrate, respectively according to NRC (1993). Water temperature, pH and dissolved oxygen (DO) throughout experimental periods were measured periodically in the morning and at noon by centigrade thermometer, Orion digital pH meter model 201 and oxygen meter, Cole Parmer model 5946, respectively.

Statistical Analysis:

Data were statistically analyzed in a one- way analysis of variance using SPSS program (SPSS, 2010). Mean of treatments were compared by Duncan multiple range test (Duncan, 1955) when the variance analysis was significant

Table (1). Composition and proximate analysis of the experimental diets

Ingredient	Treatments			
	Yemen fish meal		Herring fish meal	
	60%	80%	60%	80%
Herring fish meal 72 %	0	0	42.50	55.50
Yemen fish meal 60%	50.00	66.60	0.00	0.00
Soybean meal	44.00	21.00	42.10	19.00
Yellow corn	1.60	8.00	11.00	21.10
Salt	0.1	0.1	0.1	0.1
Vit. and Min. premix[1]	0.3	0.3	0.3	0.3
Calcium diphosphate	1	1	1	1
Linseed oil	3	3	3	3
Determined nutrients composition				
Dry matter (DM)	92	91.6	91.6	90.8
Crude protein (CP)	50.46	51.25	50.09	50.25
Ether extract (EE)	9.24	11.08	7.76	9.03
Crude fiber (CF)	2.52	1.38	2.65	1.60
Ash %	11.73	13.42	8.37	8.83
Nitrogen free extract (NFE)	18.27	16.11	22.43	22.23
GE (Kcal/Kg diet)	4.573	4.655	4.588	4.667

[1] *Each kg contains 2000000 IU vit. A, 400000 IU vit. D_3 , 4000 mg vit. E, 300 mg vit K_3, 200 mg vit B_1, 800 mg vit B_2, 4000 mg nicotinic acid, 2.0 mg B_{12}, 2000 mg pantothenic acid, 300 mg vit. B_6, 200 mg folic acid, 10mg biotin , 100 mg choline chloride, 1600 mg Cu, 156 mg I, 6421 mg Fe, 12800 mg Mn, 9000 mg Zn, 32 mg Se , 53 mg cobalt and 1400 mg ethoxyquine.*

RESULTS AND DISCUSSIONS

Water quality parameters measured were suitable for the normal growth of European eel. The values recorded were 24-28^{o}, 6.95-7.5 mg/l and 6.3-7.88 for temperature, dissolved oxygen and pH but ammonia not detected.

Results of Table (2) showed that the positive significant differences between treatments as percentage of fish meal protein increased in diets. The values cleared that the Herring fish meal (HFM) and Yemen fish meal (YFM) recorded significantly higher values in eel final weight, weight gain, daily gain, SGR and survival rate at level 80% than other treatment. The mean weight of fish fed diets containing 80% HFM and YFM from diet protein were significantly (P≤0.05) higher than those fed 60% HFM and YFM. This difference persisted for the duration of the experiment with final weights of eel fed 80% HFM and YFM diet protein being similar to each other and approximately 29 and 24% higher than those fed lower amounts of protein 60% YFM for HFM and YFM 80%, respectively. The growth performance parameters of eels measured improved as FM protein level % in the diet increased. There is no significant benefit for growth improvement of eel between fish meal type at the same level 80%. These results are in agreement with results obtained by Tibbetts *et al*. (2000) and Engin and Carter (2005). Regarding to the diets price (price of one Kg was 15 and 8.0 L.E for Herring and Yemen fish meal, respectively) it's cleared that YFM diets at 80% was the best diets because the high final weight and no significant with HFM. These results may be due to the presence of FM which contains the essential amino acids.

Table (2). Effect of diet protein source and its percentage on growth performance of European eel.

Item	Treatments				SED
	Yemen fish meal		Herring fish meal		
	60%	80%	60%	80%	
Initial weight, g	0.14	0.14	0.14	0.14	0.007
Final weight, g	3.70^{c}	4.60^{a}	4.04^{b}	4.79^{a}	0.076
Total gain, g (1)	3.56^{c}	4.46^{a}	3.90^{b}	4.65^{a}	0.076
Daily gain, g (2)	0.034^{c}	0.042^{a}	0.037^{b}	0.044^{a}	0.009
SGR, % (3)	3.09^{c}	3.29^{a}	3.17^{b}	3.33^{a}	0.019
Survival rate%	72.25^{b}	81.25^{ab}	83.75^{ab}	88.75^{a}	3.06

** Average in the same row having different superscripts (a and b) significantly differed at P≤0.05*
** SED is the standard error of difference, SGR is specific growth rate*

Feed utilization

Results of Table (3) showed that the positive significant differences between feed utilization parameters as percentage of fish meal protein increased in diets. The values cleared that the HFM and YFM recorded the best values in eel FCR, and highest values of PER, and EPV at level 80% than other treatment. The mean FCR of fish fed diets containing 80% HFM and YFM from diet protein were significantly (P≤0.05) better than those fed 60% HFM and YFM. The FCR of eels measured improved as FM protein level % in the diet increased. There is no significant benefit for PPV and EER of eel between fish meal type. These results may be due to the presence of FM which contains the essential amino acids. These results agreed with results obtained by Tibbetts *et al*. (2000) and Engin and Carter (2005). Regarding to the dies price it's cleared that YFM diets at 80% was the best diets because the best FCR and PER.

Table (3). Effect of diet protein source and its percentage on feed utilization of European eel.

Item	Treatments				SED
	Yemen fish meal		Herring fish meal		
	60%	80%	60%	80%	
Feed intake, g/fish	17.69^{b}	19.94^{a}	19.59^{ab}	21.14^{a}	0.76
FCR	4.98^{a}	4.48^{b}	5.03^{a}	4.55^{b}	0.13
Protein utilization					
PER	0.400^{b}	0.435^{a}	0.395^{b}	0.435^{a}	0.012
PPV, %	7.86	7.61	7.13	7.93	0.34
Energy utilization					
EER	0.0025	0.0020	0.0020	0.0021	0.0003
EPV, %	0.240^{c}	0.295^{a}	0.260^{bc}	0.280^{ab}	0.0079

** Average in the same row having different superscripts (a and b) significantly differed at P≤0.05*
** SED is the standard error of difference*

Body chemical composition:

Table (4) showed the effect of replacement of HFM by YFM in diets eel and no consistent trend was observed. Significant differences observed between CP%, GE content and EE but no differences between DM and ash. CP% decreased with HFM and YHM at 80% and no differences between them and differed than HFM and YFM at 60% but EE and GE takes the opposite protein trend. Regarding to the dies price it's cleared that YFM diets at 80% was the best diets because the final aim of eel aquaculture in body composition was the GE and EE

Table (4). Effect of diet protein source and its percentage on body chemical composition of European eel.

Items	Start	Treatments				SED
		Yemen fish meal		Herring fish meal		
		60%	80%	60%	80%	
DM	27.25	26.12	28.93	27.14	28.27	1.07
CP	58.62	74.90^{a}	60.23^{c}	65.87^{b}	63.73^{bc}	1.30
EE	31.22	13.93^{c}	29.72^{a}	24.27^{b}	25.63^{b}	0.80
Ash	10.16	11.17	10.06	9.87	10.65	0.76
GE, kcal/g	6.253	5.530^{c}	6.202^{a}	6.006^{b}	6.013^{b}	0.05

** Average in the same row having different superscripts (a and b) significantly differed at P≤0.05*
** SED is the standard error of difference*

Economic evaluation

Most of fishermen catch fries, when fries very small some fishermen resort to incubation it at home to increasing in weight. Table (5) shows that the net returns were different/1000 fry nursed, where it ranged between 235 to 710 (LE). However, net returns/total costs showed the best value with eels received Yemen fish meal at 80% in the diet followed by Herring 60 and 80%, respectively. Fishermen can incubation the eels at home using diets containing Yemen fish meal at 80% from total protein.

Table (5). Effect of diet protein source and its percentage on economic evaluation of European eel.

Item	Treatments			
	Yemen fish meal		Herring fish meal	
	60%	80%	60%	80%
	Per 1000 fry			
Fry nursing costs[@], LE.	265	290	325	360
Fry selling price, LE.[*]	500	1000	1000	1000
Net returns, LE.	235	710	675	640
Net returns/ total costs, %.	88.68	244.83	207.69	177.78

@ for fish aquaria, equipments and feed.
** Selling prices according to GAFRD prices (500 L.E/1000 fry) for fries < 4 g and (1000 L.E/1000 fry) from 4-5 g/fry*

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تأثير نوع مسحوق السمك ونسبته بالعليقة على مظاهر النمو والاستفادة من الغذاء والتركيب الكيماوى لثعبان السمك الاوروبى

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أجريت هذه الدراسة بوحدة الأبحاث بقسم الإنتاج الحيوانى- كلية الزراعة- جامعة الفيوم من شهر أبريل وحتى يوليو ٢٠١٢ (٩٠ يوم). قسمت زريعة الثعابين الى أربع مجموعات مثلت كل معاملة بمكررين (مسحوق اسماك (هرنج، يمنى) كمصدر للبروتين، نسب إضافة مختلفة (٦٠ و٨٠%) وضعت ٤٠ سمكة بمتوسط وزن ٥.٧٥ جم ± ٠.٠٢ جم/٤٠ سمكة/حوض.

كونت أربع علائق تجريبية متماثلة فى البروتين والطاقة وتحتوى ٥٠.٥% بروتين خام و ٤.٦٢٠ ك كالورى/جم طاقة كلية وقد أظهرت النتائج أن مسحوق الأسماك (هرنج) ومسحوق الأسماك (يمنى) سجلوا أعلى القيم فى الوزن النهائى والزيادة فى الوزن والزيادة اليومية ومعدل النمو النوعى ومعدل الإعاشة على مستوى ٨٠% عن باقى المعاملات. مقاييس مظاهر النمو للثعابين تحسنت بزيادة نسبة الإضافة للعليقة ولا توجد فروق معنوية واضحة لتحسن النمو للثعابين بين المسحوقين تحت نفس النسبة ٨٠%.

مسحوق الأسماك الهرنج واليمنى سجلوا أفضل قيم فى التحويل الغذائى وأعلى قيم لكفاءة البروتين وكذلك الطاقة عند مستوى ٨٠% عن باقى المعاملات ولا توجد فروق معنوية بين القيمة الإنتاجية للبروتين والكفاءة النسبية للطاقة بين أنواع المساحيق.

وجدت اختلافات معنوية بين نسبة البروين ومحتوى الطاقة والدهن أما المادة الجافة والرماد لم توجد بينهم فروق معنوية. انخفض البروتين الخام مع مستوى ٨٠% فى كلا المسحوقين ولا توجد فروق بينهم عند هذا المستوى ولكن يختلف عن مستواهم عند ٦٠%

سجل مستوى الإضافة ٨٠% لمسحوق السمك اليمنى أعلى معدل ربح وأعلى قيمة اقتصادية نتيجة الاختلاف في النمو مع رخص سعر العليقة عند مقارنة أسعار البيع طبقا لأحجام الزريعة.