Replacement of fishmeal with soybean meal for the diet of seabass, *Lates calcarifer*

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Abstract. Fishmeal is one of the essential raw materials in the fish diet, and this material is expensive and rarely available in the rural area. Therefore, the present study aimed to explore the possibility to replace the fishmeal with the soybean meal in the diet of Asian seabass *Lates calcarifer*. The study was conducted from November 2018 to January 2019 at Center for Brackish Water Aquaculture in Ujung Batee, Aceh Besar District, Indonesia. The completely randomized experimental design method was used in this study with six treatments and four replications. The tested treatment was the replacement proportion of fish meal with the soybean meal in the diet, namely: 0%, 20%, 40%, 60%, 80%, and 100%. The experimental fish were stocked at one fish per liter of seawater. The fish were fed on the experimental diet at feeding level of 10% body weight two times a day. The results showed that the proportion of the soybean meal in the diet gave the significant effect on the weight gain, specific growth rate, feeding conversion ratio and feed efficiency (P<0.05), but did not provide the considerable impact on the survival rate (P>0.05). In conclusion that approximately 40% of the fish meal can be replaced with soybean meal for Asian seabass diet.

1. Introduction

Seabass, *Lates calcarifer* is one of the commercial marine fish in Indonesia. Presently, the seabass production came from the wild (capture) and aquaculture. The total production of the seabass in 2010 was 0.1 million tons where the aquaculture was contributed 7,500 tons [1], and these values were very scare compared to other marine species in Indonesia. One of the problems in seabass culture is higher in production cost, especially for the feed. This is because of the seabass feed has higher protein content which contributed mostly from the fishmeal. On the other hand, the production of fishmeal worldwide was stagnant even tend to decrease [2]. This condition resulted in decreasing the supply and increasing the price. Therefore, it was very urgent to explore the alternative protein sources from plant-based protein [3] and soybean meal is one of the promising sources for replacing the fishmeal in the fish diet[4-6]. Soybean meal is cheap compared than fishmeal, and this meal has higher crude protein content (43-48 % crude protein) with the balances of amino acid composition [7] compared to others plant-based protein sources [8-10]. However, the soybean meal had the antitrypsin that can...
inhibit the growth of the fish [11]; therefore the application of the soybean meal in the fish diet must be a certain level or may not exceed the tolerance limits.

The substitution of the fishmeal with soybean meal has been successfully applied on several species of fish, for example in grouper *Plectropomus leopardus*[9], and snakehead fish *Channas triata*[12]. However, no study on seabass (*L. calcarifer*) was conducted previously. Therefore, the objective of the present study was to evaluate the optimum proportion of the soybean meal in replacing the fishmeal in the diet of the seabass.

### 2. Materials and Methods

#### 2.1. Experimental design and diet

The completely randomized experimental design with six treatments of replacement proportion and four replications were used in this study. The tested treatment was (A) 0% soybean meal + 100% fishmeal, (B) 20% soybean meal + 80% fish meal, (C) 40% soybean meal + 60% fishmeal, (D) 60% soybean meal + 40% fish meal, (E) 80% soybean meal + 20% fish meal, (F) 100% soybean meal + 0% fish meal. The experimental diet was contained 41% crude protein, and the compositions of the raw materials of experimental diets were presented in Table 1.

#### Table 1. The raw materials and its proportion of the experimental diet used in this study

| Raw materials  | A (0)  | B (20%) | C (40%) | D (60%) | E (80%) | F (100%) |
|---------------|--------|---------|---------|---------|---------|----------|
| Fishmeal      | 450    | 360     | 270     | 180     | 90      | 0        |
| Soybean meal  | 0      | 90      | 180     | 270     | 360     | 450      |
| Casein        | 240    | 260     | 260     | 270     | 290     | 310      |
| Starch        | 30     | 30      | 30      | 30      | 30      | 30       |
| Cornmeal      | 80     | 80      | 80      | 70      | 60      | 50       |
| Fine bran     | 100    | 80      | 80      | 80      | 70      | 60       |
| Fish oil      | 70     | 70      | 70      | 70      | 70      | 70       |
| Vitamins mix  | 20     | 20      | 20      | 20      | 20      | 20       |
| Minerals mix  | 10     | 10      | 10      | 10      | 10      | 10       |
| Total (g)     | 1000   | 1000    | 1000    | 1000    | 1000    | 1000     |

Note: SBM = Soybean meal, FM = Fishmeal

#### 2.2. Experimental fish and feeding

The fish was purchased from Center for Brackish Water Aquaculture in Ujung Batee, Aceh Besar, Indonesia. The fish size ranges 3-5 gram in body weight and 5-7 cm total length. The fish were stocked into a plastic container with 10 L of seawater at a stocking density of 10 fish per container (one fish per liter of sea waters). The fish was fed on an experimental diet two times a day on 9 AM and 3 PM at feeding ration of 10% body weight for 60 days. The total weight gain of the fish was monitored 10 days interval by measured and weighed all of the fish samples in every container. The unconsumed feed and feces were siphoned two hours after feeding, while the loose water was refilled.

#### 2.3. Measured parameters

The weight gain was calculated based on Muchlisin et al.[13,14] as follow:

\[ WG = Wt - Wo \]
Where WG is weight gain (g), Wo is the body weight at the start of experiment (g), Wt is the body weight at the end of experiment (g).

The specific growth rate was calculated based on Zonneveld et al. [15] as follow:

$$SGR = \left( \frac{(\ln W_t - \ln W_o)}{t} \right) \times 100$$

Where SGR is specific growth rate (% day\(^{-1}\)), t is experimental duration (day).

The survival rate was calculated based on Muchlisin et al. [13, 16] as follow:

$$SR = \left( \frac{N_0 - N_t}{N_0} \right) \times 100$$

Where SR is survival rate (%), \(N_0\) is total fish at the start of experiment and \(N_t\) is the total of fish at the end of the experiment.

The feed conversion ratio was calculated based on Goddar [17] as follow:

$$FCR = \left( \frac{F}{W_t - W_o} \right)$$

Where FCR is Feeding Conversion Ratio (%), Fish total of feed during of the experiment (g).

While, the feed efficiency was calculated based on Muchlisin et al. [13] as follow:

$$FE = \frac{1}{FCR} \times 100$$

Where EP is feed efficiency (%), FCR is feed conversion ratio.

### 2.4. Data analysis

The data were subjected to the one-way analysis of variant (one-way ANOVA) test and followed by Duncan's multiple range tests.

### 3. Results and Discussion

The one-way ANOVA test showed that the proportion of the soybean meal gave the significant effect on the weight gain, specific growth rate, feed conversion ratio and feed efficiency (P<0.05), but did not give a significant effect on the survival rate (P>0.05). Based on Duncan's multiple range test showed that the best weight gain has resulted in treatment C (40% Soybean meal), this value was significantly different from other treatments. The higher specific growth rate was also recorded at fish fed on 40% soybean meal (treatment C), but this value was not different significantly with treatment A (0 soybean meal) and treatment B (20% soybean meal) (P>0.05). The feed conversion ratio and feed efficiency were also recorded at treatment C, but the values were not significantly different with treatment A, B, and D (P>0.05). However, the higher survival rate was found at fish fed without fishmeal, but this value was not different significantly with other treatments (P>0.05; Table 2). The growth trend of every treatment was presented in Figure 1. The water temperature ranges from 27 to 30 °C, pH 7.3 to 7.9, dissolved oxygen ranges from 5.50 to 6.45 ppm, and the salinity ranges 31 to 33 ppt.

The study showed that the fishmeal could be replaced by soybean meal as much as 40% without gave the negative effect; however, at the higher level above this value will inhibit the growth performance and feed utilization of seabass *L. calcarifer*. According to Baeverfjord and Krogdahl, [18], the soybean meal contains the anti-nutrition such as trypsin inhibitor, hemagglutinins, phytate,
allergens, oligosaccharides, lectins, saponin, and isoflavones. On the hand, the fish meal has a good amino acids composition [10].

In treatments A and B although they contain a lot of fishmeal, but the fish growth is lower than treatment C. This may be due to feed that only uses fish meal has incomplete and unbalance amino acids composition, so it is necessary to add another source of plant-based protein sources so thus the composition of amino acids will be more complete and balances, resulting in higher growth performance and good feed utilization as recorded in treatment C of this study. The water quality parameters during the experiment were still at the optimum level for fish marine fish [19].

Table 2. Growth performance, survival rate, feed conversion ratio, and feed efficiency of seabass *Lates calcarifer* fed on the experimental diet for 60 days. The mean±SD value at the same row with different superscript are significantly different at 95% confident level (P<0.05)

| Parameter     | Composition of the raw materials |
|---------------|----------------------------------|
|               | A (0) | B (20%) | C (40%) | D (60%) | E (80%) | F (100%) |
| WG (g)        | 1.13±0.15c | 1.14±0.10c | 1.32±0.13d | 0.83±0.11b | 0.86±0.10b | 0.54±0.13a |
| SGR (% day⁻¹) | 0.44±0.07c | 0.43±0.02c | 0.49±0.04c | 0.31±0.03b | 0.35±0.06b | 0.23±0.06a |
| SR (%)        | 65.0±5.77c | 65.0±5.77c | 70.0±0.00a | 70.0±0.00a | 60.0±11.54a | 75.0±10.0a |
| FCR           | 2.26±0.19ab | 2.13±0.22a | 2.06±0.15a | 2.23±0.21ab | 2.47±0.15bc | 2.70±0.07c |
| FE (%)        | 44.61±4.05bc | 47.23±5.08c | 48.91±3.26c | 44.6±4.21bc | 40.7±2.44ab | 37.06±0.97a |

Note: WG= Weigh gain, SGR= Specific growth rate, SR= Survival rate, FCR= Feed conversion ratio, FE= Feed efficiency

![Figure 1](image)

**Figure 1.** The growth trend of the seabass at different feeding trial

**Conclusion**
The fishmeal in the diet of seabass *L. calcarifer* can be replaced by soybean meal as much as 40% without gave the negative effect on the growth performance and feed utilization.

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