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ScienceDirect
Aquaculture 263 (2007) 211–219
Aquaculture
www.elsevier.com/locate/aqua-online

Effects of total replacement of fish oil by vegetable oils in the diets of sharpsnout seabream (*Diplodus puntazzo*)

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Received 13 June 2006; received in revised form 28 September 2006; accepted 28 September 2006

Abstract

The aim of this study was to determine the impact of dietary replacement of fish oil by vegetable oils on sharpsnout seabream growth, nutritive utilization, somatic parameters, body composition, feed digestibility, and muscle fatty acid profile, as well as to make an estimate of its economic repercussions. To this end, three isonitrogenous (48% crude protein) and isoenergetic (23 MJ/kg) experimental diets were formulated, using three different lipid sources: fish oil (FO), soybean oil (SO) and linseed oil (LO). These diets were fed to triplicate groups of 30 sharpsnout seabream with an initial average weight of 14.9 g, three times a day to apparent satiation, over 92 days at 24.6±1.1 °C. Our results show that the replacement of fish oil with soybean or linseed oil in sharpsnout seabream diets does not affect growth or feed utilization after three months of feeding. Fish on an SO diet exhibited higher hepatosomatic indices, whereas fillet percentages were significantly lower in fish that had been fed an FO diet. Apparent digestibility coefficients for dry matter, crude protein and crude lipid were significantly lower in fish that had consumed an LO diet. The muscle fatty acid composition reflected that of the diet. Consumption of vegetable oils reduced the muscle content of ARA (arachidonic acid), EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) to a lower degree than their corresponding reductions in the diet after fish oil replacement, which highlights their importance. Vegetable oils also increased the muscle content of linoleic and linolenic acids. In terms of economic performance, the SO diet was the least expensive diet, and had the best economic conversion ratio.

Keywords: Sharpsnout seabream; *Diplodus puntazzo*; Fish oil replacement; Soybean oil; Linseed oil; Alternative lipid sources

1. Introduction

Sharpsnout seabream is a promising fish with many qualities that make it an excellent new species for culture (Franicevic, 1989; García Gómez and Ortega Ros, 1993; Caggiano et al., 1993; Abellán et al., 1994). This is a sparid fish, having more omnivorous feeding habits and a quality very similar to that of gilthead seabream. Pilot pre-growout and growout studies have been conducted with highly promising results, under both intensive and extensive culture conditions (Bermúdez et al., 1989; Kentouri et al., 1992; Divanach et al., 1993; Gatland, 1995). Feeding costs account for around 35–50% (García García et al., 2001; Vielma et al., 2000) of the total expenses at intensive aquaculture facilities. For those trying to culture new species, achieving a competitive economic performance is a high priority.

In just a few decades, fish farming has developed into a highly efficient industry producing animal protein for human consumption. Besides good growing conditions, having a reliable supply of effective feeds is a prerequisite

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doi:10.1016/j.aquaculture.2006.09.039

Table 1
Experimental diet composition (g kg^{-1}diet)

Ingredients	Diet		
	FO	SO	LO
Fish meal	460	460	460
Wheat meal	220	220	220
Wheat gluten	150	150	150
Cod liver oil	160	0	0
Soybean oil	0	160	0
Linseed oil	0	0	160
Vitamin–mineral premix [a]	10	10	10

[a] Vitamin and mineral premix, according to NRC (1993) recommendations for fish.

for productive and sustainable fish farming. In general, fish feed is made using fish oil as the main source of lipids, both because it has been readily available and because it has a high content of n-3 HUFA (highly unsaturated fatty acids), which are considered essential fatty acids for marine fish (Sargent and Tacon, 1999). However, even the most optimistic projections anticipate that in a few years, global fish oil production may not be enough to cover the increasing demand for animal feed. On the contrary, global vegetable oil production has increased in recent years, reaching volumes 100 times that of fish oil (Bimbo, 1990). As a result, prices for vegetable oils have been more stable and have even decreased in some markets, with some vegetable oils becoming even less expensive than fish oil. Some vegetable oils, such as soybean and linseed oil, are considered good alternative lipid sources for salmonids and freshwater fish (Bell et al., 2001; Rosenlund et al., 2001; Caballero et al., 2002). However, the use of vegetable oils as the only lipid source in marine fish feed is limited by their low ability to convert the linoleic and linolenic acids (abundant in many vegetable oils) into arachidonic (ARA), eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids, which are essential for marine fish and are found in high concentrations in fish oil. Therefore, successful replacement of fish oil with vegetable oils would reduce both the absolute dependence on this ingredient and associated costs.

Fishes with more omnivorous feeding habits, such as sharpsnout seabream (Sala and Ballesteros, 1997), may be able to use dietary vegetable oils in a more efficient manner.

Therefore, the aim of this study was to assess the effects of complete replacement of dietary fish oil by soybean or linseed oil on sharpsnout seabream growth, its nutritive utilization, somatic parameters, body composition, feed digestibility, and muscle fatty acid profile, as well as to estimate the economic impact of such a replacement.

2. Materials and methods

2.1. Animals and housing

Sharpsnout seabream (with an initial average weight of 14.3 g) were obtained from the Valle Ca Zuliani Societa Agricola S.R.L. (Pila di Porto Tolle, Italy) hatchery and kept at the IMIDA aquaculture facilities (San Pedro del Pinatar, Murcia, Spain). Fish were allowed to acclimatize in raceway-type, 5500-l open-circuit seawater tanks, feeding on a commercially available feed for gilthead seabream. Afterwards, the fish were distributed between nine 360-l cylindro-conical tanks supplied with running seawater (salinity: 37 g/l; NO^{-2}:<0.1 mg/l; NO^{-3}:<0.1 mg/l; NH_3:<0.5 mg/l; pH: 7.7). Testing conditions included 30 fish per tank, with each diet being experimentally tested in triplicate. The tanks were part of a recirculating system fitted with biological filtration, an ultraviolet lamp, and a thermostat that controlled the experimental temperature (Cerezo and García García, 2004). 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) conditions at constant temperature (24.6±1.1 °C), and allowed to feed to satiety with experimental diets (Table 1) three times a day, 7 days a week. The experiment lasted 92 days (from June to September).

2.2. Experimental diets

Based on previous works (Hernández et al., 2001, 2003), three isonitrogenous and isoenergetic diets were formulated with a lipid content of about 20%. Cod liver oil was the only lipid source added to the fish oil (FO) diet, which served as a control. For the other two diets, cod liver oil was completely replaced by either soybean oil (SO) or linseed oil (LO). The ingredients were mixed

Table 2
Proximate composition analysis of experimental diets (as % of dry matter)

Components	Diet		
	FO	SO	LO
Dry matter	85.6	88.4	89.5
Crude protein	48.7	49.2	48.6
Crude fat	21.5	21.6	21.1
Ash	10.3	8.0	7.9
NFE [a]	4.4	8.9	11.2
Fiber	0.6	0.7	0.7
Gross energy (MJ/kg of feed)	21.6	22.8	22.6

[a] Nitrogen free extract.