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Evaluation of Smoked Skipjack Processing Byproduct Meal as an Alternative Feed Ingredient for Juvenile Humpback Grouper *Cromileptes altivelis*

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ABSTRACT

This study aimed to evaluate the utilization of smoked skipjack processing byproduct meal (SPBM) to reduce the use of fish meal (FM) for juvenile humpback grouper *Cromileptes altivelis*. This study consisted of digestibility test of SPBM and biological test to observe growth performance. Five isonitrogenous and isocaloric experimental diets were used: Diet A contains 0% SPBM as a control diet, and diets B, C, D, and E contain 25%, 50%, 75%, and 100% of SPBM protein to substitute FM, respectively. Digestibility trial was performed for 14 days by adding Cr_2O_3 into the experimental diets and collecting fecal matter 40–60 minutes after each feeding. For growth trial, juvenile humpback grouper were kept in glass aquariums and fed by the experimental diet until apparent satiation for 60 days. Our result shows that the dry matter and protein SPBM apparent digestibility coefficient is lower compared to FM. The fish that was fed with diet B and C performed a comparable specific growth rate, feed efficiency, and protein retention compared to control ($p > 0.05$). However, lower specific growth rate, feeding efficiency, and protein retention were observed in fish that was fed with diet D (75% SPBM) and diet E (100% SPBM; $p < 0.05$). These results indicate that up to 50% of smoked SPBM can be used for the diet of humpback grouper.

1. Introduction

Humpback grouper *Cromileptes altivelis* is a commercially important marine finfish in Indonesia with a strong market demand in global market. This species is listed as threatened species by the International Union for Conservation of Nature because of overexploitation (Shapawi *et al.* 2008), and thus, expanding culture activity of humpback grouper will fulfill market demand and in the same time protect its natural population. Farming of this species are done around areas such as: Riau Island, Lampung, Bali, East Java, North Sulawesi, and Lombok (Alfero *et al.* 2010) with the selling price of this species reported to reach US$ 50/kg (Harianto 2009).

Aside from the marketing visibility, humpback grouper culture is still facing some issues because this industry still mainly uses trash fish as a feed source. The use of trash fish is strongly discouraged on the grounds of inconsistency of its supply and quality, high risk of infecting pathogen (Kim *et al.* 2007), and increase of nitrogen and phosphorus pollution (Islam 2005; Pomeroy *et al.* 2006). Therefore, there is an urgent need to develop a formulated diet that not only fulfills the species' biological requirement but also produces low waste outputs for a better and more sustainable practice of humpback grouper culture.

The development of practical diets for grouper has been initiated by many researchers (Usman *et al.* 2005; Tuan & William 2007). The research shows that grouper requires around 48%–55% of protein and 12%–18% lipid in the diet. Protein requirement of aquaculture species is determined by the compatibility of amino acids profile of the cultured organism. To date, fish meal (FM) has been considered as the best protein source for aquaculture feed because it has high protein level and suitable amino acid content. With the increasing growth of global aquaculture production, aquaculture industries now consume >80% of FM and fish oil as their feed ingredients (Tacon & Matian 2008). However, most forage fish, which are source of FM and fish oil, are now in the stage

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of fully exploited, overexploited, or in the process of recovering from overexploitation (Alder *et al.* 2008). Therefore, the use of FM-based diet is not considered as sustainable aquaculture practice. With this aforementioned issue, there is an urgent need to find suitable alternatives protein source to replace or reduce the use of FM. The alternative protein source must fulfill the following requirements, e.g. local based, considered as byproduct materials and not containing hazard materials.

Smoked skipjack processing byproduct meal (SPBM) is considered as a potential alternative to substitute FM in aquafeeds. According to the Indonesian Ministry of Marine and Fisheries Affair (2009), skipjack production in 2008 was 301.531 ton and only 68.304 ton was processed to smoked skipjack because of the high amount of byproduct. Proximate analyses show that byproduct of smoked skipjack (SPBM) meal contained 55% protein, 3%–4% lipid, and 42% ash content and may be used to substitute FM. Given the abundant availability of the ingredient, the aim of this study was to assess the possibility of SPBM meal as an FM replacement ingredient in the diet of humpback grouper.

2. Materials and Methods

2.1. Experimental fish

Fish that was used for this study is a juvenile humpback grouper with an initial average body weight of 7.8 ± 0.04 g and body length 7.6 ± 0.10 cm. This fish was obtained from Marine Research Center Hatchery of Gondol Bali, Indonesia, and was acclimated with both laboratory condition and experimental diet for 7 days before experimentation.

2.2. Experimental diet

2.2.1. Digestibility trial

Digestibility test for FM and SPBM was performed by indirect methods as described in Watanabe (1998). Chromic oxide at the level of 0.5% was added as an indicator to determine total and protein apparent digestibility coefficients (ADC). Commercial diet with 49% crude protein content was used as reference diet. The formula and proximate composition of experimental diets for digestibility test are presented in Table 1.

2.2.2. Growth trial

Five isonitrogenous and isocaloric diets were formulated to contain 48% protein and 4.5 cal/g diets. As a control diet, 100% protein in the diet was provided by fish meal, whereas in treatment diets B, C, D, and E, SPBM contributed 25%, 50%, 75% ,and 100% of the diet total protein, respectively, in substitution of FM protein.

Table 1. The formula and proximate composition of experimental diets for digestibility test

Material	Composition (%)		
	Reference	FM	SPBM
Diet A	94.5	64.5	64.5
Binder	5.0	5.0	5.0
Cr_2O_3	0.5	0.5	0.5
FM	0.0	30.0	0.0
SPBM	0.0	0.0	30.0
Total	100	100	100
Proximate composition			
Crude protein	46.3	50.4	47.5
Crude lipid	15.8	14.8	12
NFE	11.02	8.3	7.7
Fiber	6.7	5.9	6.1
Ash	19.9	20.5	27.1

FM = fish meal; NFE = nitrogen-free extract; SPBM = skipjack processing byproduct meal.

Feed macromaterials were milled to get 70-μm particle sizes. Pelleting was performed to get a pellet size of 2 mm in diameter and 2 mm in length; thereafter, the pellet was dried at 60°C for 24 hours. The formula and proximate composition of the experimental diets are presented in Table 2.

2.2.3. Rearing condition

Juvenile fish was obtained from Marine Research Center Hatchery of Gondol Bali, Indonesia. Fish were acclimated to laboratory condition for 10 days before experimentation.

Fish for digestibility test were reared in glass aquarium (100 × 50 × 40 cm) at a density of 10 fish and fed with experimental diet to satiation level. Feces collection was started after 7 days of feeding acclimation. The feces were collected twice a day, 1 hour after feeding for 14 days. Subsequently, the feces were dried and stored at −20°C until further analysis. The total and protein ADC for the SPBM and fish meal were calculated according to Watanabe (1988).

After adaptation period, the fish for biological test were starved for 24 hours. Fish with an average body weight of 7.80 ± 0.04 g were reared in glass aquaria (50 × 50 × 40 cm) previously filled with 80-L chlorinated sea water and arranged in a recirculating system. The fish were stocked at a density of seven fish/aquarium. Water temperature was maintained at 29 ± 1°C using water heater. Fish were fed three times daily to satiation for 60 days experimental period, and total daily feed consumption was recorded. Water quality was maintained by siphoning the fecal material out two times daily before feeding time. At the end of the rearing period, fish were starved for 24 hours, weighed, and stored at −20°C until further analyses.

For total ammonia nitrogen measurement, the remaining fish of each treatment were collected together and reared on an aquarium at a density of 10 fish and fed for 3 days at the level of 5% of biomass. One hour after feeding, all fish were transferred to new aquarium and all aerations were stopped. Samples of sea water were taken at 0, 2, 4, 8, and 16 hours.

During experimental period, dissolved oxygen was found to be stable at a concentration of 5 mg/L (Oxygen meter, YSI Model 57; YSI Industries, Yellow Spring, OH, USA) and salinity was 30–31 g/L (Hand Atago refractometer).

Table 2. Feed composition, proximate analysis, energy, Ca, P, and Fe of experimental diets (%)

Feed ingredients	Substitution of FM by SPBM protein (%)				
	(A) 0	(B) 25	(B) 50	(D)75	(E) 100
FM*	35.0	26.3	17.5	8.8	0,0
SPBM†	0.0	10.4	20.7	31.1	41.5
SBM, SHM, PBM, Pollard	50.0	48.3	46.8	45.1	43.5
Fish oil	8.0	8.0	8.0	8.0	8.0
Vitamin and mineral mix	7.0	7.0	7.0	7.0	7.0
Proximate composition (% dry weight)					
Crude protein	48.9	48.6	48.1	48.1	48.1
Crude lipid	16.7	15.8	15.1	14.4	14.6
NFE	11.7	10.4	9.1	7.1	6.3
Fiber	2,0	2.0	2.1	2.2	2.2
Ash	21.1	23.4	25.8	28.3	29,0
Energy (kcal GE‡/100 g)	481.0	465.6	449.4	435.5	433.7
C/P (kcal/g protein)	9.8	9.6	9.4	9.1	9.1

FM = fish meal; NFE = nitrogen-free extract; PBM = poultry byproduct meal; SBM = soybean meal; SHM = shrimp head meal; SPBM = skipjack processing byproduct meal. Q8

* Fish meal: 62.8% crude protein, 13.3% lipid content.;

† SPBM: 53% crude protein, 3.86% lipid content.;

‡ GE (gross energy), protein: 5.6 kcal/g; lipid: 9.4 kcal/g; carbohydrate: 5.1 kcal/g (Halver, 2002)..

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