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SARDEGNA RICERCHE

PortoConte Ricerche

PROTEIN & ENERGY REQUIREMENTS IN GILTHEAD SEA BREAM

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GAB Grupo de Acuicultura y Biodiversidad

THE DETERMINATION OF PROTEIN AND ENERGY REQUIREMENTS IN AQUACULTURE IS ONE OF THE THREE MAIN ALTERNATIVES FOR IMPROVING THE FEEDING ON INTENSIVE SYSTEMS

INTENSIVE AQUACULTURE BASED IN DRY AQUA-FEEDS:

+ SHRIMPS

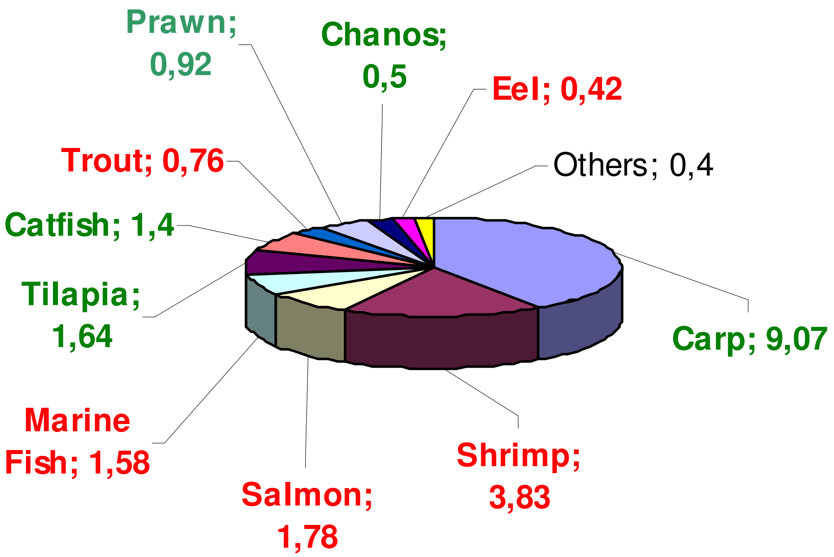
+ SALMONIDS

+ EEL

+ SEA BREAM

+ SEA BASS

Feedstuffs consumption by several species (Tacon, 2004, adapted by Robaina & Schuchardt, 2009)



EXTENSIVE AQUACULTURE BASED IN NATURAL FEEDING:

+ MOLLUSCS

+ CIPRINIDS

+ SILURIDS

Main species farmed in the World (FAO, 2005)

Especie		2005
Wakame	*(Undaria pinnatifida)*	7,65 x 106 Tm
Ostra japonesa	*(Crassostrea gigas)*	4,50 x 106 Tm
Carpa plateada	*(Hypophthalmichthys molitrix)*	4,15 x 106 Tm
Carpa herbívora	*(Ctenopharyngodon idella)*	3,90 x 106 Tm
Carpa común	*(Cyprinus carpio)*	3,04 x 106 Tm
Almeja japonesa	*(Ruditapes philippinarum)*	2,95 x 106 Tm
Carpa cabezona	*(Hypophthalmichthys nobilis)*	2,21 x 106 Tm
Carpín dorado	*(Carassius carassius)*	2,09 x 106 Tm
Tilapia del Nilo	*(Oreochromis niloticus)*	1,70 x 106 Tm
Langostino blanco	*(Litopenaeus vannamei)*	1,60 x 106 Tm
Total 10 Principales Especies		33,79 x 106 Tm
Total Resto de las Especies		35,22 x 106 Tm
TOTAL MUNDIAL		62,96 x 106 Tm

7,45 M Tm

12 %

15,4 M Tm

24 %

CHINA:	**70.7 %**
Rest of Asia:	**20.2 %**

European Union:	**2.7 %**
Suthamérica:	**2.1 %**

Main species farmed in Europe (FEAP, 2006)

Especie	Producción 2006
Anguilas	7.790 Tm.
Carpas	72.660 Tm.
Doradas	113.585 Tm.
Esturiones	65 Tm.
Lubinas	96.447 Tm.
Peces planos	9.020 Tm.
Salmón	763.648 Tm.
Silúridos	6.760 Tm.
Tilapias	750 Tm.
Truchas	334.060 Tm.
Otros peces a. dulce	350 Tm.
Otros peces marinos	18.695 Tm.
TOTAL	1.423.830 Tm.

Doradas, Lubinas: FCR = 2

Salmón, Truchas: FCR = 1

MAIN ALTERNATIVES FOR IMPROVING THE FEEDING ON INTENSIVE SYSTEMS

1) ESTABLISHMENT OF OPTIMUM PROTEIN AND ENERGY LEVELS ON DIETS → Relation DP / DE → Feed companies

2) UTILIZATION OF ALTERNATIVES PROTEIN AND LIPID SOURCES → Requirements EAA → Feed companies

3) OPTIMIZATION OF FEEDING STRATEGIES → Feeding Rate / Number and hour of meals → Feed companies and Fishfarms

Cost of gilthead production (€)
(De Benito et al., 2007)

Comercial size (g)	450	900	1200
Personnel	789.423	841.103	906.383
Fingerlings	2.405.229	1.202.614	901.961
Feed (€) **(% total)**	**3.043.709** **40 %**	**3.444.883** **49 %**	**3.720.984** **52 %**
General	948.000	1.109.000	1.142.000
Repayment	380.258	410.377	425.943
TOTAL	7.566.619	7.007.977	7.097.271
Unitary Cost (€/kg)	3,78	3,50	3,55

HOW HAVE THE OPTIMUM NUTRIENT REQUIREMENT BEEN EXPRESED?

AQUACULTURE → "optimum dietary levels"

¿¿¿ + % ó g protein / Kg diet
+ MJ energy / Kg diet ???

ANIMAL PRODUCTION → "requirements"

+ g protein / Kg metabolic weight /day
+ MJ energía / Kg metabolic weight /day

WHICH ARE THESE OPTIMUM PROTEIN AND ENERGY (LIPID) LEVELS IN AQUAFEED?

+ Omnivorous fish: 25-45 % CP / 12-16 % EE
+ Carnivorous fish: 40-50 % CP / 20-30 % EE

THESE DIETARY LEVELS ARE HIGH, BUT ARE THE PROTEIN AND ENERGY REQUIREMENTS HIGH?

+ YES FOR PROTEIN: THE CARNIVOROUS HABITS PROMOTE THE USE OF PROTEIN FOR OBTAINING ENERGY → LOWER PROTEIN RETENTION

+ NO FOR ENERGY: LOW CONVERSION INDEXES → LOW CONSUMPTION ENERGY:

+ POIQUILOTERMIC CHARACTER OF FISH
+ NITROGEN EXCRECION AS NH_3
+ EASY MOVIMENT INTO THE WATER

THE PROTEIN AND ENERGY LEVELS ARE INTER-RELATED:
→ OPTIMUM PROTEIN / ENERGY RATIO

⇓

Considering that fish eat to satisfy their energy needs:

+ Low P/E → the voluntary ingestion stops before protein intake was enough

+ high P/E → protein intake is in excess and the profitability is low because the protein waste

⇓ ⇓ ⇓ ⇓ ⇓ ⇓

LOW GROWTH – FATTENING – HIGH N EXCRETION

DETERMINATION OF OPTIMUM DIETARY LEVELS?

or

APLICATION OF A FACTORIAL MODEL FOR NEEDS?

Lupatsch y col. (1998, 2001, 2002)

HOW HAVE THE PROTEIN AND ENERGY DIETARY LEVELS BEEN DETERMINED ?

↓

IN THE PASS → THROUGH TRIALS USING SEVERAL DIETS CONTAINING DIFFERENT LEVELS OF NUTRIENT AND USING ANOVA FOR STATISTICAL ANALYSIS OR "BROKEN LINE"

↓

ACTUALLY THROUGH REGRESION ANALYSIS

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Especies (IW - FW) Reference	DP / EE (g/Kg diet)	DE (MJ/Kg diet)	DP/DE (g / MJ)	SGR (%/d)	FCR
Sea bream (25-95 g)	374 / 161	17,1	21,9	1,19	1,61
Lupatsch et al. (2001a)	456 / 178	18,1	25,2	1,33	1,35
	377 / 220	18,2	20,7	1,39	1,27
	547 / 184	19,4	28,2	1,41	1,23
Sea bream (32-110 g)	459 / 176	18,9	24,3	1,30	1,26
Lupatsch et al. (2001a)	421 /225	19,6	21,5	1,33	1,22
	390 / 256	20,4	19,1	1,24	1,33
	369 / 314	20,6	17,9	1,24	1,23
	339 / 352	21,6	15,7	1,19	1,27
Sea bream (42-145 g)	438 / 150	19,4	22,6	1,65	1,56 c
Santinha et al. (1999)	**441** / 209	**21,2**	**20,8**	**1,61**	**1,26 a**
	489 / 151	20,3	24,1	1,67	1,41 b
	477 / 208	21,2	22,5	1,67	1,26 a
Sea bream (105-170 g)	416 / 156	19,1	21,8	1,28 b	1,40 b
Ekmann et al. (2002)	**410 / 194**	**19,9**	**20,6**	**1,37 a**	**1,20 a**
	418 / 212	20,4	20,5	1,40 a	1,20 a
	422 / 246	21,2	19,9	1,42 a	1,20 a
	427 / 271	**21,8**	**19,6**	**1,55 a**	**1,15 a**
	424 / 315	22,8	18,6	1,48 a	1,08 a
Sea bream (70-400 g)	400 / 151	18,6	21,5	0,94 b	1,41-1,54
Vergara et al. (1999)	**398 / 228**	**20,4**	**19,5**	**0,98 a**	**1,41-1,54**
	405 / 270	21,3	19,0	0,97 a	1,41-1,54
Sea bream (24-417 g)	378 / 110	15,9	23,8	1,17 b	2,21 c
Moñino et al. (2002)	395 / 140	16,8	23,5	1,17 b	1,78 b
	369 / 210	17,4	21,2	1,16 b	1,64 b
	420 / 260	**23,1**	**18,2**	**1,25 a**	**1,38 a**

Different trials varying protein, energy and protein/energy ratio by several authors

Opt: 44% CP - 21% EE (Santinha et al., 1999)

Opt: 41% CP - 19% EE (Ekmann et al., 2002)

Opt: 43% CP - 27% EE (Ekmann et al., 2002)

Opt: 40% CP - 23% EE (Vergara et al., 1999)

Opt: 42% CP - 26% EE (Moñino et al., 2002)

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Aquaculture Nutrition 2001 **7**; 71–80

Effects of varying dietary protein and energy supply on growth, body composition and protein utilization in gilthead seabream (*Sparus aurata* L.)

I. LUPATSCH[1], G. WM. KISSIL[1], D. SKLAN[2] & E. PFEFFER[3]

[1] *National Center for Mariculture, Israel Oceanographic & Limnological Research, P.O.B. 1212, Eilat 88 112, Israel;* [2] *Faculty of Agriculture, Hebrew University of Jerusalem, P.O.B. 12, Rehovot 76100, Israel;* [3] *Institut für Tierernährung der Rheinischen Friedrich-Wilhelms-Universität Bonn, 53 115 Bonn, Endenicher Allee 15, Germany*

Table 2 Composition and proximate analysis (g kg^{-1} as fed) of diets in Trials 1, 2 and 3

	Trial 1						Trial 2				Trial 3				
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
Composition (g kg^{-1})															
Fish meal A[1]							600	735	885	600					
Fish meal B[2]											870	805	750	700	650
Fish meal C[3]	620	620	620	780	780	780									
Fish oil[4]	–	40	85	–	25	65	95	95	95	163	100	150	200	250	300
Cornstarch[5]	–	–	–	–	–	–	285	150	–	150		–	–	–	–
Cellulose	360	320	275	200	175	135	–	–	–	67	–	–	–	–	–
Vitamin mix[6]	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Sipernat[7]	10	10	10	10	10	10	10	10	10	10	20	35	40	40	40
Analysis (g kg^{-1})															
Dry matter	931	930	934	935	940	931	928	931	923	926	932	938	940	945	948
Crude protein	417	418	411	502	506	498	427	520	624	429	522	480	442	420	385
Crude lipid	66	101	131	85	115	140	161	178	184	220	176	225	256	314	352
Ash	112	108	104	114	115	115	99	123	131	97	129	134	139	149	149
Gross energy (MJ)	18.37	19.35	19.95	19.37	19.51	20.45	20.23	20.79	21.58	21.69	21.10	21.81	22.53	22.66	23.59
Digestible crude protein[8] (DCP)	344	345	339	414	418	411	376	457	549	377	459	422	389	370	339
Digestible energy[9] (DE) (MJ kg^{-1})	10.02	11.59	13.03	12.58	13.37	14.89	17.13	18.15	19.45	18.18	18.86	19.62	20.39	20.62	21.57
DCP/DE (g MJ^{-1})	34.3	29.8	26.0	32.9	31.3	27.6	21.9	25.2	28.2	20.7	24.3	21.5	19.1	17.9	15.7

$$WG = -8.57 + 1.38\,DE - 0.033\,DE^2$$

DEopm = 20,9 MJ/Kg diet

$$PG = -2.02 + 0.32\,EDF - 0.0084\,EDF^2$$

DEopm = 19,0 MJ/Kg diet

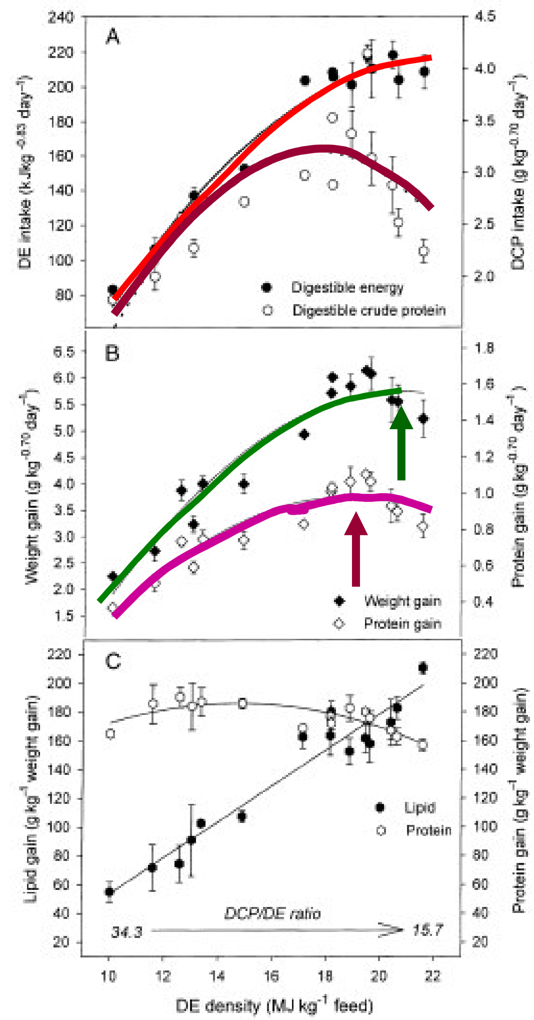
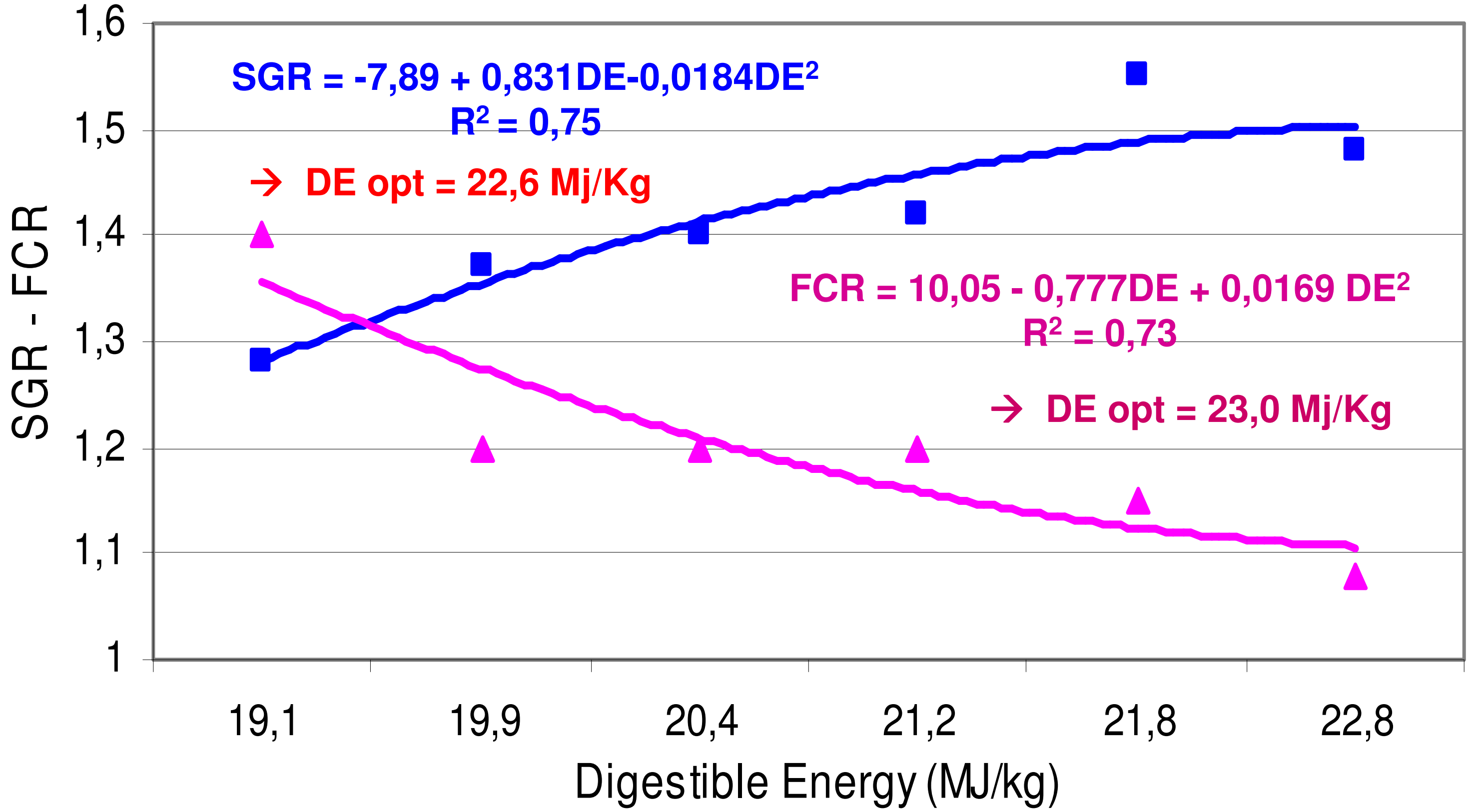


Figure 2 Daily intake of DE and DCP (A) per metabolic weights of kg$^{0.83}$ and kg$^{0.70}$, (B) weight and protein gain (g kg$^{-0.70}$ day^{-1}) and protein and lipid retention (C) per unit weight gain (g kg^{-1}) of *S. aurata* fed 15 diets varying in DE content (MJ kg^{-1}). Each point represents mean ± SD of triplicate treatments.



Quadratic regresion of SGR and FCR in funstion of Digestible Energy (Self made from Ekmann et al., 2002)

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Estudio del crecimie
nutritivo y de la proc
de la dorada *Sparus a*
con piensos comerci
en proteína y lípidos

A. Moñino[1], *A. Tomás*[1], *M. F*
A. Tiana[3] *y M. Jover*[1]

[1] Grupo de Investigación en Recursos Acuíco
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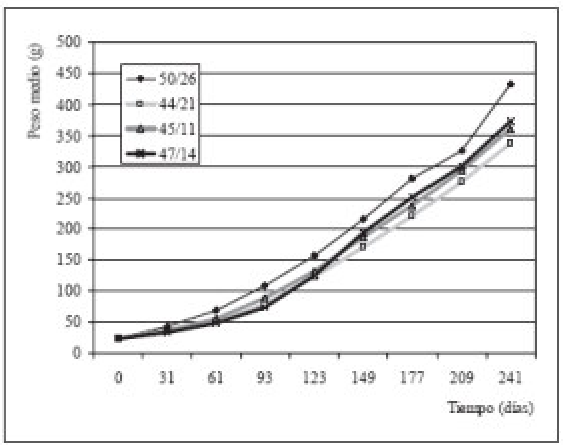
Piensos	Ecodiva	Ecoplús	Estándar	Ecoprime	Ecodiva + Ecoprime
PB (%)/GB (%)	(50/26)	(44/21)	(45/11)	(47/14)	
Precio del pienso (PTA/kg)	162	111	86	103	111,5
(equiv. €)	0,97	0,67	0,52	0,62	0,67
Índice conversión económico (PTA/kg)	223,6	182,0	190,1	183,3	194,0
(equiv. €)	1,34	1,09	1,14	1,10	1,17
Biomasa final de las doradas (kg)	3 065	2 552	2 805	2 810	3 065
Valor de la venta (miles de PTA)	2 880	2 275	2 566	2 564	2 888
(equiv. miles de €)	17,31	13,67	15,42	15,41	17,36
Coste del pienso (miles de PTA)	685	465	533	515	560
(equiv. miles de €)	4,12	2,80	3,20	3,10	3,37
Margen bruto (miles de PTA) (1)	2 195	1 810	2 033	2 049	2 319
(equiv. miles de €)	13,05	10,88	12,22	12,22	13,94
Margen sobre ventas (%) (2)	76,2	79,6	79,2	79,9	80,5
Productividad económica (3)	4,2	4,9	4,8	5,0	5,1
Proporción margen/pienso (4)	3,2	3,9	3,8	4,0	4,1



Piensos	Ecodiva	Ecoplús	Estándar	Ecoprime
PB (%)/GB (%)	(50/26)	(44/21)	(45/11)	(47/14)
Peso inicial (g)	24,0 ± 0,8	23,5 ± 1,2	23,3 ± 0,4	23,8 ± 1,2
Peso final (g)	417,0 ± 9,8	326,2 ± 7,1	351,7 ± 4,9	352,7 ± 5,2
Peso medio	a	c	b	b
TCI (%/día) (1)	1,25	1,16	1,17	1,17
Crecimiento medio	a	b	b	b
CTC (2)	0,00163	0,00143	0,00147	0,00149
TID (%) (3)	0,99	1,15	1,56	1,26
Ingestión media	a	b	c	d
IC (4)	1,38	1,64	2,21	1,78
Conversión media	a	b	c	b
Supervivencia (%)	73,5	78,3	79,7	79,6

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THE AQUAFEED COMPANIES DESIGN THE DIETS:

→ PROTEIN, LIPID AND ENERGY LEVELS

BUT IT IS NECESSARY TO STABLISH THE INGESTION LEVELS!

FEEDING TABLE FOR SEA BREAM
Diet 37,8 % DP – 17 % EE – 17,8 MJ/kg DE

Tª (ºC) / Weight (g)	60-100	200-300	400-500
14	0,8	0,6	0,5
16	1,3	0,8	0,7
18	1,6	1,0	0,9
20	1,9	1,2	1,1
22	2,1	1,4	1,2
24	2,3	1,6	1,4
26	2,5	1,7	1,5

FEEDING TABLE FOR SEA BREAM
Diet 39,6 % DP – 25 % EE – 20,5 MJ/kg DE

Tª (ºC) / Weight (g)	60-100	200-300	400-500
14	0,7	0,5	0,4
16	1,1	0,7	0,6
18	1,4	0,9	0,7
20	1,6	1,0	0,9
22	1,8	1,2	1,0
24	1,9	1,3	1,1
26	2,1	1,4	1,2

ARE THESE FEEDING RATES CORRECTELY DETERMINED?

FEEDING RATES AND INGESTION FOR SEA BREAM (250 g and 22 ºC) USING SEVERAL DIETS

DIETS DP (g/Kg) - DE (MJ/Kg)	378 – 17,8	378 – 19,0	396 – 20,5
D.F.R. (Kg diet/100 Kg fish/day)	1,4	> 1,3	> 1,2
Energy Intake (KJ energy/ 100 Kg fish/day)	24,9	= 24,7	= 24,6
Protein Intake (g protein/100 Kg fish/day)	530	> 492	> 475

It is possible to establish a feeding rate for equalling energy ingestion

Energy Level in Diet (MJ/Kg)	Daily Feeding Rate (Kg diet/100kg fish/day)	Daily Energy Intake (MJ/100Kg fish/day)
17,8	1,40	24,9
19,0	1,31	24,9
20,5	1,21	24,9

What happen with protein intake?

When dietary energy increases→ the feeding rate must be reduced for maintaining the energy intake

But for maintaining the protein intake → the dietary protein level also must be increased

→ It is necessary to maintain the Protein/Energy Ratio

¡¡¡IT IS NECESSARY TO DETERMINE THE PROTEIN AND ENERGY NEEDS OF FISH INSTEAD (or BEFORE) DIETARY LEVEL !!!

A FIRST STEP →

Estimation of energy needs expressed in NED (MJ DE/Kg fish) in different species (Bailey & Alanärä, 2006)

Species	Nº	N.E.D. (MJ/Kg fish)	Intervale N.E.D.	Model N.E.D. – Weight
Rainbow troutt	26	14,5	12,0 `- 17,0	10,58 + 0,80 lnP
Salmon	24	16,2	12,3 – 21,3	10,77 + 1,05 lnP
Turbot	8	15,8	13,1 – 18,0	-
Sea bass	15	22,3	19,7 – 26,2	-
Gilthead sea bream	8	22,0	18,4 – 26,0	-

FACTORIAL ENERGETIC MODEL FOR ESTABLISHING THE OPTIMUM ENERGY AND PROTEIN REQUIREMENTS OF SEA BREAM, THE OPTIMUM PROTEIN AND ENERGY DIATARY LEVELS AND THE FEEDIG RATES

(LUPATSCH et al., 1998, 1998, 2001, 2003)

National Center for Mariculture, Israel Oceanographic and Limnological Research, P.O.B. 1212, Eilat 88112, Israel

→ It is necessary the evaluation of protein and energy used for maintaining and protein and energy retained in growth

1.- ***Predicting aquaculture waste from gilthead seabream (Sparus aurata) culture using a nutritional approach*.**
Lupatsch & Kissil, 1997 - Aquat. Living Resour.: 11: 265-268

2.- ***Energy and protein requirements for maintenance and growth in gilthead seabrea m (Sparus aurata)***
Lupatsch, Kissil, Sklan y Pfeffer, 1998 - Aquaculture Nutrition: 4: 165-173

3.- ***Effects of varying dietary protein and energy supply on growth, body composition and protein utilization in gilthead seabream (Sparus aurata)***
Lupatsch, Kissil, Sklan y Pfeffer, 2001- Aquaculture Nutrition, 7: 71-80

4.- **Defining energy and protein requirements of gilthead seabream *(Sparus aurata)* to optimize feeds and feeding regimes.**
Lupatsch Kissil, Sklan 2003 - *The Israeli J. of Aquaculture – 55, 243-257.*

DEFINING ENERGY AND PROTEIN REQUIREMENTS OF GILTHEAD SEABREAM *(SPARUS AURATA)* TO OPTIMIZE FEEDS AND FEEDING REGIMES

The Israeli Journal of Aquaculture – Bamidgeh 55(4), 2003, 243-257. 243

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Objectives

+ To improve the previous sea bream growth model

+ To study the effect of temperature in energy and protein efficiency

+ To determine the Protein and Energy requirements for growth

Material and methods

+ initial growth trials using sea bream with several weight fed to apparent saciation (2-3 meals/day) for establishing growth model and body composition

+ fasting trials using fish from 1 to 470 g during 30 days for metabolic growth

+ five growth trials during 39-65 days and initial weight 21- 95 g; dietary DP/DE ratio of 21-29 g/Mj, several levels of restricted feeding: fasting, low, medium and high; two temperatures 20 and 28ºC

	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Fish/tank	19	13	13	18	21
Initial weight (g)	40.1	72.4	94.4	86.1	21.4
Diets (see Table 1)	A	A	A	B, C, D	B, C, D
Feeding levels		low, medium, high + starvation		low, medium, high, maximum + starvation	
Replicates	2	2	2	-	2
Duration (days)	41	41	41	65	39
Water temperature (°C)	20.5	20.5	20.5	21.5	28

Growth and Intake Models

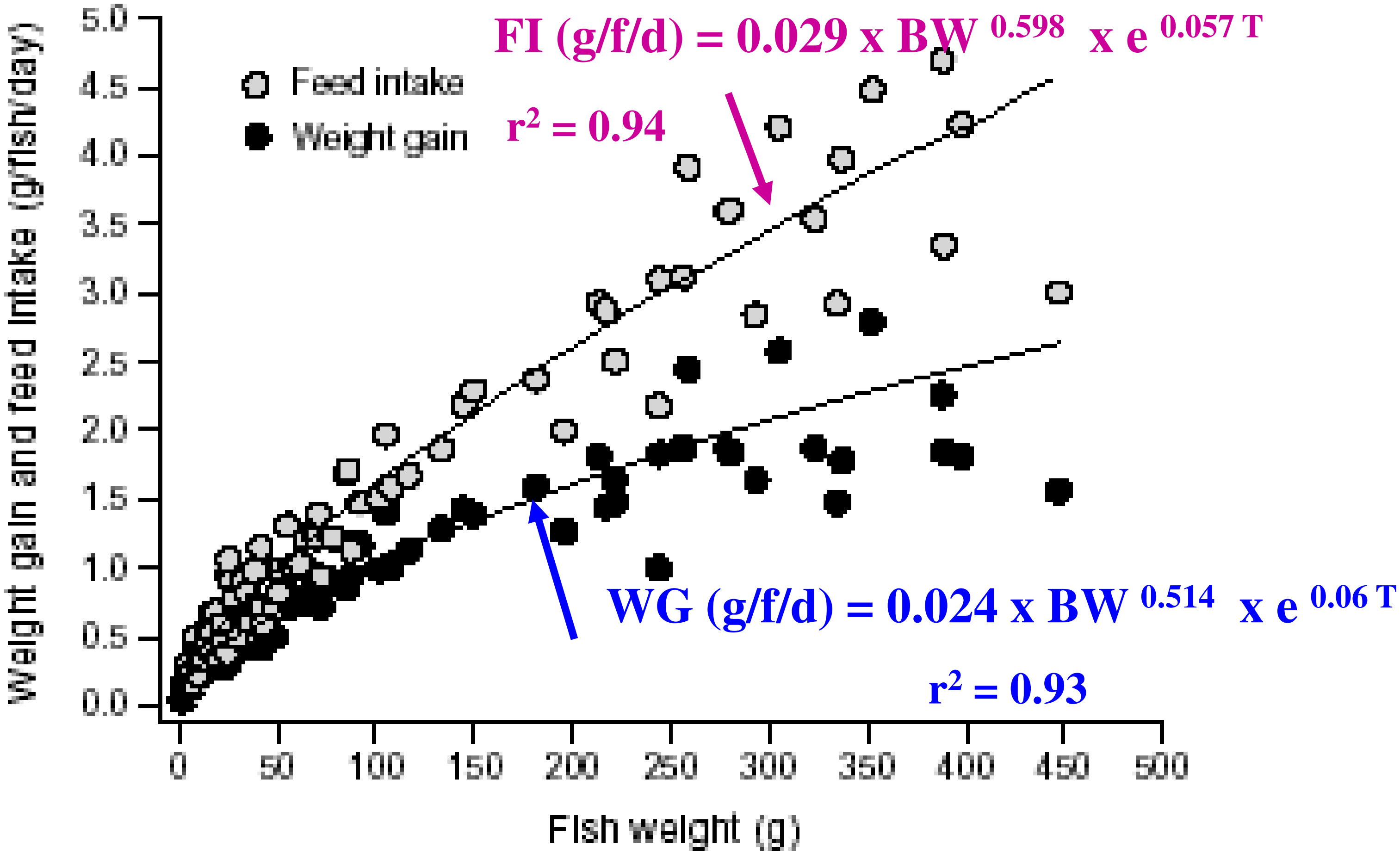


Fig. 1. Daily weight gain (g) and feed intake (g) in relation to increasing body weight in gilthead seabream. Corresponding equations 1 and 3 are presented in the text.

Body Composition

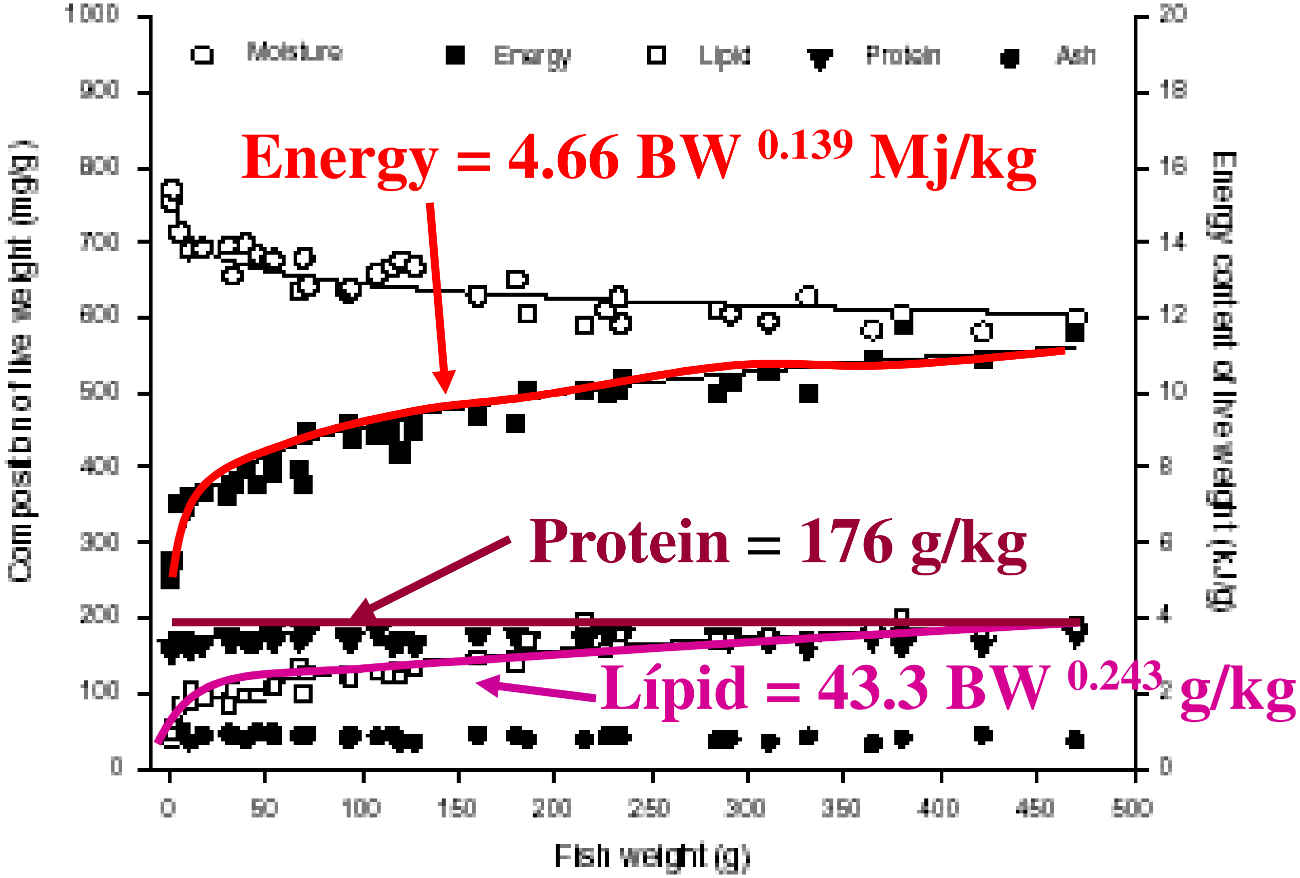
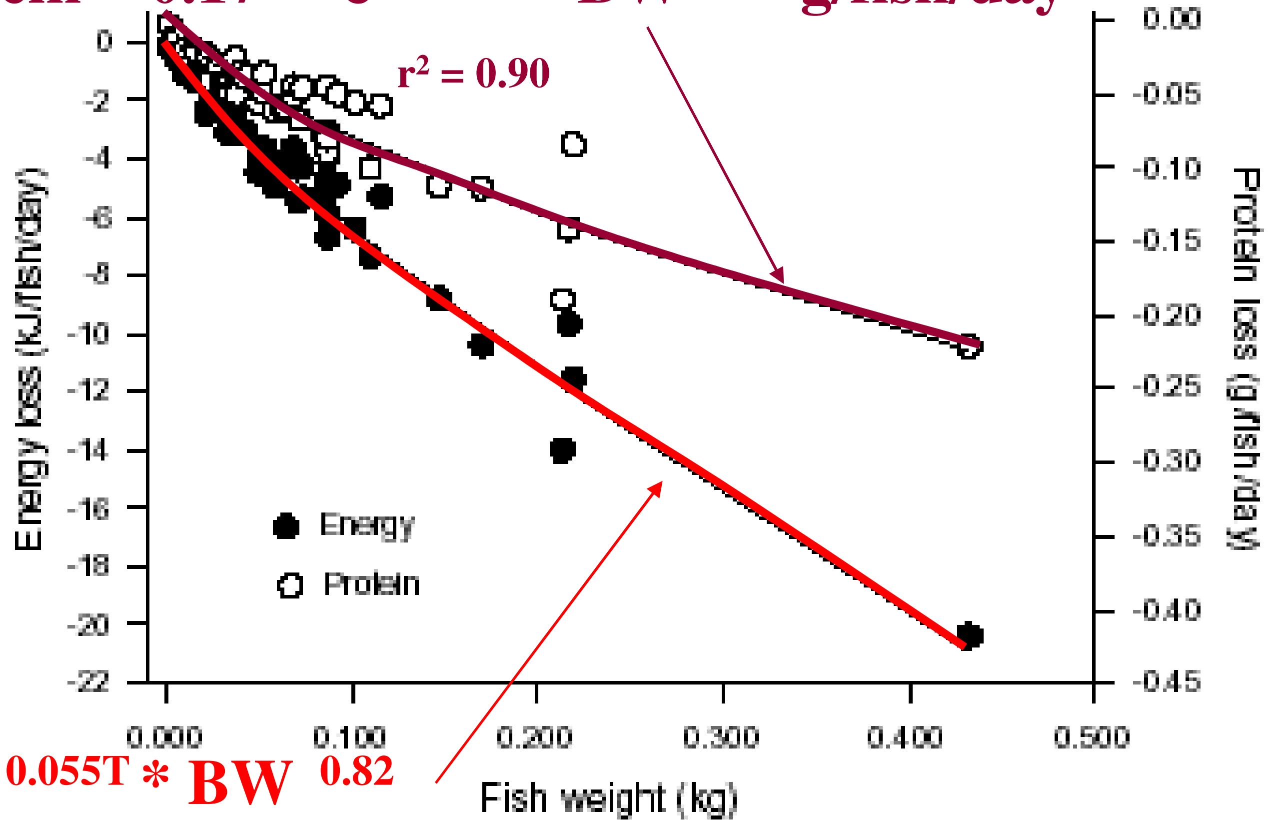


Fig. 2. Proximate body composition of gilthead seabream at various sizes. Each data point represents analysis of a group of fish. Corresponding equations 4 to 6 are presented in the text.

Lost of energy and protein during fasting

Proteín = $0.17 * e^{0.036T} * BW^{0.70}$ g/fish/day

$r^2 = 0.90$



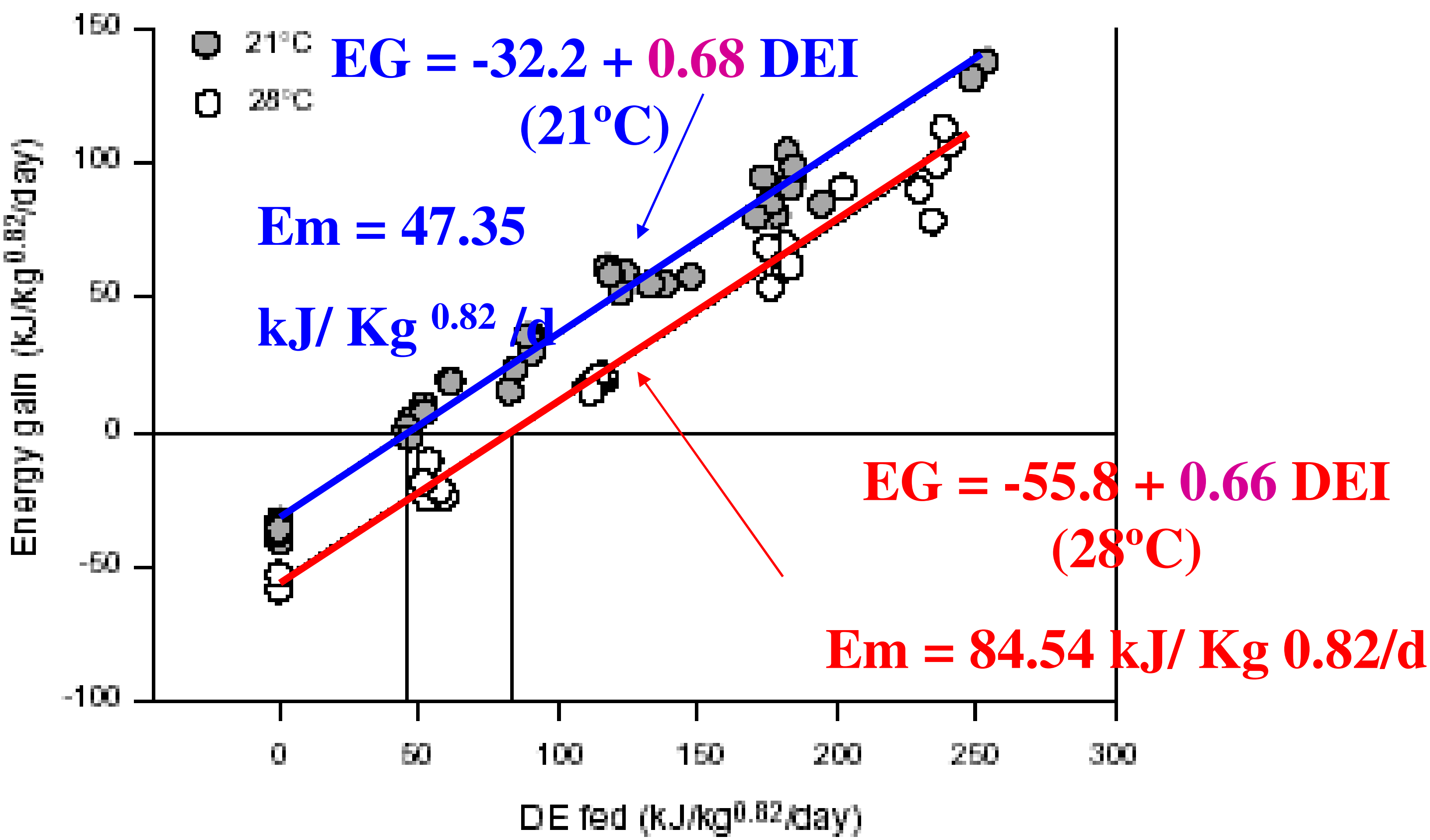
Energy = $11.6 * e^{0.055T} * BW^{0.82}$ kJ/pez/día

$r^2 = 0.97$

Fig. 3. Energy (kJ/fish/day) and protein (g/fish/day) losses in gilthead seabream after starvation. Corresponding equations 7 and 9 are presented in the text.

Metabolic Weight Prot: $Kg^{0.7}$ **Metabolic Weight Energía: $Kg^{0.82}$**

Retention of energy and efficiency energy



→ Em = 16.6 kJ $e^{0.055T}$/ Kg $^{0.82}$/d

→ Ef Em= 0.67

Retention of proteín and protein efficiency

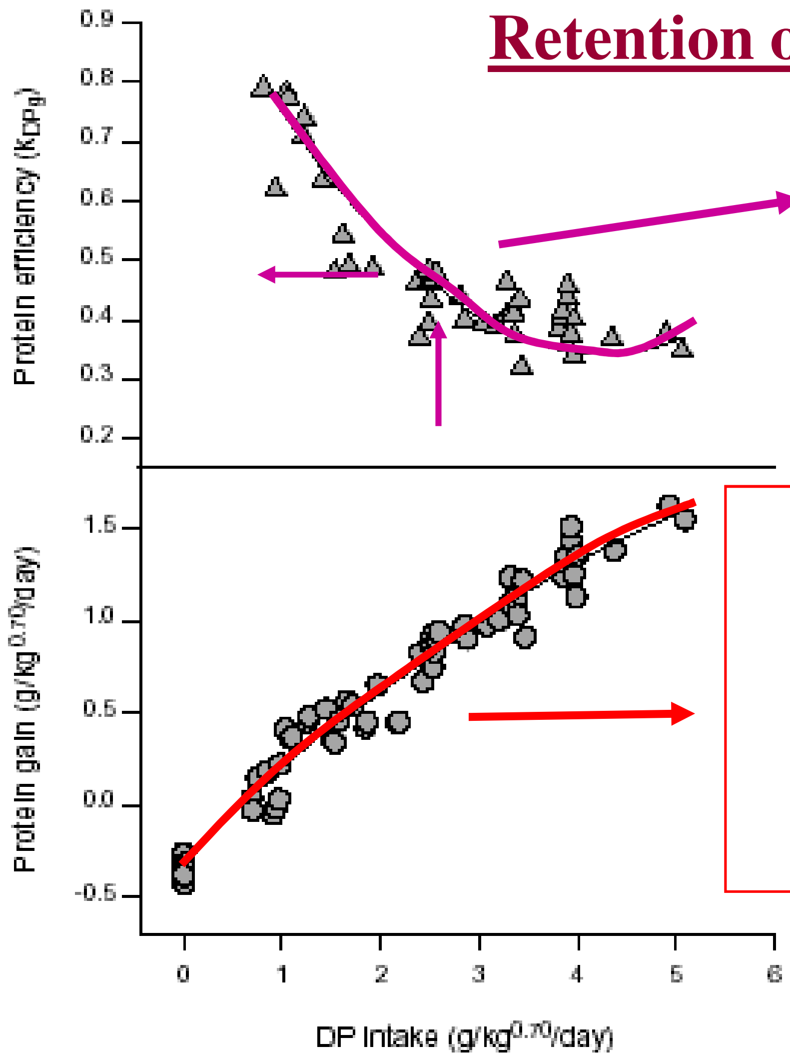


Fig. 6. Relationship between protein efficiency for growth (k_{DPg}) and protein gain in gilthead seabream fed varying levels of digestible protein.

Optimum efficiency

Ef Pr = 0.47

Independent of Temperature

$$PG = 3.16\ [1 - e^{-0.159\ (PI\ -\ 0.62)}]$$

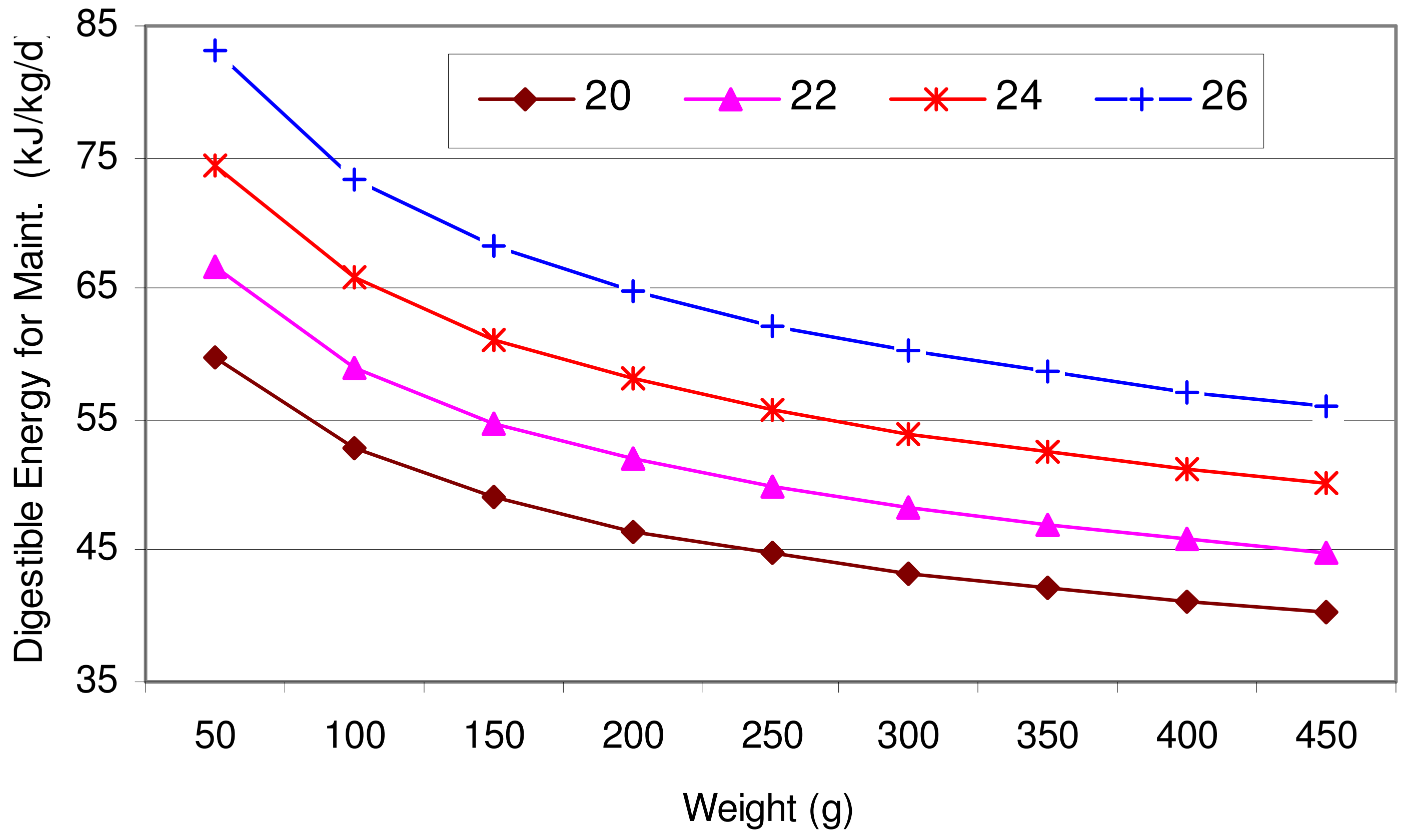
$$Pm = 0.62\ g\ /Kg^{0.7}\ /\ d$$

Table 5. Proposed diet formulations and practical feeding tables for gilthead seabream during all stages of the growth period (at 23°C).

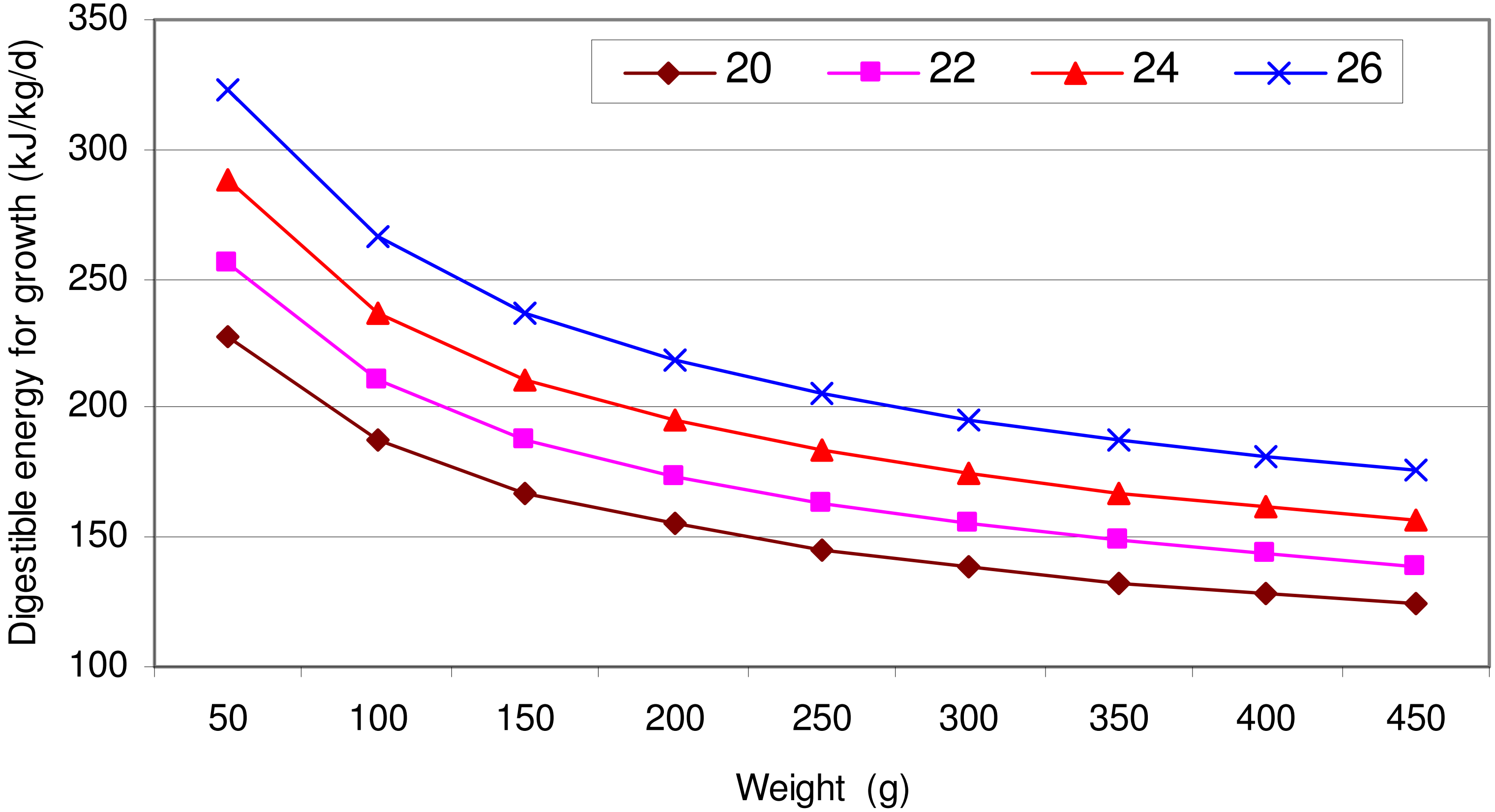
Weight (g)	*Feed composition (per kg feed)**		*Weight gain (g/fish/day)*	*Feed intake (g/fish/day)*	*Days of growth*	*FCR*
	Crude protein (g)	*Gross energy (MJ)*				
1-5	540	19.8	0.16	0.16	25	1.00
5-10	500	19.8	0.26	0.28	19	1.08
10-50	480	20.0	0.51	0.61	78	1.20
50-100	450	20.2	0.86	1.18	58	1.37
100-200	420	20.7	1.23	1.81	81	1.47
200-300	400	21.2	1.61	2.58	62	1.60
300-400	400	22.0	1.92	3.21	52	1.67

* assuming digestibility of protein 85% and of energy 80%

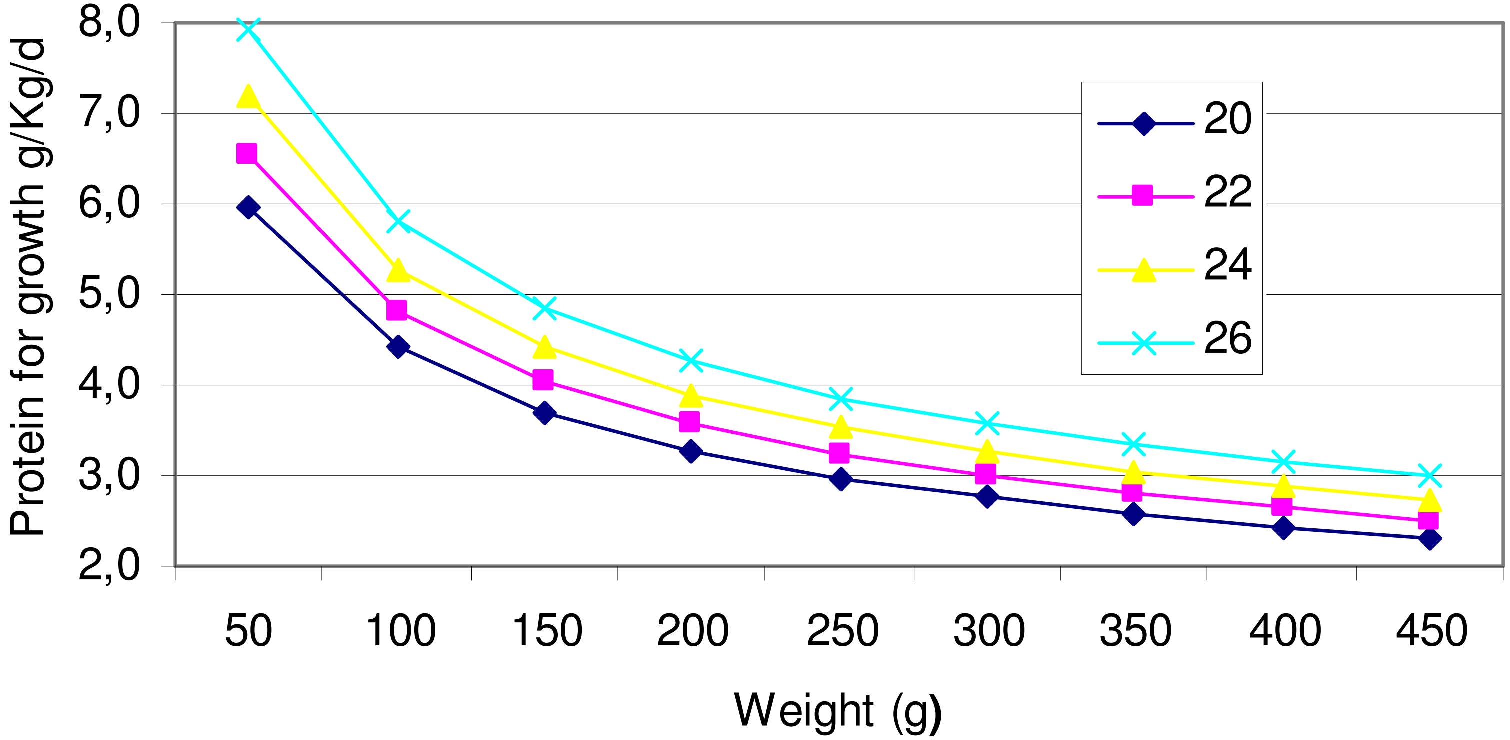
Energy needs for maintenance of sea bream (self made from Lupatsch et al., 2003a)



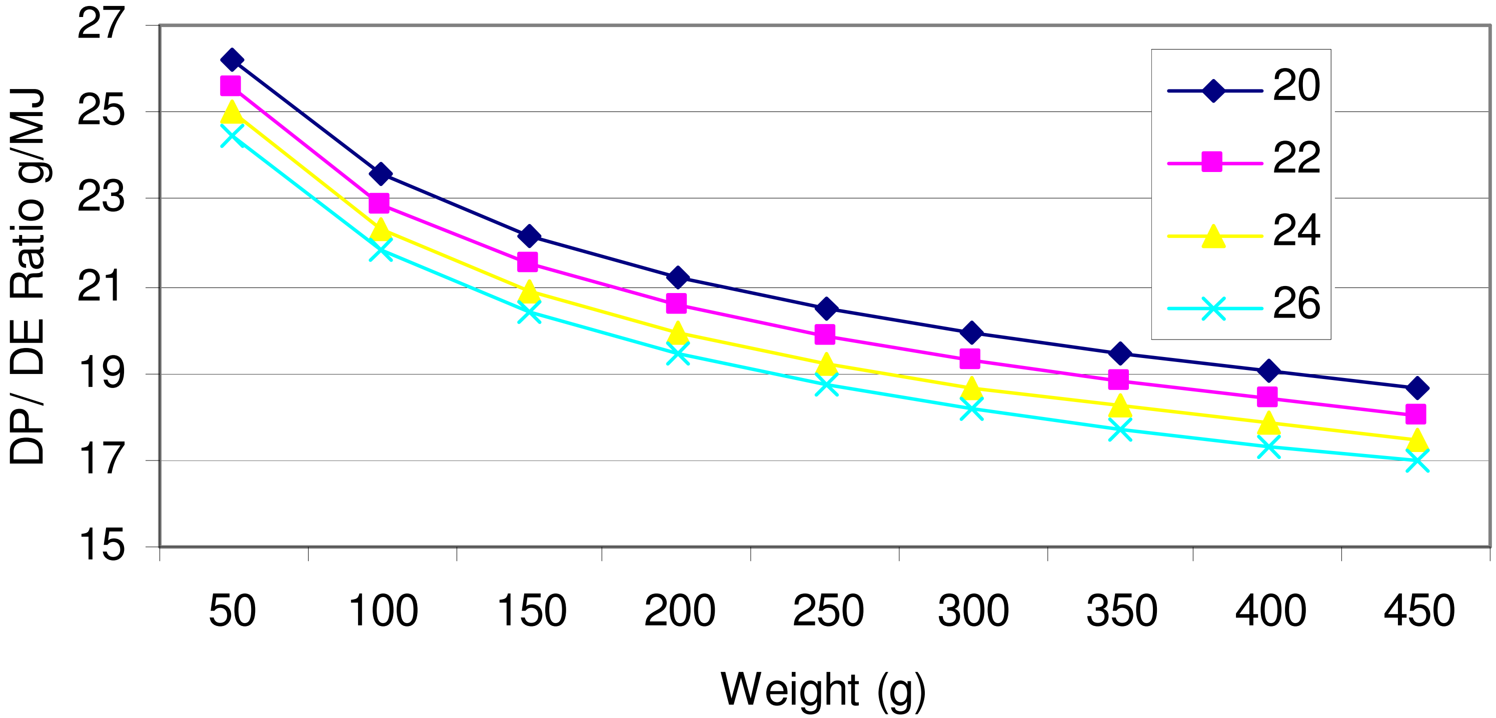
Estimation of energy needs for growth of sea bream (self made from Lupatsch et al., 2003a)



Estimation of protein needs for growth of sea bream (self made from Lupatsch et al., 2003a)



Estimation of optimum DP/DE ratio in diets for growth of sea bream (self made from Lupatsch et al., 2003a)



Optimum diet design for gilthead sea bream using energy and protein requirements at 25 ºC (Self made from Lupatsch et al., 2003 a,b)

Weight (g)	25			75			250		
Energy needs (kJ/kg/d)	372,4			271,9			194,4		
Daily growth (g/kg/d)	22,5			13,2			7,3		
Dietary energy (kJ/g)	18	20	22	18	20	22	18	20	22
Diet intake (g/kg/d)	20,7	18,6	16,9	15,1	13,6	12,4	10,8	9,7	8,8
Protein needs (g/kg/d)	10,3			6,3			3,7		
Dietary protein level (g/Kg)	498	553	609	416	463	509	342	380	418
Protein / Energy Ratio (g/MJ)	27,7	27,7	27,7	23,1	23,1	23,1	19,0	19,0	19,0
Expected FCR	0,92	0,83	0,75	1,14	1,03	0,94	1,47	1,32	1,20

Formulation of diets with different energy and protein level for sea bream 250 g at 25ºC (Self made)

Ingredient (g/kg)	34/18	38/20	42/22
Fish meal	402	461	426
Gluten of wheat	0	0	180
Soybean meal	200	250	100
Wheat	236	57	0
Fish oil	76	111	142
Soybean oil	76	111	142
Vit-Min mixture	10	10	10
Digestible protein (g/kg)	342	380	418
Digestible energy (MJ/kg)	18	20	22
Protein / energy ratio (g/MJ)	19,0	19,0	19,0
Lipids (%)	19.8	26.9	32.7
Carbohydrates (%)	25,7	14,4	7,0

Economic analysis of feeding sea bream 250 g at 25ºC with different diets containing several protein and energy levels (Self made)

Ingredient (g/kg)	34/18	38/20	42/22
Price (€/kg diet)	0,715	0,799	0,884
Feed Conversion Ratio	1,47	1,32	1,20
Economic Conversion Ratio (€/kg fish)	1,051	1,057	1,063

¿¿ ARE THESE RESULTS APPLIED FOR ALL SEABREAM ??

1) IT IS NECESSARY TO STUDY DIFFERENT GENETIC STRAINS

2) REAL PRODUCCTION CONDITIONS

3) ALL INTERVALE OF TEMPERATURES

IS IT NECESSARY TO DETERMINE OTHER NUTRIENTES REQUIREMENTS?

YES!
ESENTIAL AMINOACID AND FATTY ACIDS NEEDS MUST BE STUDIED FOR APPROACHING TO THE OPTIMUM UTILIZATION OF SEVERAL ALTERNATIVE PROTEIN AND LIPID SOURCES

FISH AND OIL FISH ARE THE OPTIMUM PROTEIN AND LIPID SOURCES, BECAUSE THEY HAVE A GOOD DIGESTIBILITY AND A OPTIMUM EAA AND EFA

HIGH PRICE → HIGH COST OF DIETS

LIMITED SUPLY → OVEREXPLOTATION OF SEA

ALTERNATIVE SOURCES FOR INCREASING AND CHEAPENING THE FISH PRODUCTION

→ PLANT PROTEIN AND PLANT OILS

UNIVERSIDAD POLITECNICA DE VALENCIA

GAB Grupo de Acuicultura y Biodiversidad

A LOT OF PAPERS HAVE BEEN PUBLISHED STUDING ALTERNATIVE PROTEIN PLANT FOR SEABREAM, AND OTHER SPECIES, BUT THE SCHEME HAS BEEN VERY SIMPLE:

DOSE – RESPONSE TRIALS HAS BEEN DEVELOPED, USING SEVERAL SUSTITUTIONS LEVELS, WITHOUT O WITH SUPLEMENTATION OF ESSENTIAL AMINOACIDS

SUSTITUTION LEVELS OF AROUND 30% OF FISH MEAL GIVE GOODS RESULTS, BUT THE MIXTURE OF SEVERAL VEGETABLES HAVE GIVEN THE BEST RESULTS, BECAUSE AN EFFECT OF AMINOACID COMPLEMENTATION

Preliminary results of fish meal replacement in gilthead seabream (Sparus aurata) by three plant proteins (Kissil and Lupatsch, 2002)

Table 1 Experimental diet composition and proximate analysis

Diets	FM	WG	SPC	CG	25%	50%	75%	100%
Ingredients (kg^{-1} as fed)								
Fish meal	680				475	300	155	
Wheat gluten		510			60	110	150	190
Soyprotein conc.			700		65	120	160	210
Corn gluten				650	65	120	160	210
Wheat meal	200	110	24	33	173	138	121	90
Fish oil	110	190	195	180	135	155	170	180
Supplemental AAcids		45	6	42	2	10	19	30
Vitamin mix	10	10	10	10	10	10	10	10
Mineral mix		135	65	85	15	37	55	80

	FM	WG	SPC	CG	25	50	75	100
WG (g/f/d)	0,87 b	0,98 a	0,76 c	0,70 c	0,94 a	0,98 a	0,96 a	0,92 a
FCR	1,34 b	1,22 a	1,45 c	1,44 c	1,29 ab	1,21 a	1,21 a	1,26 ab

¡THANKS FOR YOUR ATENTION!