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Effects of partial replacement of fish meal by soybean meal in sharpsnout seabream (*Diplodus puntazzo*) diet

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Abstract

We have studied the possible use of soybean meal (SM) in sharpsnout seabream diets by progressively increasing its inclusion level (0%, 20%, 40% and 60%) at the expense of fish meal in isonitrogenous (45%) and isoenergetic formulated (20 MJ/kg) diets. Fish of two different sizes (48 g and 195 g of initial weight) were kept in seawater tanks (26 °C on average) and fed to satiety until they reached a weight of 118 g and 340 g, after 64 and 91 days respectively. Feed consumption increased along with the soybean meal content of the diet, the differences becoming statistically significant in smaller animals as from 40% of inclusion. In larger animals, the diet containing the highest level of soybean meal produced the lowest final weight. As the soybean meal content increased, feeding efficiency and protein utilization of the diet decreased, an effect probably due to the smaller digestibility coefficient observed for these diets. Based on the results of the sensory test, flesh quality was very little affected, albeit fish feeding on diets with partial replacement of fish meal tended to be somewhat softer. Despite extending the fattening period required to reach the same final weight, the economic analysis indicates that inclusion of soybean meal in the diet reduces feeding costs.

Keywords: Sharpsnout seabream; *Diplodus puntazzo*; Fish meal replacement; Soybean meal; Alternative protein sources

1. Introduction

Sharpsnout seabream is a sparid fish that has drawn much attention from researchers and farmers, as it is endowed with many qualities that would make it a superb new species for culture (Caggiano et al., 1993). Pilot pre-growout and growout studies have been conducted, both under intensive (tanks and floating cages) and extensive (pools) culture conditions (Bermúdez et al., 1989; Divanach et al., 1993; Abellán et al., 1994; Gatland, 1995), with highly encouraging results, very similar to those of gilthead seabream. Some farms are already offering this species commercially.

Feeding costs make up a large percentage of the total expenses of an intensive aquaculture facility; and for those trying to culture new species, achieving a competitive economic performance is a high priority.

Available data show that currently about 30% to 50% of fish meal can be successfully replaced in fish feeds by plant protein sources (Francis et al., 2001), although

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Table 1
Composition of experimental diets (g kg^{-1}diet)

Ingredients	Diet			
	0% SM (Control)	20% SM	40% SM	60% SM
Fish meal	482	373	264	155
Soybean meal	0	200	400	600
Wheat meal	318	221	124	27
Idros-P[a]	95	95	95	95
Fish oil	100	106	112	118
Vitamin–mineral mix[b]	5	5	5	5

[a]Amino acid hydrolysate to make feed more compact.
[b]Vitamin and mineral premix meeting NRC (1993) recommendations.

there may be important differences depending on the species. Some studies reveal that total replacement is possible at least in rainbow trout (Kaushik et al., 1995; Watanabe et al., 1998), whereas data on gilthead seabream are not so conclusive (Robaina et al., 1995, 1998). Many studies have shown considerable success in partially or totally replacing fish meal with soybean meal and other soybean products in diets for various fish species (Olli et al., 1995; Boonyaratpalin et al., 1998; Quartararo et al., 1998; Arndt et al., 1999). Yet, other authors report that high inclusion levels of full-fat and solvent-extracted soybean meal reduce weight gain and feed efficiency (Oliva-Teles et al., 1994; Olli and Krogdahl, 1994, 1995; Olli et al., 1994b; Rumsey et al., 1994a; Kaushik et al., 1995; Hardy, 1996; Refstie et al., 1998), and cause morphological changes in the distal intestinal epithelium (Rumsey et al., 1994a,b; Baeverfjord and Krogdahl, 1996; Bakke-McKellep et al., 2000). Soybean meals have a high content of available protein with a well-balanced amino acid profile, a constant composition, a reasonable price, and there is a steady supply available; however, their methionine level is low, and they also contain approximately 30% of indigestible carbohydrates, and several compounds or anti-nutritional factors that may disturb the digestive process (Olli et al., 1994a; Storebakken et al., 2000), as many of them have been reported to hinder digestion in rainbow trout (Olli and Krogdahl, 1994; Rumsey et al., 1994b; Bureau et al., 1996).

It may well be that fish with more omnivorous feeding habits, like sharpsnout seabream (Sala and Ballesteros, 1997), could make a more efficient use of high levels of dietary soybean meal.

The aim of this work was to evaluate the impact of replacing fish meal by soybean meal in sharpsnout seabream diet on several aspects related to growth performance, nutritional use of the diet, economic performance and consumer's acceptance.

2. Materials and methods

2.1. Animals and housing

Sharpsnout seabream (*Diplodus puntazzo*) (5–15 g) were captured in the Mar Menor (Murcia, Spain) and kept at the IMIDA aquaculture facilities (San Pedro del Pinatar, Murcia, Spain) until they reached an appropriate weight. Fish were held in raceways tanks (5500 l max. volume) supplied with running seawater (37 g/l). The water flow was constantly regulated to maintain dissolved oxygen at 70% of the saturation level. Animals were kept under natural photoperiod (37°50′N, 0°46′W) and water temperature conditions, and allowed to feed to satiety three times a day, 7 days a week, with a commercial gilthead seabream diet (SKRETTING, Spain).

2.2. Experimental diets

Prior to diet formulation, the nutrient composition of the ingredients was determined. Four isonitrogenous and isoenergetic diets were formulated using commercial ingredients (Table 1) provided by DIBAQ-DIPROTEG S.A. (Spain). Soybean meal was included in the diets at levels of 20, 40 and 60%, which correspond to 23, 45 and 68% of fish meal replacement. The control diet was prepared with fish meal as the major source of protein. The ingredients were mixed and the diets prepared by cooking-extrusion with a semi-industrial twin-screw extruder (CLEXTRAL BC-45). Diet samples were subjected to proximate composition analysis, the results of which are presented in Table 2. Gross energy was determined according to the following energy coefficients (Miglavs and Jobling, 1989): 23.6 kJ/g for protein, 38.9 kJ/g lipids, and 16.7 kJ/g for carbohydrates.

Table 2
Feed composition expressed as a percentage of wet substance

	Diet							
Pellet (mm)	Experiment 1 (2 mm)				Experiment 2 (3 mm)			
Components	0% SM	20% SM	40% SM	60% SM	0 % SM	20% SM	40% SM	60% SM
Dry matter	94.8	94.5	94.0	93.7	93.9	94.0	93.9	93.9
Crude protein	40.4	39.9	38.6	38.1	44.0	43.9	44.5	45.7
Crude fat	14.4	13.9	13.8	12.6	16.8	15.0	14.7	13.6
Ash	11.2	10.7	10.6	9.6	8.2	8.1	8.1	7.9
NFE[a]	27.2	28.3	29.2	31.2	24.1	25.5	24.5	24.1
Fiber	1.6	1.7	1.8	2.2	0.9	1.5	2.1	2.6
Gross energy (MJ/kg feed)	19.7	19.5	19.4	19.1	20.9	20.4	20.3	20.1

[a] Nitrogen free extract.