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Growth performance of sea bass fed increasing levels of pea-wheat protein in diets varying in fish meal quality

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ABSTRACT: A 11-week trial was carried out to compare the growth performance of sea bass (*D. labrax*) fed six isonitrogenous isocaloric diets where protein from two fish meals of different nutritive value was replaced with graded levels (0, 50 or 75%) of a mixture made up by a pea protein concentrate and wheat gluten. Fish meal quality did not affect (P>0.05) weight gain or feed efficiency in fish fed graded levels of plant protein in the diet. Feed intake decreased (P<0.05) as the level of plant protein was increased in the diet but this did not led to impaired growth or feed conversion rate. Protein efficiency and retention were equally improved (P<0.05) only with diets where a poor quality fish meal was substituted by protein rich-plant ingredients. Calculations based on the mass balance of nutrients of sea bass proven the inclusion of a mixture of highly purified plant-protein derivatives in complete diets for the sea bass, to be beneficial in reducing pollution load.

Key words: *Dicentrarchus labrax*, Fish meal, Plant protein sources, Growth.

INTRODUCTION – The increasing use of plant protein-rich derivatives, to spare fish meal in practical diets for carnivorous fish, stresses the need to optimize the ratio between alternate vs. conventional protein sources in terms of growth performance, feed efficiency and environmental sustainability. However, little or no information is currently available on the effects of varying fish meal quality in diets including high proportions of vegetable protein source in fish species others than salmonids (Mundheim *et al*., 2004). The study was aimed at evaluating to what extent fish meals varying in nutritive value could affect growth response and efficiency in sea bass (*D. labrax*, L.) fed complete diets with increasing proportions of highly purified and digestible protein rich-plant derivatives which were shown to be promising alternate protein sources in previous studies with sea bass (Tibaldi *et al*., 2003, 2005).

MATERIAL AND METHODS – Six grossly isonitrogenous (49.8% DM) and isolipidic (18.5% DM) pelletted preparations were formulated (Table 1). Two fish meals of different quality label (High-Chile prime *vs* Poor-Perù FAQ) were the sole protein sources in diets HF and MF, respectively. A vegetable mix (veg-mix) made up by pea protein concentrate (PPC) and wheat gluten (WGM) in the ratio 65/35 (w/w) was used to replace, 50 and 75% protein from the two fish meals in diets HFV50, HFV75 and PFV50, PFV75, respectively. Preparations containing the highest proportion of veg-mix were made not limiting in essential amino acids through adequate supplementation. Acid insoluble ash (celite®) was added as an external marker to all diets to measure feed digestibility. The six diets were randomly assigned to triplicate groups of sea bass (individual body weight: 23.3±1g) each consisting of 26 specimens, according to a factorial design combining two fish meal sources and three levels of plant protein inclusion. Fish groups kept in 250-L tanks in an indoor, partially recirculating marine water system (24.1±0.9°C, 28±2 ‰ salinity), were fed the test diets to visual satiety in two daily meals over 11 weeks. Feed intake per group was recorded daily. At the beginning and end of the trial fish were group-weighed and individual fish samples per group were killed, pooled, minced and freeze-dried for subsequent whole body composition analysis. Apparent dry matter and protein digestibility of the diets, was measured in a separate trial as described by Tulli *et al*. (2004). Proximate analysis of feeds, faeces and fish whole body were carried out according to AOAC (1990). Data were subjected to a two-way ANOVA and the Duncan's multiple range test was applied for mean comparisons at a significance level of 5% (Snedecor and Cochran, 1989).

RESULTS AND CONCLUSIONS – Growth and feed conversion rates were not affected (P>0.05) by fish meal quality in diets varying in plant protein level (Table 2). Growth response was not impaired in fish fed the highest level of veg mix. while SGR improved (P<0.05) by replacing up to 50% fish meal protein in the diet. FCR also

Table 1. Composition (g/kg), proximate analysis and gross energy (kJ/g DM) of the diets.

	HF	HFV50	HFV75	PF	PFV50	PFV75
Fish meal Chile Prime	700	350	175	-	-	-
Fish meal Perù FAQ	-	-	-	720	360	180
Veg. mix	-	303	453	-	301	452
L-met	-	-	2	-	-	2
L-trp	-	-	1	-	-	1
Pregel. wheat starch	135	151	162	113	143	158
Cod liver oil	85	111	122	87	111	122
Mineral mix *	5	10	10	5	10	10
Vitamin mix **	10	10	10	10	10	10
Binder + soy lecithin	50	50	50	50	50	50
Celite®	15	15	15	15	15	15
Moisture %	6.3	6.1	5.5	6.7	5.7	5.2
Crude protein % DM	49.2	50.0	49.7	50.1	49.7	50.1
Ether extract % DM	18.6	19.0	18.9	18.3	18.1	18.3
Starch % DM	12.9	15.3	16.7	11.1	14.7	16.1
Ash % DM	14.3	9.5	7.0	15.1	9.9	7.3
Gross energy	21.7	20.7	21.7	20.6	20.2	20.6

*Mineral mix (g/kg premix): $CaHPO_4$+2H_2O 666.7; NaCl 17.7; MgO 288.6; $FeCO_3$ 61.7; KI 4.3; ZnO 10.86; $MnSO_4$+ H_2O 0.6; MnO 8.6; CuSO 4 1.0; Na Selenite 0,04. **Vitamin mix (mg/kg diet): Thiamin HCl 40; Riboflavin 40; Pyridoxine HCl b 40; Cyanocobalamin 0.01; Niacin 300; Ca Pantothenate 50; Folic acid 5; Biotin 3; Choline chloride 3763; Myoinositol 500; stay C 200; a-tocopherol 350; Menadione 50 ; Vit. A acetate5000 UI/kg diet; Cholecalciferol 2400UI/kg diet.

improved (P<0.05) in response to increasing levels of dietary plant protein. This was somewhat a consequence of a parallel reduction in feed consumption (P<0.05) but not in digestible protein intake which resulted similar among diets first because all preparations including the mix of highly purified plant protein sources, resulted in higher apparent protein digestibility relative to fish meal-based ones (98 vs 95%, P<0.05). Besides reduced feed consumption was associated to increasing duration of a single meal (measured over three consecutive days) in fish groups fed graded levels of vegetable proteins (Figure 1). Both responses are consistent with reduced levels of dietary feeding attractants-stimulants when fish meals are substituted by plant proteins in the diet.

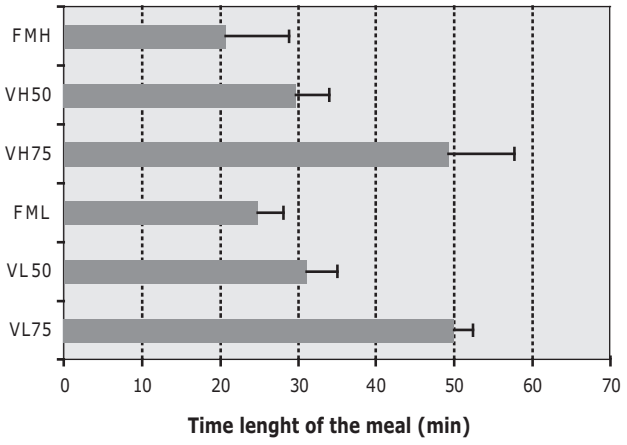
As shown in Table 3, protein efficiency indices (PER and GNR) resulted very high with all treatments. A significant interaction between fish meal quality and veg-mix level was observed in that both parameters improved (P<0.05) only when increasing levels of plant protein were used to replace the poor quality fish meal. Table 3 also presents estimates of total solids and nitrogen waste load in sea bass fed the experimental diets, as obtained from the mass balance of nutrients.

Table 2. Growth performances, feed and digestible protein intakes, feed conversion rate as affected by fish meal quality and plant protein level.

	Fish Meal quality		Plant Protein level			ems
	HF	PF	0	50	75	
Final body weight (g)	63.7	63.5	62.4b	65.3a	63.1b	1.86
Weight gain (% IBW)	164.0	164.6	160.7b	166.3a	165.8ab	18.64
Specific growth rate (SGR)	1.29	1.29	1.27b	1.33a	1.28b	0.0008
Feed intake (g/kg ABW/d)	15.15	15.12	15.42a	15.19b	14.80c	0.022
Feed conversion rate (FCR)	1.20	1.20	1.25a	1.19b	1.17c	0.0003
Dig. protein intake (g/kg ABW/d)	6.4	6.3	6.3	6.4	6.3	0.0024

a, b, c: P<0.05, 14 df.

Figura 1. Effect of the dietary treatment on the time lenght of a single meal.



A beneficial effect of replacing fish meal with graded levels of highly purified and digestible plant proteins is evident in terms of total solids wasted to the environment particularly when low-quality fish meals are being substituted. In conclusion, in sea bass fed to satiation diets not limiting in essential amino acids, fish meal quality did not affect growth response or feed efficiency, whereas protein utilisation was improved when a poor quality fish meal was replaced by graded levels of plant protein. Apart from reduced palatability, a definite mixture of pea protein concentrate and wheat gluten, which were singly shown to be highly digestible ingredients in previous studies with sea bass (Tibaldi *et al*., 2003, 2005), allowed very high levels of plant protein to be included in complete diets for this fish species with potential side effects in terms of reduction of environmental pollution as much beneficial as the poorer is the quality of the fish meal being replaced.

Table 3. Protein efficiency ratio (PER), gross protein retention (GPR) and estimates of total solid and nitrogen waste load (kg /T biomass gain) of sea bass fed the experimental diets.

	HF	HFV50	HFV75	PF	PFV50	PFV75	*ems*
PER	1.78^{a}	1.77^{a}	1.80^{a}	1.69^{b}	1.79^{a}	1.82*a*	0.0006
GNR (% N intake)	32.2^{ab}	31.4^{bc}	32.9^{a}	30.8^{c}	33.0^{a}	33.3*a*	0.462
Total solids	185	152	131	275	189	149	
Total nitrogen	57.7	59.1	60.3	60.5	56.7	59.1	

a, b, c: P<0,05, 12 df.

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