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Pea protein concentrate as a substitute for fish meal protein in sea bass diet

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RIASSUNTO – Il concentrato proteico di pisello quale sostituto della farina di pesce in diete per spigola. *L'esperimento si proponeva di valutare la risposta zootecnica della spigola (*D. labrax*) a diete complete, isoproteiche ed isocaloriche, dove un concentrato proteico di pisello (CPP) sostituiva quote crescenti (30, 60, 90%) di proteina da farina di pesce che rappresentava la sola fonte proteica nella tesi di controllo. La digeribilità dei nutrienti e dell'energia delle diete a confronto è risultata simile (P>0,05). La sostituzione fino al 60% della proteina da pesce con CPP ha dato luogo a tassi di crescita, conversione alimentare, ritenzione proteica ed energetica, sovrapponibili (P>0,05) a quelli rilevati nella tesi di controllo. Tutti i parametri di risposta sono peggiorati (P<0,05) al massimo livello di inclusione di CPP in seguito ad una marcata riduzione dell'appetibilità della dieta.*

Key words: Dicentrarchus labrax, protein sources, pea protein concentrate, growth.

INTRODUCTION – Pea seeds, even if lower in protein than oilseed meals, have been shown to successfully replace moderate amounts of fish meal protein in diets for carnivorous fish species (Kaushik *et al.*, 1993, Gouveia and Davies, 2000). A further processing of such pulses provides concentrated protein products which look very promising as fish meal substitutes in aquafeeds (Thiessen *et al.*, 2003). The aim of the present study was to evaluate nutrient digestibility, growth response, nutrient and energy retention efficiencies and whole body composition of sea bass (*Dicentrarchus labrax*, L.) fed complete diets in which a pea protein concentrate (PPC) was used to replace graded levels of fish meal protein.

MATERIAL AND METHODS – Four isoproteic (CP, 48%) and isolipidic (CL, 16%) pelletted diets were prepared (Table 1). A diet containing a white fish meal as the sole protein source (FM), was used as a control treatment and compared with diets PPC30, PPC60 and PPC90 where a pea protein concentrate (PPC, crude protein 78% - Roquette-Frères, France) was included to replace 30, 60 and 90% of fish meal protein, respectively. Acid insoluble ash (celite®) as an external marker, was added to all diets for measuring nutrient digestibility. The PPC-based diets were supplemented with L-methionine to match the dietary essential amino acid requirement profile of the sea bass (Tibaldi *et al.*, 1996). Each of the four diets was assigned to triplicate groups of 30 sea bass (initial BW, 44±1 g) according to a random design. Fish were kept in 200-L tanks at 23.5±1.0°C, 32±2 ‰, salinity and fed to visual satiety in two daily meals over 104 days. The actual feed intake in each unit was recorded daily. At the beginning and end of the trial fish were group-weighed and random samples of fish were killed by an overdose of anaesthetic than pooled, minced and freeze-dried for subsequent analysis of whole body composition. The apparent digestibility of protein and energy of each diet was measured in duplicate in a separate trial, using the indirect method (acid insoluble ash as an indigestible tracer) and settling columns for faecal collection, as described by Tulli and Tibaldi (2001). Proximate analysis of feeds, faeces and fish whole body were carried out according to AOAC (1990). Data were subjected to one-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 – All diets resulted in similar nutrient and gross energy digestibility coefficients (P>0.05, results not shown) so that replacing graded levels of fish meal protein by pea protein concentrate did not affect digestible protein and energy contents or the DP/DE ratio of the diets (Table 1).

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

	FM	PPC30	PPC60	PPC90
Danish fish meal LT	650	455	258	70
Pea protein concentrate		180	360	530
Gelatinised wheat starch	210	212	213	216
Cod liver oil	80	93	107	120
Mineral-vitamin supplement	20	20	20	20
Binder	15	15	15	15
Celite®	15	15	15	
Soy lecithin	10	10	10	
L-methionine	-	-	24	
Moisture	6.2	5.9	5.8	
Crude protein	48.2	47.7	48.3	
Crude lipid	15.0	15.4	15.5	
Gross energy	21.4	22.0	22.5	
Dig. Protein (DP % DM)	46.4	46.4	47.0	
Dig. Energy (DE kJ/g DM)	20.8	21.1	21.8	
DP/DE (gkJ-1)	22.3	22.0	21.6	

As shown in Table 2, replacing FM protein for PPC up to 60%, did not influence diet palatability while a marked depression in the absolute feed intake (P<0.05) occurred in fish fed the highest level of PPC in the diet. Growth performance, (e.g., final weight, weight gain, specific growth rate-SGR) were also reduced in sea bass given diet PPC90

(P<0.05) relative to the other treatments which did not differ among each other. The same classification by diet was observed in terms of feed conversion rate (FCR), protein efficiency ratio (PER), gross protein and energy retention efficiencies (GPR, GER), which resulted impaired in fish fed diet PPC90 relative to the other treatments (P<0.05).

Table 2. Feed intake, growth performance, feed utilisation, protein and energy retention efficiencies in sea bass fed the experimental diets over 104 days.

	Dietary treatment				
	FM	PPC 30	PPC 60	PPC 90	SEM
Final Body Weight (g)	118.0a	119.7a	125.0a	93.5b	4.32
Weight gain (%)	168.8a	170.4a	183.9a	112.7b	8.873
SGR	0.95a	0.96a	1.00a	0.73b	0.032
Feed Intake (g/fish/d)	0.94a	0.95a	1.01a	0.78b	0.003
FCR	1.35a	1.40a	1.38a	1.78b	0.056
PER	1.54a	1.51a	1.50a	1.14b	0.054
GPR	26.0a	25.8a	27.8a	21.3b	1.548
GER	39.6a	35.7a	35.4a	27.7b	3.532

Means in the same row not sharing a common letter are significantly different (P<0.05). SGR: [100x(Ln fin. BW-Ln init. BW)/days]; FCR: feed intake/weight gain; PER: weight gain/crude protein intake; GPR: protein gain x 100/crude protein intake; GER: energy gain x 100/ gross energy intake.

The whole body composition of fish at the end of the experiment (Table 3) was not statistically affected by dietary treatments even if there was a tendency towards reduced overall adiposity as the level of PPC was increased in the diet.

Table 3. Whole body composition of sea bass fed the test diets for 104 days.

	Dietary treatment				
	FM	CPP 30	CPP 60	CPP 90	SEM
Protein (% DM)	43.10	43.93	45.85	45.65	1.675
Total lipid (% DM)	42.93	41.28	40.98	39.05	3.332
Energy (kJg^{-1} DM)	25.21	24.71	24.83	24.78	1.131

The results of the present study have shown the pea protein concentrate here tested to be of high nutritive value to sea bass. It could be used to replace up to 60% of fish meal protein in complete feeds, without adverse effects on nutrient digestibility, growth performance, feed conversion rate, or protein and energy retention efficiencies, providing the major essential amino acid limitations (i.e., methionine) are amended through adequate dietary supplementation. All response criteria here investigated were consistent in indicating that impaired diet palatability could represent a major limiting factor to achieve an almost complete replacement of fish meal protein for pea protein concentrate in the diet of sea bass.

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