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Enrichment of feed for growth of cantang grouper (*E. fuscoguttatus* x *E. lanceolatus*) in floating cages

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Abstract. Grouper (*Epinephelus* sp.) is one of the superior species in the development of marine culture in Indonesia which has high economic value and has become an export commodity. One of the factors that influence production results in aquaculture is feed. Good quality of feed is crucial for fish survival and growth. Therefore, the feed given to cultured fish must be able to meet all the nutrients needed. One way that can be used to improve nutrition in feed is enrichment. This study aims to determine the enrichment of feed on the growth of cantang grouper by addition multivitamins to the feed. Cantang grouper reared in two floating net cages; one is given artificial feed without enrichment and the other one with multivitamin enrichment. The multivitamin dose for enrichment is 0.3%. Sampling was carried out by measuring the weight and length of 10 fishes every seven days from each floating net cage. The growth of cantang grouper which was given a multivitamin enrichment in the feed showed a growth rate 2.53 grams/day, length of growth 0.055 cm/day, feed efficiency was 29.4% higher and FCR was 3.4 lower compared to the grouper without enriched feed.

1. Introduction

Grouper fish (*Epinephelus* sp.) is one of the superior species in the development of marine culture in Indonesia. Grouper aquaculture is generally conducted in floating net cages located in offshore waters [3]. One of the factors that affect the production results of aquaculture is feed. Good quality feed will determine the survival and growth of fish, so the feed given to cultured fish must fulfill all the nutrients needed by fish [12]. One manner that can be used to improve nutrition in feed is through feed enrichment.

Feed enrichment is the activity to add additional substances to the feed for some purposes. The ingredients that can be added is vitamin. The feed enrichment with the addition of vitamins can affect the growth of fish. This is according to the statement of [9] which states that as one of the micronutrients needed in feeds, the vitamins needed are few but have a significant role for fish growth and survival. One of the vitamins that has important role to increase the fish growth rate is vitamin C. According to [7] the growth rate of fish will be higher if the vitamin C in the feed is increased according to the need of the fish, this also will increase the value of feed efficiency in fish. there is



also vitamin B complex to maintain fish health. In accordance with the statement [5] that the B complex vitamin has role as metabolic enzyme cofactor so that it is able to maintain a healthy body. The purpose of this study is to determine the effect of feed enrichment for the growth of cantang grouper fish in floating net cages by adding multivitamin.

2. Materials and methods

2.1. Fish

The fish used to be tested in this research is cantang grouper that are developed in floating net cages in the Brackish Water Aquaculture Fisheries Office, Situbondo, East Java. Cantang grouper are placed in floating net cages with size of length 12-15 cm and weight 35-50 grams.

2.2. Rearing of cantang grouper in floating cages

The floating net cages used in this research were 2 floating net cages with a size of 3 m x 3 m x 3 m and a size of 4 m x 4 m x 4 m. The density of cantang grouper in each cage is 300-400 fishes/cages for the size of 3 m x 3 m x 3 m and for 400-500 fishes/cages for the size of 4 m x 4 m x 4 m.

2.3. Feed and additives

The material used in the feed enrichment research for the growth of cantang grouper in floating net cages is commercial feed with 45% of protein (Table 1) multivitamin, and binder (progol). The multivitamin used for feed enrichment includes several vitamins including: vitamin A, vitamin B complex, vitamin C, vitamin D, and vitamin E. The multivitamin dose used is 3 g/kg of feed (0.3%). The artificial feed used is commercial feed with nutritional content as shown in Table 1.

Table 1. Nutrients in commercial feed of the cantang grouper

Type of feed	Nutrient content					
	Protein (%)	Fat (%)	Crude fiber (%)	Ash (%)	Water content (%)	Carbohydrates (%)
Pellets	45	10	2	13	10	-

2.4. Feed enrichment method

The feed enrichment method is started with making enrichment solutions by dissolving multivitamins and binder (progol) in 1 L of fresh water for 25 kg of feed. The dose of vitamin used was 0.3% or 3 grams for 1 kg of feed. The ingredients were mixed together in the feed to be enriched, then stirred with hand until all feed is mixed with enrichment solution.

The feed that has been mixed with the enrichment solution was then placed in a drying container and then flattened and then dried. Drying the feed is not allowed to be exposed to direct sunlight because it will cause the oxidation of fatty acids that could cause rancidity in the feed. Feed that has dried can be packaged in the original sack of feed and stored in a place that is not humid. Packaging of feed that had been enriched in the sack did not need to be tied back. This is to avoid the occurrence of rancidity in the feed. The save period of enriched feed was only for 1 day. Beside being repackaged, feed that has been enriched can be directly given to the grouper.

2.5. Feeding

The feeding frequency on the development of cantang grouper fish in floating net cages is 2 times a day, at 08.00 WIB and at 11.00 WIB. While the method of feeding the fish in an *ad satiation* manner is that the feed is given little by little until the fish no longer want to eat the feed, so that the feed given is not excessive. The total of feed given is usually around 10-15% of fish biomass.

2.6. Measurement parameters

The parameter measured in this research includes the length growth, weight growth, specific growth rate, feed conversion/feed conversion ratio (FCR) and feed efficiency.

- Growth of length and weight
Measurement of Length and weight are conducted every 7 days for 1 month rearing of cantang grouper. To calculate growth in length and weight using formula:

$$\text{Length} = \frac{P_t - P_o}{t}$$

P_t = Final length of fish (cm)
 P_o = Initial length of fish (cm)
 t = Observation time (day)

$$\text{GR} = \frac{W_t - W_o}{t}$$

GR = Growth Rate (gram / day)
 W_t = Final weight of fish (gram)
 W_o = Initial weight of fish (gram)
 t = Observation time (days)

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

SGR = Specific Growth Rate (%)
 W_t = Final weight of fish (gram)
 W_o = Initial weight of fish (gram)
 t = Observation time (days)

- Feed conversion ratio and feed efficiency
Calculation of feed conversion value, feed efficiency, and survival are conducted at the end of culture. The formulas used to calculate feed conversion ratio and feed efficiency are:

$$\text{FCR} = \frac{F}{(W_t + D) - W_o}$$

FCR = Feed Conversion Ratio
 F = Amount of feed consumed (grams)
 W_t = Final weight of fish (grams)
 D = Weight of dead fish (grams)
 W_o = Initial weight of fish (grams)

$$\text{FE} = \frac{W_t - W_o}{F} \times 100\%$$

FE = Feed efficiency (%)
 W_t = Final weight of fish (gram)
 W_o = Initial weight of fish (gram)
 F = Total weight of feed during maintenance (grams)

2.7. Water quality

The water quality measuring in floating net cages for the care grouper is conducted every once a week. The water sample were tested at a fish health and environmental laboratory. The results of the measurement of water quality of the culture media of grouper in floating cages, that are temperature 26-29°C; pH 8,275-8,365; 34 ppt salinity; DO 4.84-5.93 mg/l and ammonia <0.014 mg/l. The water quality of the culture media of grouper fish is still within the optimal range for grouper growth.

3. Results and discussion

3.1 Results

The results of feed enrichment on the growth of cantang grouper in floating cages obtained data of weight growth (Table 2) and length growth (Table 3).

Table 2. Weight growth of grouper in floating cages

Treatment	Average of weight (gram)				GR (gram/day)	SGR (%)
	t-0	t-7	t-14	t-21		
With Enrichment	387	404	454	480	2.53	0.575
Without Enrichment	387	401	449	459	2.4	0.569

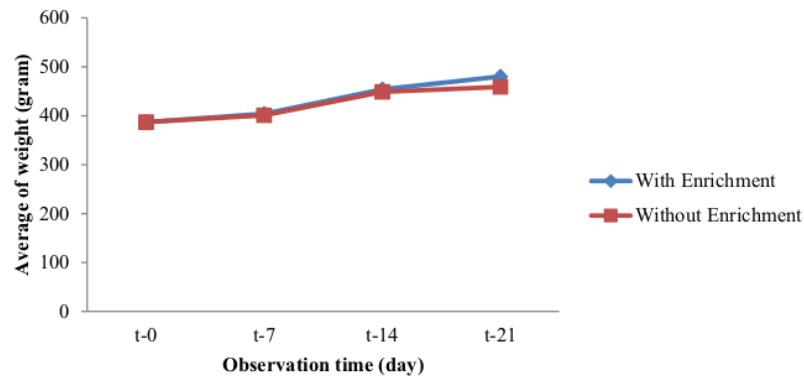


Figure 1. Growth chart of cantang grouper

The weight measurement, resulted that the average final weight of the cantang grouper that given enrichment was higher with an increase in weight of 2.53 grams/day or 0.575%. While the average final weight of the cantang grouper without enrichment was lower with an increase in weight of 2.4 grams/day or 0.569%. The value of growth rate obtained gives the value of feed conversion and feed efficiency as listed in Table 4.

Table 3. The length growth of cantang grouper in floating cages

Treatment	Average of length (cm)				Length (cm/day)
	t0	t7	t14	t21	
With Enrichment	26.05	27.27	21.11	28.91	0.055
Without Enrichment	26.05	26.15	26.47	27.2	0.038

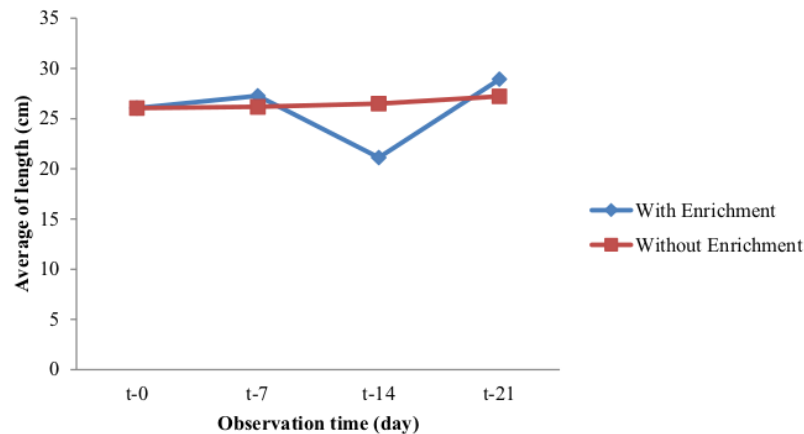


Figure 2. Growth chart of cantang grouper length

The length measurement, resulted that the average final length of the cantang grouper that given enrichment was higher with an increase in length of 0.055 cm/day. While the average final length of the cantang grouper without enrichment was lower with an increase in weight of 0.038 cm/day.

Table 4. The growth of FCR (Feed Conversion Ratio) and FE (Feed Efficiency) parameters of cantang grouper

Treatment	FCR	FE (%)
With Enrichment	3.4	29.4
Without Enrichment	3.57	28.01

Cantang grouper with enrichment results in a lower feed conversion value (FCR) of 3.4 compared to cantang grouper without enrichment which is 3.57. While the value of feed efficiency of cantang grouper with enrichment is higher was 29.4% compared with cantang grouper without enrichment was 28.01%.

3.2 Discussion

From the Figure 1 and 2, it can be seen that the growth (the increase of weight and length) of the cantang grouper in floating cages at BPBAP Situbondo which is given food enrichment for 30 days is bigger than the growth of the grouper that are not given enrichment. The high value of growth rate in the grouper which is enriched is because of the influence of the multivitamin added in the feed.

One of the vitamins that has important role to increase the fish growth rate is vitamin C. According to [7] the growth rate of fish will be higher if the vitamin C in the feed is increased according to the need of the fish, this also will increase the value of feed efficiency in fish. Beside, to increase the rate of growth, the addition of vitamin C to the diet also has function as immunostimulant. According to the statement [4] which states that vitamin C is one of the important feed nutrients that really determines the rate of growth and endurance of fish. Beside its role in the metabolic process, vitamin C also plays role as immunostimulant that can increase the body resistance of fish. [6] is also

mentioned that vitamin C (ascorbic acid) is one of the ingredients that mostly used in the prevention of fish diseases, vitamin C in the fish body has role in reducing stress and accelerating the process of wound healing.

Other material included in multivitamins is Vitamin A. Vitamin A plays a role in various physiological functions of the body and influences the process of protein synthesis so that it will affect the cell growth. Thus the function of vitamin A is very influential towards fish growth. Vitamin A plays a role in the formation of bones and teeth and fish appetite. Vitamin A deficiency will cause stunted bone growth and abnormal bone shape and cause low fish appetite [11].

Included in the multivitamin given to the cantang grouper, there is also vitamin B complex to maintain fish health. In accordance with the statement [5] that the B complex vitamin has role as metabolic enzyme cofactor so that it is able to maintain a healthy body. The content of vitamins B1, B2 and B6 in each multivitamin also has important role in the transformation of energy, synthesis of pentose and coenzyme components, which are basically related to metabolism in the fish body [11].

There are also other types of vitamins that have functions as antioxidant, which is vitamin E or commonly called α -tocopherol. Vitamin E has the main function as antioxidant that prevents peroxidation of fatty acids, especially PUFA (*polyunsaturated fatty acid*) [13], so the function of adding vitamin E in the feed can be used to prevent fat oxidation which can cause rancidity in the feed.

The optimal increase in the fish body length based on sampling result is affected by the availability of vitamin D in feed. Vitamin D has role in helping the formation and hardening the bones by regulating calcium and phosphorus that are available in the blood to be deposited in the process of bone hardening. On the other hand, vitamin D collaborates with vitamin A and vitamin C in maintaining bones. Lack of vitamin D in fish food will cause abnormality in bones.

The total of feed given during the care of the cantang grouper with enrichment in floating cages produces an FCR value of 3.4 and without enrichment produces an FCR of 3.57. Both of these values approach the opinion [1] which states that the value of FCR 3-4 is the ratio value of feed conversion to grouper. This means that the total of feed consumed to produce 1 kg of bush grouper meat needs 3-4 kg of artificial feed. This explains that the FCR value in the care of groupers that are being fed with enrichment is better than the care of groupers without feed enrichment. According to [2], the smaller the feed conversion ratio, the feed consumed by fish becomes good to support the growth of domestic fish and conversely the bigger the feed conversion ratio indicates that the feed provided is not effective to support fish growth. Feed conversion values is different depends on the type of feed, species, fish size and water temperature [1].

From the measurement results, it is obtained that the feed utilization efficiency is 29.4%. This indicates that the feed can be used efficiently by the cantang grouper for 29.4% of the feed provided. The higher the value of feed efficiency proves the better feed [8]. Factors that determine the high and low efficiency of feed is the type of source of nutrition and the total of each component of the feed nutrition [10].

4. Conclusion

Feed for the growth of cantang groupers in floating net cages by adding multivitamins to the feed can increase the growth rate and feed efficiency and improve the feed conversion value in cantang grouper.

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