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Effects of lipid on growth and feed utilization of white seabass (*Atractoscion nobilis*) fingerlings

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Abstract

A study was carried out to examine the effect of lipid level on growth and feed utilization of white seabass. Fingerling white seabass (27 days old, 0.65±0.05 g, 32±3.2 mm) were fed four formulated diets with four levels of lipid (15.5%, 18%, 19.5% and 21.5% of dry matter) at one level of protein (61% crude protein, dry matter (DM) basis) for six weeks. Survival exceeded 90% for all treatments. Weight gain (g) and specific growth rate (SGR, % day^{-1}) values indicated that fish fed diets with 15.5% and 18% lipid exhibited higher growth performance. Lowest growth was recorded for fish fed diets with 19.5% and 21.5% lipid. Feed intake (FI, g $fish^{-1}$) was also significantly ($P<0.001$) affected by dietary lipid levels and tended to decrease with increasing lipid levels. However, the fish that showed the highest FI were those that were fed the 15.5% and 18% lipid diets. Feed conversion ratio (FCR) values indicated that diets containing 19.5% and 21.5% lipid were more efficiently utilized. No significant differences in muscle composition were observed among fish fed the different diets. However, there was a strong linear relationship ($P<0.05$) between dietary lipid level and liver lipid. Hepatosomatic index (HSI) increased with dietary lipid level. Results indicated that fish performed best with the diets containing 15.5% and 18% lipid when protein concentration was 61.45±0.07%. And, reduced growth and increased body fat were evident when dietary energy increased from 24.2 to 24.9 kJ g^{-1}. More work is needed to determine the precise dietary protein and carbohydrate requirements for this profitable aquaculture species.

Keywords: Dietary lipids; Growth; Feed utilization; White seabass *Atractoscion nobilis*

1. Introduction

White seabass is an important commercial and sport fish species in Southern California and Baja California, Mexico (Vojkovich and Reed, 1983). Their wide acceptance as an excellent food fish and high market value has led to over-harvesting of wild stocks in many areas (Drawbridge and Kent, 1998). Although, the production of this species for stock enhancement is now a well-controlled process that results in the release of hundreds of thousands of fingerlings annually, nevertheless, the nutritional requirements of this species have not been well defined (Kent et al., 2001). More information of this carnivorous marine species is needed

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to improve growth and feed efficiency and to minimize waste outputs to ensure economical and environmental sustainability of white seabass culture (Drawbridge and Kent, 2001).

Dietary lipid plays a major role in providing a source of concentrated energy and essential fatty acids, especially for carnivorous fish as these species have a limited ability to utilize carbohydrates as an energy source (Oliva-Teles, 2000; Sargent et al., 2002). The increase in digestible energy content of fish diets, by lipid supplementation, has been shown to have a protein sparing effect, therefore reducing nitrogen losses to the environment (Cho and Bureau, 2001). Several studies have shown that providing adequate energy with dietary lipids can minimize the use of more high-priced protein as an energy source (Peres and Oliva-Teles, 1999, 2001; Ai et al., 2004; Hung et al., 2004; Kim and Lee, 2005). So, an adequate lipid level in the diet is important for the growth performance of fish and product quality (Hamre et al., 2004; Tibbetts et al., 2005), and also for the formulation of diets (Pausa et al., 1998). The objective of the present study was to determine the effects of dietary lipid levels on growth, feed efficiency and muscle and liver composition of white seabass fingerlings.

2. Materials and methods

2.1. Diet formulation

Four isonitrogenous diets (61.5% CP) were formulated to contain four lipid levels (15.5%, 18.0%, 19.5% and 21.5% of dry matter). Formulation and proximate analysis of the diets are given in Table 1. Freeze-dried white fish muscle meal and krill meal were the major dietary protein sources. Cod liver oil and corn starch were used as lipid and carbohydrate sources, respectively. All ingredients were blended in a Kitchen Aid mixer (Hobart, Troy, OH, USA), to produce a homogeneous mixture. The wet mixture was pelleted through a 3-mm die in a commercial meat grinder and pellets were dried in a convection oven for 8 h at 65 °C. The dry pellets were placed in covered plastic bags and stored at −20 °C until use. The control diet (CD, Table 1) was a commercially available marine grower feed (Skretting, Vancouver, British Columbia, Canada) currently used in hatchery production of white seabass.

Table 1
Ingredient and proximate composition of the formulated diets and control diet (CD) (g/100 g dry weight)

Ingredients (g/100 g)	Dietary treatments				
	15.5L	18L	19.5L	21.5L	CD
Muscle fish meal [a]	56.47	57.47	58.47	59.47	
Krill meal [b]	16.76	13.95	11.14	8.33	
Cod liver oil [c]	8.66	10.97	13.28	15.59	
Lecithin	1	1	1	1	
Gelatin	5	5.75	6.5	7.25	
Corn starch	5	4	3	2	
Mineral premix [d]	4	3.88	3.75	3.63	
Vitamin premix [e]	3	2.88	2.75	2.63	
Na benzoate	0.1	0.1	0.1	0.1	
Antioxidant premix [f]	0.01	0.01	0.01	0.01	
Proximate composition: (g/100 g dry weight)					
Crude protein (N×6.25)	61.5	61.4	61.2	61.8	50.0
Crude lipid	15.5	18.0	19.5	21.5	15.1
Ash	7.5	7.4	6.4	6.1	10.8
NFE+crude fiber [g]	15.5	13.3	12.9	10.6	24.1
Gross energy (kJ g^{-1})	23.4	24.1	24.6	24.9	21.8
DP:DE ratio (g/MJ) [h]	26.8	25.9	25.2	24.8	23.8

[a] Made from white fish muscle (81.3% protein, 10.8% lipid, 6.4% ash).
[b] Krill meal (65.8% protein, 10.8% lipid, 7% ash), from Skretting, Vancouver, British Columbia, Canada.
[c] Cod liver oil.
[d] g/kg mineral premix: KH_2PO_4 320; NaH_2PO_4, 250; $Ca(H_2PO_4)_2$, 200; $MgSO_4.7H_2O$, 150; calcium lactate, 35; ferric citrate, 25; NaCl, 10, $ZnSO_4.7H_2O$, 3.53; $MnSO_4.H_2O$, 1.62; $CuSO_4.5H_2O$, 0.31; $CoCl_2.6H_2O$, 0.01; crystalline silica, 17.0.
[e] g/kg vitamin premix: inositol, 256.39; choline chloride, 149.78; niacin, 51.28; riboflavin; ρ-amino benzoic acid, 25.53; pantothenic acid, 17.92; β-carotene, 9.39; menadione, 6.11; thiamin-HCl, 3.85; pyridoxine, 3.06; folic acid, 0.96; biotin, 0.39; cholecalciferol, 25793 IU, α-tocopherol, 25643 IU; vitamin B_{12}, 5.59 mg.
[f] Butylatedhydroxytoluene.
[g] Nitrogen free extract (NFE)+crude fiber=100−(% crude protein +% total lipid+% ash).
[h] Digestible protein:digestible energy (DP:DE).

2.2. Animals and husbandry

A total of 750 white seabass, *Atractoscion nobilis*, fingerlings (27 days old, 0.65±0.05 g, 32±3.2 mm) were randomly distributed among 15 square plastic tanks at a stocking density of 50 fish per tank. Each tank of 60 l was supplied with recirculated seawater with a sand filter and a biofilter at a flow rate of 1.46 l min^{-1}. The photoperiod, temperature and salinity of the seawater in the tanks were maintained at 14:10 h (fluorescent light), 23±0.5 °C and 33‰, respectively.

Fish were acclimated in the system for one week before beginning the feeding trial. During this period, the fingerlings were fed the 15.5% lipid diet. Each dietary treatment was assigned to three tanks in a completely randomized design. Fish were fed to apparent satiation, four meals per day (0700, 1200, 1700 and 2200 h), 7 days per week for 6 weeks. Satiation was