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Full Length Research Paper

Growth and nutrient efficiency of meagre (*Argyrosomus regius*, Asso1801) fed extruded diets with different protein and lipid levels

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Four commercial diets containing different levels of crude protein and crude lipid (44/25, 43/21, 46/20 and 47/20%) were assayed in duplicated groups in juvenile meagre (*Argyrosomus regius)* (initial individual weights were 94 g) in an experiment lasting 173 days. The essential amino acid contents (expressed in g/kg of diet basis) in diets 46/20 and 47/20 were higher than in diets 44/25 and 43/21. The HUFAs represented 184 and 207 g/kg in diets 46/20 and 47/20, respectively and 98 and 116 g/kg in diets 44/25 and 43/21, respectively. The fish fed diet 47/20 obtained the best growth and efficiency results, reaching a final individual weight of 393 g, followed by the meagre fed with diet 46/20. Meagre from the 47/20 group retained more of the ingested protein and energy than those fed diets 46/20. Fish fed 44/25 and 43/21 obtained the significantly lowest protein and energy efficiency. The retention of individual amino acids (AAs) in fish fed diets generally decreased in order of diets 46/20, 43/21 and 44/25. The IAA retention of meagre fed diet 47/20 was around 24.8% in phenylalanine and 39.7% in lysine. The results of the current experiment show that the fish fed commercial diet 47/20 obtained the best results in meagre growth, followed by fish fed diet 46/20. Diets 43/21 and 44/25 presented the worst growth and feed efficiency results.

Key words: Meagre, protein level, lipid level, extruded diets.

INTRODUCTION

Nowadays, the production in Mediterranean aquaculture of species such as gilthead sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) is consolidated, and their production is saturating the fish market. As a consequence of this, the price of sea bream has dropped considerably in recent years, and economic profit diminished in aquaculture based only on sea bream production. One alternative to maintain the profitability of aquaculture marine companies is species diversification, such as yellowtail, *Seriola dumerili* (Jover et al., 1999), eel, *Anguilla anguilla* (Asturiano et al., 2006), Bluefin tuna *Thunnus thynnus* (Aguado-Gimenez and Garcia-Garcia, 2005), but their reproductive cycle is not closed. Other candidates are Sharpsnout sea bream, *Diplodus puntazzo* (Hernández et al., 2007), or red porgy, *Pagrus pagrus* (Kalinowski et al., 2007) but they are also *Sparids*.

Meagre (*Argyrosomus regius)* aquaculture has recently developed, starting in the mid 1990s in Southern France, and is much less advanced than for developed farm fish species such as sea bass, sea bream or turbot. An interest in culture of sciaenid fishes has grown rapidly in recent years.

The first production figures date from 1997. Today, meagre is produced in several countries in the Mediterranean basin. However, even though techniques for the different stages of rearing are fairly well established, production has not yet reached its full potential and rearing experiments are still very limited.

Meagre could be interesting for aquaculture: high flesh quality and flavour, high commercial value over 2 kg,

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rapid growth between 16 and 20°C, high tolerance to salinity, have excellent biological characteristics, because they withstand captivity perfectly, with high growth (Calderon et al., 1997) and good feed conversion ratio. Juveniles (Age 1) eat small demersal fish and crustaceans (mysids and shrimp). When they reach 30 to 40 cm, they feed on pelagic fish and cephalopods (Calderon et al., 1997).

Meagre production has been increasing in recent years with a significant production in 2006, as a result of the achievement of reproduction in captivity. According to Apromar (2008), meagre production in that year was around 845 tm with which a new growth is observed compared with 2005, which is indicative of the establishment and the importance of its production. However, there are few studies on growth (Calderon et al., 1997; Poli et al., 2003), feeding and specific diets for this species and it is necessary to establish the dietary nutrient levels to optimise the growth and the nutrient efficiency, because until now their feeding has been based on data from other species.

The aim of this trial was to evaluate the growth and nutrient efficiency of juvenile meagre feeding four commercial diets with different levels of protein and lipids.

MATERIALS AND METHODS

Production system

The trials were conducted in 8 octagonal concrete tanks (4000 L) inside a recirculated seawater system at the aquaculture laboratory (Animal Science Department at the Polytechnic University of Valencia, Valencia, Spain). The tanks were set up in a marine water recirculation system (70 m^3 of capacity) with a rotary mechanic filter and a gravity biofilter of around 6 m^3 capacity. A half of water system was exchanged once a month. All tanks were equipped with aeration and water was heated by a heat pump (TRANE CXAN 490, 123.3 kW) installed in the system. The equipments used to control water parameters were an oxy-meter (OxyGuard, Handy Polaris V 1.26, for temperature and dissolved oxygen measured every two days at 9 a.m.), a refractometer with 0 to 100% capacity (Zuzi, A67410, for salinity measured every 3 days) and a kit using the colorimetric method to determinate nitrate,–ammonia and nitrite nitrogen (measured every 3 days). The kits were obtained from AquaMerck (Merck KGaA, Darmstadt, Germany). Photoperiod was natural and all tanks had similar light conditions. Each experimental diet was tested in duplicate.

Fish and experimental design

Meagre juveniles were transported to the experimental facilities of Polytechnic University of Valencia from IFAPA (El Toruño, Cadiz, Spain). The fish were acclimated to the experimental conditions and fed a diet 47% Crude Protein (CP) and 20% Cruce Lipid (CL) for 6 weeks before starting the experiment. 340 meagres with initial individual weights between 79 and 109 g (mean weight of 94 g) were randomly placed into the 8 tanks. Two tanks per treatment were used.

Every 7 to 8 weeks, all fish were individually weighed. Previously, the fish were anaesthetised with 30 mg/L of clove oil (Guinama®, Valencia, Spain) containing 87% of eugeno for approximately two minute. The fish were not fed for 1 day before weighing. Survival, growth and nutrient utilization indexes were as follows:

Survival (%) = 100* (Final number fish- Initial number fish)/ Initial number fish
Specific growth rate (% day^{-1}), SGR = 100 × ln (final weight / initial weight) / days
Feed Intake ratio (g 100 g $fish^{-1}$ day^{-1}), FI = 100 × feed consumption (g) / average biomass (g) × days
Feed conversion ratio, FCR = feed offered (g) / weight gain (g)
Protein efficiency ratio, PER = weight gain (g) / protein intake (g)

At the experimental commencement, three fish of each weight (79 and 109 g) and at the end 10 fish per tank, the fish were slaughtered by a thermoshock in a melting ice bath, to determine biometric parameters and were sampled and stored at -30°C to determine proximate and amino acid body composition. Biometric parameters considered were as follows:

Condition factor, CF (g/cm^3) = 100 × total weight (g) / total length (cm^3)
Dressout percentage, DP (%) = 100 × (total fish weight (g) -visceral weight (g) -head weight (g))/ fish weight
Mesenteric fat (%), MF = 100 × mesenteric fat weight (g)/ fish weight (g).
Hepatosomatic index (%), HSI = 100 × liver weight (g) / fish weight (g)
Viscerosomatic index (%), VSI = 100× visceral weight (g) / fish weight (g)

Diets and feeding

The four diets were assayed in duplicated groups during 173 days of experiment. The extruded diets containing different levels of crude protein and crude lipid (44/25, 43/21, 46/20 and 47/20%) and their proximate composition is showed in Table 1. The diets were provided by two feed companies (Dibaq-diproteg, Segovia, Spain and Skretting, Burgos, Spain). All diets containing fish meal and fish oil, soybean by-products, cereals meals, and vitamins and minerals complex.

During the trial, the fish were fed twice daily (0900 and 1700), 6 days a week. Feed distribution was done by hand until visual satiation and the total amount of feed distributed was recorded.

Analytical methods

Composition of diets and fish body composition were analysed following AOAC (1990) procedures: dry matter (105°C to constant weight), ash (incinerated at 550°C to constant weight), and crude protein (N × 6.25) by the Kjeldahl method after an acid digestion (Kjeltec 2300 auto analyser, Tecator Höganas, Sweden), crude lipid extracted with dichloromethane-methanol (Soxtec 1043 extraction unit, Tecator) and crude fibre by acid and basic digestion (Fibertec system M., 1020 Hot Estractor, Tecator). N-free extract, NFE was calculated as 1000- CP-CL-Ash-CF (g/kg) and gross energy, GE: using: 23.9 kJ/g proteins, 39.8 kJ/g lipids and 17.6 kJ/g carbohydrates. All analyses were performed in triplicate.

Crude protein efficiency, gross energy efficiency and amino acid efficiency were calculated as follows:

Crude protein efficiency, CPE (%) = (Fish protein gain. g) × 100 / (protein intake. g)
Gross energy efficiency, GEE (%) = (Fish energy gain. kJ) × 100 / (energy intake. kJ)
Amino acid efficiency (%) = (Fish amino acid gain. g) × 100 / (amino

Table 1 . Proximate composition of extruded diets.

Parameter	Diet			
	44/25	43/21	46/20	47/20
Analysed composition (g/kg dry matter basis)				
Dry matter (DM)	919	928	962	912
Crude protein (CP)	463	478	488	469
Crude lipid (CL)	245	219	190	205
Ash	59	68	83	116
Crude fibre (CF)	16	22	07	22
Calculated values				
N-free extract (NFE)[y]	216	213	234	188
GE (MJ/kg)[z]	24.6	23.9	23.3	22.7
CP/GE (g/MJ)[z]	18.8	20.0	21.0	20.7

acid intake. g).

The amino acid content in diets was determined after acid hydrolysis with HCL 6 N at 110°C for 23 h. as previously described by Bosch et al. (2006), using a Waters (Milford, MA, USA) HPLC system consisting of two pumps (Mod. 515, Waters), an autosampler (Mod. 717, Waters), a fluorescence detector (Mod. 474, Waters) and a temperature control module. Aminobutyric acid was added as internal standard after hydrolysation. The amino acids were derivatised with AQC (6-aminoquinolyl-N-hydroxysuccinimidyl carbamate) and separated with a C-18 reverse-phase column Waters Acc. Tag (150 × 3.9 mm). Methionine and cystine were determined separately as methionine sulphone and cysteic acid respectively after performic acid oxidation followed by acid hydrolysis.

Fatty acid profile (expressed in % of area, as saturated (C12 : 0, C14 : 0, C15 : 0, C16 : 0, C17 : 0, C18 : 0, C20 : 0, C22 : 0 and C24 : 0), Monounsaturated (C16 : 1, C17 : 1, C18 : 1, C18 : 1*n* – 7, C18 : 1*n* - 9t, C18 : 1*n* - 9c, C20 : 1*n* – 9, C22 : 1*n* – 9, C24 : 1*n* – 9), Polyunsatured *n* – 6 (C18 : 2*n* - 6c, C18 : 3*n* – 6, C20 : 2*n* – 6, C20 : 3*n* – 6 and C20 : 4*n* – 6), Polyunsatured *n* – 3 (C18 : 3*n* – 3, C20 : 3*n* – 3, EPA, C20 : 5*n* – 3 and DHA, C22 : 6*n* – 3) and HUFAs (EPA, C20 : 5*n* – 3 and DHA, C22 : 6*n* – 3)) was determined in diets and in the whole initial fish body by gas chromatography. Lipids from samples were extracted according to Folch et al. (1957) and fatty acids were transformed to methyl esters with boron fluoride-methanol following Morrison and Smith (1964).

Fatty acids were analysed using a Finnigan Focus GC (Thermo Electron Corporation, Milan, Italy) gas chromatograph equipped with a FID detector, an IS 3000 Autoinjector and a Supelco (PA, USA) SP-2560 (100 m × 0.25 mm ID, 0.20 µm film) capillary column. Helium was used as the carrier gas at a flow of 20 cm/s. Injector and detector temperatures were set at 260°C. The oven temperature was initially programmed at 140°C for 5 min and then increased at a rate of 4°C/min to a final temperature of 240°C. Peaks were identified by comparing relative retention times with standards (Supelco, PA, USA).

Statistical analysis

Growth data and feed utilisation were treated using one-way analysis of variance (ANOVA), as the initial weight differed, it was used as a covariate (Snedecor and Cochran 1971). Newman-Keuls test was used to assess specific differences among diets at 0.05 levels (Statgraphics, 1989).

RESULTS

Water temperature (23±1°C) and dissolved oxygen (7±0.5 mg/L) were measured daily. Salinity (33±1 g/L), pH (7.3±0.5), NH_3-N (0.05±0.1 mg/L), NO_2-N (0.34±0.2 mg/L) and NO_3-N (41.1±33.7 mg/L) were measured three times a week.

The composition of test diets including dry matter, crude protein, crude lipid, ash, gross energy were shown in Table 1. In addition, the amino acid profiles of the diets were also variable (Table 2).

The amino acid (Table 2) and fatty acid profile (Table 3) were different among diets. HUFAs represented 18.4 and 20.7% in diets 46/20 and 47/20, respectively, and 9.8 and 11.6% in diets 44/25 and 43/21, respectively, less than the HUFAs profile (14.4 and 16.3%, respectively, for each weight of the initial meagres (79 and 109 g). However, with the polyunsatured *n* – 6 the profile shows the opposite.

Differences in meagre growth were observed during all the experiment and fish fed diet 47/20 presented the highest weight. Significant differences were not observed in final fish survival during the feeding period with four diets and values were in the 70 to 85% range. Statistical differences were observed (Table 4) in final weight and SGR, meagre fed diet 47/20 obtained the highest final weight (393 g), followed by meagre fed with the diet 46/20 (319 g), obtaining a specific growth rate (SGR) of 1.2 and 1% /day, respectively. Fish fed diet 44/25 and 43/21 obtained the lowest final weight (174 g) and SGR (0.5% /day in both diets).

The fish fed diets 44/25 and 43/21 presented a significantly ($P < 0.05$) higher feed intake ratio (FI) (1.6 g 100 g/ fish*day) than those fed diets 46/20 and 47/20 (0.8 g 100 g/ fish*day). The feed conversion ratio (FCR) of fish fed diets 46/20 and 47/20 was significantly lower (1.5 and

Table 2. Amino acid composition (expressed in g/kg of wet fed basis) of the four diets.

Parameter	Diet			
	44/25	43/21	46/20	47/20
Essential amino acids				
Arginine	22	24	28	31
Histidine	8	7	8	13
Isoleucine	14	15	17	18
Leucine	31	31	37	34
Lysine	20	20	20	23
Methionine	10	7	10	12
Phenylalanine	17	15	19	21
Threonine	12	14	15	16
Valine	17	16	20	21
Non essential amino acids				
Alanine	20	22	24	22
Aspartic acid	29	36	39	34
Cysteine	10	11	14	13
Glutamic acid	89	65	89	101
Glycine	20	19	21	28
Proline	27	21	29	31
Serine	19	20	20	23
Tyrosine	nd	nd	12	14
IAA/DAA[z]	0.70	0.77	0.71	0.71

[z] EAA: Essential amino acids, NEAA: Non essential amino acids, nd: not detected.

Table 3. Fatty acid profile (expressed in % of area) of the four diets and initial fish whole body.

Parameter	Diet				Meagre initial weight	
	44/25	43/21	46/20	47/20		
Fatty acids profile (% area)					79±0.8	109±1.3
C12 : 0	0.0	0.0	0.0	0.1	0.0	0.0
C14 : 0	2.2	2.6	4.3	6.7	3.6	3.5
C15 : 0	0.3	0.4	0.6	0.4	0.5	0.4
C16 : 0	15.2	15.5	18.2	18.4	18.0	17.6
C16 : 1	2.6	3.1	5.0	6.8	5.1	5.0
C17 : 0	0.4	0.4	0.6	0.3	0.5	0.4
C17 : 1	0.2	0.3	0.8	0.2	0.5	0.3
C18 : 0	4.1	4.4	4.1	3.7	5.6	4.9
C18 : 1*n* – 7	2.2	2.3	2.8	2.8	2.8	2.7
C18 : 1*n* - 9t	0.1	0.2	0.3	0.2	0.2	0.1
C18 : 1*n* - 9c	20.7	19.8	19.1	13.5	17.9	17.4
C18 : 2*n* - 6c	31.5	27.7	14.0	17.2	22.1	22.1
C18 : 3*n* – 3	4.2	3.9	2.2	2.4	2.2	2.3
C18 : 3*n* – 6	0.1	0.1	0.1	0.2	0.1	0.1
C20 : 0	0.3	0.3	0.3	0.2	0.3	0.2
C20 : 1*n* – 9	2.0	2.5	3.2	1.2	1.6	1.5
C20 : 2*n* – 6	0.6	0.8	1.3	1.8	0.9	1.0
C20 : 3*n* – 3	0.1	0.2	0.0	0.1	0.1	0.1
C20 : 3*n* – 6	0.1	0.1	0.2	0.1	0.1	0.1
C20 : 4*n* – 6	0.6	0.6	0.0	0.8	1.1	1.1

Table 3. Contd.

C20 : 5*n* – 3	3.2	3.9	6.3	13.5	5.6	6.1
C22 : 0	0.3	0.3	0.2	0.2	0.2	0.2
C22 : 1*n* – 9	1.6	2.1	2.8	0.7	1.1	1.1
C22 : 2	0.3	0.4	0.8	0.6	0.1	0.4
C22 : 6*n* – 3	6.6	7.7	12.1	7.2	8.8	10.2
C24 : 0	0.1	0.1	0.3	0.1	0.3	0.2
C24 : 1*n* – 9	0.4	0.4	0.6	0.3	0.9	0.7
Saturated	22.9	24.1	28.4	30.2	28.8	27.6
Monoinsaturated	29.8	30.6	34.6	25.8	30.0	28.9
Polyunsatured *n* - 6	32.9	29.3	15.5	20.2	24.4	24.4
Polyunsatured *n* - 3	14.1	15.6	20.6	23.2	16.7	18.7
HUFAs	9.8	11.6	18.4	20.7	14.4	16.3

Table 4. Effect of four diets on growth and feed utilisation of reared meagre after 173 days of experiment.

Parameter	Diet				
	44/25	**43/21**	**46/20**	**47/20**	**SEM**
Initial weight (g)	94	94	95	94	15.2
Final weight (g)	174^{c}	174^{c}	319^{b}	393^{a}	15.8
Survival (%)	85	80	76	70	5.6
SGR (% day^{-1})^{w}	0.5^{c}	0.5^{c}	1.0^{b}	1.2^{a}	0.03
FI (g 100 g $fish^{-1}$ day^{-1})^{x}	1.6^{b}	1.6^{b}	0.8^{a}	0.8^{a}	0.1
FCR^{y}	5.3^{b}	5.3^{b}	1.5^{a}	1.2^{a}	0.4
PER^{z}	0.4^{b}	0.4^{b}	1.2^{a}	1.5^{a}	0.1

Data in the same row with different superscripts differ at $P < 0.05$.

1.2, respectively) than FCR presented with diets 44/25 and 43/21 (5.3 in both diets). As a consequence of these growth results, the protein efficiency ratio was significantly lower in fish fed diets 44/25 and 43/21 (0.4) than in fish fed diets 46/20 and 47/20 (1.2 and 1.5, respectively).

Table 5 shows the biometric parameters of meagre at the beginning and end of the trial. No differences were presented in condition factor (CF), which was around 0.9 and 1.6. However, dressout percentage was significantly higher in fish fed 46/20 and 47/20 (70.3 and 72.3%, respectively) than in fish fed diets 44/25 and 43/21 (66 and 67%, respectively). Likewise, The fish that presented higher final weight also presented more mesenteric fat (0.4%) than fish fed diets 44/25 and 43/21 (0.04 and 0.1%, respectively). No differences were observed in hepatosomatic (HIS) or viscerosomatic index (VSI) of fish.

The whole-body protein and ash content did not present significant differences between diets (Table 6). However, crude lipid of whole-body fish fed diets 46/20 and 47/20 (6.9 and 7.4%, respectively) was higher than those fed diets 44/25 and 43/21 (4.3 and 5.1% respectively). No significant treatment effects were found on the amino acid concentration in whole body, except in content of leucine, alanine and cysteine, which were significantly lower in those fed diet 46/20, although these were not outstanding.

The meagre from the 47/20 group retained more of the ingested protein (Table 7) and energy (26.5% and 26.7%, respectively) than those fed the diets 46/20 (20.1 and 17.8%, respectively). The fish fed 44/25 and 43/21 significantly obtained the lowest protein and energy efficiency.

The retention of individual AAs in fish fed diets generally decreased in order of diets 46/20, 43/21 and 44/25. Except for the retention of histidine, isoleucine, glycine and proline, which was similar in fish fed diets 47/20 and 46/20, the other single retention AAs were higher in those fed diet 47/20. The IAA retention of meagre fed diet 47/20 was around 24.8% in phenylalanine and 39.7% in lysine. No significant

Table 5. Effects of four diets on biometric parameters of *Argyrosomus regius* at the beginning and at the end of trial.

Parameter	Meagre initial		Diet				
	79±0.8 g	109±1.3 g	44/25	43/21	46/20	47/20	SEM
CF	1.0	0.9	0.9	1.0	1.1	1.6	0.3
DP (%)	67.5	69.2	66.1^{a}	67^{a}	70.3^{b}	72.3^{b}	0.2
MF (%)	0.04	0.05	0.04^{b}	0.1^{b}	0.4^{a}	0.4^{a}	0.05
HSI (%)	1.6	1.7	1.1	1.4	1.9	2.1	0.2
VSI (%)	6.1	5.1	4.1	4.6	5.1	5.2	0.3

Data in the same row with different superscripts differ at $P < 0.05$.

Table 6. Proximate composition and amino acids profile of *Argyrosomus regius* at the beginning and at the end of trial, expressed in %of wet weight.

Parameter	Meagre initial		Meagre final				
	79±0.8 g	109±1.3 g	44/25	43/21	46/20	47/20	SEM
Dry matter	25.0	24.6	25.0^{b}	24.9^{b}	27.9^{a}	27.7^{a}	0.4
Crude protein	16.0	16.4	16.7	16.0	16.7	16.9	0.5
Crude lipid	3.9	4.6	4.3^{b}	5.1^{b}	6.9^{a}	7.4^{a}	0.2
Ash	5.4	5.7	5.7	5.9	6.8	7.0	0.4
Essential amino acids							
Arginine	1.09	1.10	1.18	1.45	1.21	1.36	0.13
Histidine	0.34	0.29	0.35	0.42	0.39	0.42	004
Isoleucine	0.54	0.57	0.54	0.63	0.52	0.61	0.02
Leucine	1.06	1.09	1.03^{ab}	1.20^{a}	0.97^{b}	1.13^{ab}	0.03
Lysine	1.23	1.21	1.18	1.36	1.12	1.26	0.04
Methionine	0.45	0.51	0.40	0.45	0.37	0.46	0.03
Phenylalanine	0.53	0.59	0.61	0.71	0.61	0.68	0.05
Threonine	0.65	0.71	0.73	0.87	0.65	0.81	0.05
Valine	0.64	0.67	0.65	0.74	0.61	0.72	0.03
Non essential amino acids							
Alanine	1.04	1.00	1.03^{ab}	1.23^{a}	0.91^{b}	1.08^{ab}	0.03
Aspartic acid	1.54	1.53	1.38	1.56	1.16	1.50	0.14
Cysteine	0.29	0.33	0.29^{ab}	0.31^{ab}	0.26^{b}	0.34^{a}	0.01
Glutamic Acid	2.40	2.24	2.15	2.44	1.84	2.32	0.12
Glycine	1.45	1.25	1.48	1.86	1.56	1.67	0.16
Proline	0.74	0.70	0.72	0.91	0.73	0.84	0.08
Serine	0.74	0.73	0.69	0.84	0.71	0.79	0.07
Tyrosine	0.45	0.51	0.48	0.57	0.49	0.55	0.05
EAA/NEAA^{z}	0.75	0.81	0.81	0.81	0.84	0.82	0.05

Data in the same row with different superscripts differ at $P < 0.05$, EAA: Essential amino acids, NEAA: Non essential amino acids.

differences were found in tyrosine retention among diets.

DISCUSSION

The best temperature for the growth of meagre is between 17 to 21°C, with an acceptable range of 14 to 23°C. Also it offers the added advantage of being an Euryhaline specie, what allows their adaptation to very diverse systems. This experiment will be in the acceptable temperature range for meagre and the other water quality parameters were similar to those

Table 7. Crude protein, gross energy and amino acid efficiency of *Argyrosomus regius* at the end of trial.

Parameter	Diet				
	44/25	43/21	46/20	47/20	SEM
CPE (%)[x]	5.7[c]	5.9[c]	20.1[b]	26.5[a]	1.92
GEE (%)[y]	3.6[c]	4.6[c]	17.8[b]	26.7[a]	1.82
Essential amino acids efficiency					
Arginine	8.7[c]	13.3[c]	23.9[b]	34.1[a]	2.23
Histidine	7.6[b]	13.0[b]	26.1[a]	28.3[a]	2.12
Isoleucine	5.3[d]	8.1[c]	15.3[b]	25.2[a]	0.64
Leucine	4.3[d]	7.2[c]	12.7[b]	24.4[a]	0.36
Lysine	7.6[c]	12.5[c]	27.3[b]	39.7[a]	1.46
Methionine	3.4[c]	8.9[bc]	15.6[b]	27.0[a]	2.29
Phenylalanine	5.8[c]	9.9[c]	17.1[b]	24.8[a]	1.07
Threonine	9.6[c]	13.1[c]	21.7[b]	38.7[a]	1.95
Valine	5.10[c]	8.61[bc]	15.1[b]	25.4[a]	0.47
Non essential acids efficiency					
Alanine	7.1[c]	11.3[c]	18.1[b]	30.2[a]	1.08
Aspartate	5.3[b]	7.1[b]	12.3[b]	31.2[a]	2.49
Cysteine	3.2[b]	4.3[b]	8.5[b]	19.7[a]	1.16
Glutamic acid	2.8[c]	6.4[b]	8.9[b]	16.4[a]	0.77
Glycine	11.9[b]	22.3[ab]	41.7[a]	46.3[a]	5.22
Proline	3.7[d]	9.7[c]	13.2[b]	20.3[a]	1.03
Serine	4.4[c]	8.0[c]	18.2[b]	25.1[a]	1.39
Tyrosine	-	-	21.2	29.7	1.55

Data in the same row with different superscripts differ at $P < 0.05$.

recommended for marine fish (for optimum growth fish warm water species require a minimum dissolved oxygen concentration of approximately 5.0 mg/L (Aquafarmer 2004), NH_3-N concentrations should be held below 0.05 mg/L (Timmons et al., 2002), levels below than 1.0 mg/L NO_2-N are recommended for aquaculture systems (Pillay and Kutty, 2005) and Nitrate (NO_3-N), its concentration levels should be lower than 10 mg/L (Pillay and Kutty, 2005).

The growth results obtained in the study of the meagre fed with diet 47/20 were satisfactory and comparable to those in other species such as gilthead sea bream (Martínez-Llorens et al., 2007), Mediterranean yellowtail (Jover et al., 1999) and other Scianids such as red drum (Thoman et al., 1999; Turano et al., 2002; Li et al., 2004). This growth demonstrates suitable qualities of this species for production on a commercial scale.

In the other study (Calderon et al., 1997) with juvenile meagre of 178 g initial weight fed commercial diets reached 410 g in 5 months (SGR 0.57% /day), smaller growth values to those obtained in the current trial in meagre groups fed with diets 47/20 and 46/20. (SGR 1.2 and 1.0% /day).

The diets containing high protein levels (46/20 and 47/20) obtained the best growth, as has been observed in other Scianid species, for example McGoogan and Gatlin (1999) in a 8-week feeding trial conducted with juvenile red drum where the greatest weight gain was exhibited by fish fed the diet with the high protein dietary level tested (45% CP). Likewise, Thoman et al. (1999) evaluated the influence of dietary protein on growth of juvenile red drum in a 13-week trial and observed that weigh fish gain increased with dietary protein content.

Diets 44/25 and 43/21 are not advisable for meagre feeding. The low growth obtained the fish fed these diets which contain low protein level or are inadequate amino acid profile, because the arginine, isoleucine, leucine, phenylalanine, threonine and valine percentage is so low with respect to the other diets. So meagre diets could be formulated not only with high protein contents, like Mediterranean yellowtail, whose final growth and feed efficiency also showed improvement with high dietary protein (50%) levels (Jover et al., 1999), also with an adequate amino acids profile. Worst growth together with a high feeding rate caused the poor FCR in the meagre fed 44/25 and 43/21.

The FCR is quite better than others experiments carried out in sea cages and indoor tanks with meagre

(Pastor et al., 2002).

However, the growth differences observed between fish fed diets 46/20 and 47/20 could be due to the amino acid profile of diets, which seems to be more appropriate in diet 47/20. The protein and individual amino acids retentions are thus significantly better in the fish fed with diet 47/20 than those with diet 46/20. However, in both diets the dietary lysine content is higher those requirements (15.5 g/kg) of juvenile red drum reported by Graig and Gatlin (1992).

The amino acid composition of the whole body of *Argyrosomus regius* is similar to that reported in other fish species such as Japanese flounder (Deng et al., 2006). The individual essential amino acid retention obtained in the present trial with the meagre fed diet 47/20 was similar to those obtained in Japanese flounder fed diets with 100% of fish meal protein.

The meagre fed with diets 46/20 and 47/20 presented very high dressout percentage (70.3 and 72.3, respectively), which demonstrates the edible fish percentage, similar to other fish presented with higher weight, such as the Mediterranean yellowtail (Jover et al., 1999). The meagre also obtained low body adiposity and mesenteric fat, in agreement with Piccolo et al. (2006), which together with the high growth and good adaptation to production conditions indicate that the meagre is a potential species for the diversification of Mediterranean marine aquaculture.

Conclusions

The results of the current experiment show that the fish fed commercial diet 47/20 obtained the best results in meagre growth, followed by fish fed diet 46/20. Diets 43/21 and 44/25 presented the worst growth and feed efficiency results.

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