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Submission date: 05-Nov-2019 07:50AM (UTC+0700)
Submission ID: 1207138955
File name: ESTIBILITY_AND_SURVIVAL_OF_SPIRAL_BABYLON_Babylonia_spirata.pdf (388.13K)
Word count: 2917
Character count: 15407

Jurnal Teknologi

Full Paper

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Article history
Received
11 November 2015
Received in revised form
7 January 2016
Accepted
15 February 2016

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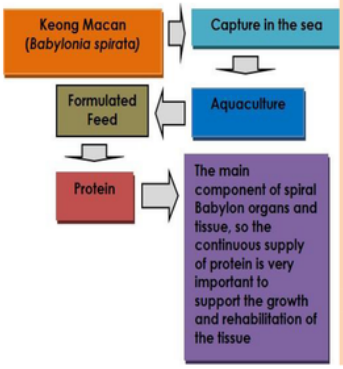
Graphical abstract



Abstract

Study aims to determine effects of protein in formulated feed on specific growth, digestibility and survival of spiral Babylon [*Babylonia spirata* (Linnaeus, 1758)] snail. The snail average weights (10.19 ± 0.124) g per individu was stocked at a density of two snails per liter, and fed formulated feed twice daily (5 % of total biomass) with three different protein levels: 30 %, 35 % and 40 % for 70 d. The results show that different protein contents significantly affected the growth of spiral Babylon ($P < 0.01$) and protein digestibility, but not the survival of spiral Babylon ($P > 0.05$) and spiral Babylon needs 35 % protein in the formulated feed.

Keywords: Formulated fed, growth, protein, Spiral Babylon [*Babylonia spirata* (Linnaeus, 1758)]

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1.0 INTRODUCTION

Spiral Babylon [*Babylonia spirata* (Linnaeus, 1758)] is one of potential marine resources for cultivation Indonesia. Spiral Babylon which are cultivated in Indonesia have been exported to RRC, Taiwan, Hongkong, Singapore and Malaysia [1]. Until now the production spiral Babylon indonesia was obtained from wild capture in the sea [2]. Aquaculture of spiral Babylon is one alternative to reduce wild capture from the sea [3, 4].

The main constraint to raise spiral Babylon is the availability of the formulated feed which meet nutrient need. The use of trash fish in the cultivation has some constraints, such as seasonal dependency and vulnerability to the diseases [5]. Therefore, complete and balanced nutrient content of the formulated feed are necessary for the spiral Babylon cultivation. On the other hand, there are no data yet for the nutrient requirement for the spiral Babylon cultivation [6].

One of the important nutrient in formulated feed is protein. Protein is the main component of spiral Babylon organs and tissue, so the continuous supply of protein is very important to support the growth and rehabilitation of the tissue. Protein deficiency can hinder the growth and leads to weight loss because protein is important to maintain vital organs [7]. Due to the importance of protein in formulated feed for spiral Babylon, there is a need to study in determining the dietary protein requirement for spiral Babylon cultivation. This study aimed to examine the effects of protein content in formulated feed on specific growth, digestibility rate and survival of spiral Babylon.

2.0 MATERIAL AND METHOD

Feeding experiments used in this study were made in the form of pasta feed with protein contents of 30 % (treatment A), 35 % (treatment B) and 40 % (treatment C). The formulated feed consisted of fish meal, soybean meal, corn meal, rice bran, and dextrin. Proximate analysis of feed ingredients was conducted to determine the nutrient contents. The formulated feed ingredients and proximate analysis can be seen in Table 1.

Table 1 Prepared feed formulation for Spiral Babylon (*B. spirata* L.)

Material (g)	Treatment		
	A	B	C
Fish meal	36.85	45.2	53.37
Soybean meal	24.55	30.00	35.69
Corn meal	10.87	6.28	1.68
Rice bran	10.86	6.28	1.68
Dextrin	10.87	6.18	1.58
Fish oil	1	1	1
Vegetable oil	1	1	1
Premix	2	2	2
Tapioca	2	2	2
Total	100	100	100

Table 2 Proximate analysis feeding experiments

Nutririon	Treatment		
	A	B	C
Protein (%)	30.04	35.40	40.02
Fat (%)	3.61	4.19	4.19
Water	46.52	44.72	44.64
Ash	6.63	6.65	6.41
Crude fiber	5.98	7.73	3.75
Gross energy (g · kkal^{-1})	4.2	4.4	4.6
P/E ratio (mg · kkal^{-1})	71.42	80.45	86.86

Explanation:
A: Formulated fed with protein contents of 30 %
B: Formulated fed with protein contents of 35 %
C: Formulated fed with protein contents of 40 %

Feed formulation in this research was modified from carbohydrate sources [3]. The mean weight of spiral Babylon used in this study was (10.19 ± 0.124) g per snail. They were obtained from Jepara sea stretching from Kartini beach to Panjang island. Spiral Babylon (*B. spirata*) used in this study were healthy individuals and had uniform size [5]. The snails were stocked at a density of two snails per liter [1]. Adaptation of the snails on formulated feed was required before conducting the experiment by feeding the animal with chopped fish which were already mixed with formulated feed for 7 d [4]. The spiral Babylon was raised in rectangular fiberglass containers with the dimension of 1.0 m × 3.0 m × 1.0 m which were equipped with aeration and water circulation. Water was replaced daily (25 % water volume). To keep the containers clean, the feces of the animals were syphoned every day before feeding. This study was conducted in 17 d and the animal growth was examined every week. Biological variables examination were specific growth, protein efficiency ratio, digestibility rate, and survival rate, while variables of the water quality were salinity, pH, temperature, dissolved oxygen, Ammoniac, Nitrate and Nitrite. Experimental design used Completely Randomized Design (CRD) with three levels of protein content as a treatment and each treatment repeated four times. Effect of the treatments was tested using an analysis of variance. To determine optimum level of protein, Polynomial Orthogonal test was conducted [8].

3.0 RESULTS AND DISCUSSION

Results of specific growth rate, protein efficiency ratio, feeding efficiency, digestibility, and survival rate during study were shown in the Table 3.

Table 3 Spesific growth rate (SGR), protein efficiency ratio (PER), survival rate (SR) and digestibility (raw protein and total) of spiral Babylon

Variables	Protein Content (%)		
	30	35	40
Specific growth rate (%/day) *)	0.107 ± 0.010^{b}	0.180 ± 0.010^{a}	0.097 ± 0.062^{b}
Protein efficiency ratio (%) *)	0.113 ± 0.013^{b}	0.202 ± 0.007^{a}	0.068 ± 0.003^{b}
Survival rate (%) *)	95 833± 7.217^{a}	95 833± 7,217^{a}	91 667± 7,217^{a}
Digestibility of raw protein (%)*)	54.54 ± 1.224^{b}	64.607± 0.502^{a}	59.029± 0.043^{b}
Digestibility of total protein (%) *)	51.61 ± 0.358^{b}	53.544± 0.558^{a}	42.077± 0.846^{b}

Note: Value with the different superscript in a column showing a significant difference (P < 0.05)
*) (value ± se)

The Table 3 shows that the highest rate of specific growth resulted from feeding with the protein content of 35 % (treatment B) was (0.180 ± 0.010) % d^{-1}, while the lowest was (0.097 ± 0.006) % d^{-1} from feeding with the protein content of 40 % (treatment C). Feeding treatment with 35 % protein content (treatment B) has the best effect on specific growth rate than those of 30 % (treatment A) and 40 % (treatment C). Protein content of prepared feeds affected the specific growth rate of spiral Babylon. The protein utilization for growth highly depends on fish size, protein quality, energy content of feed, balanced nutrient, and feeding rate [9]. Protein deficiency can hinder the specific growth, followed by muscle loss due to utilization of protein in the muscle to maintain vital organs [7].

The weight growth of spiral Babylon by feeding them formulated feed containing 30 % and 40 % of protein were slower than that of 35 %. It indicated that protein level less than 35 % in its formulated feed cannot fulfill protein need which was used for metabolism and amino acid supply in creating protein. Protein deficiency can hinder the specific growth. The higher the protein the higher the growth, therefore protein content in their feed highly affected the growth [13]. Protein is essential nutrient for survival and growth [10, 11]. Moreover, protein is continuously needed for growth and tissue rehabilitation [7]. Protein deficiency can hinder the specific growth, followed by muscle loss due to utilization of protein in the muscle to maintain vital organs.

Protein content significantly ($P < 0.01$) affected on specific growth of the spiral Babylon. Based on polynomial orthogonal test, the relationship between protein and specific growth has quadratic pattern relationship as shown in Figure 1 with the equation $Y = -3{,}623 + 0{,}218x - 0{,}003x^2$, $R^2 = 94{,}4$. The daily growth rate of spiral Babylon (Y) was 0.22 % d^{-1} when the protein content (X) was in the optimum level of 35.20 %.

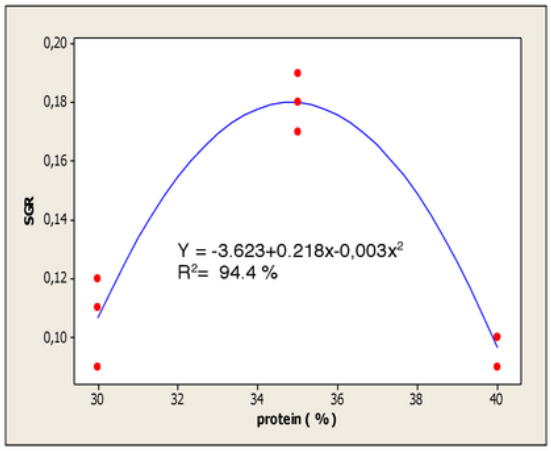

Figure 1 Polynomial orthogonal chart of specific growth rate (SGR) of spiral Babylon during the survey

The source of the formulated feed for the testing was made of fish meal. Fish meal is the source of protein and contains the whole essential amino acid. Fish meal that was suitable with the dietary requirement of spiral Babylon in this study was fish meal with 35 % protein. Therefore, at the 35 % of protein level in their feeding spiral Babylon needs lower feeding intake as indicated by the high values of feeding protein efficiency ratio. Excess supply of protein can reduce the growth because the energy should be used to build up the protein instead of using it for metabolism [12].

Several factors that affect protein requirement for the growth are type, age, and size of fish, water temperature, and protein quality based on amino acid composition [13]. Based on polynomial orthogonal test, the relationship between protein and protein efficiency ratio was quadratic with the equation of $Y = -5.067 + 0.306x - 0.004x^2$, $R^2 = 97.0$ %. The maximum protein efficiency ratio of spiral Babylon (Y) was 0.247 and was reached at 34.75 % protein content as shown in Figure 2.

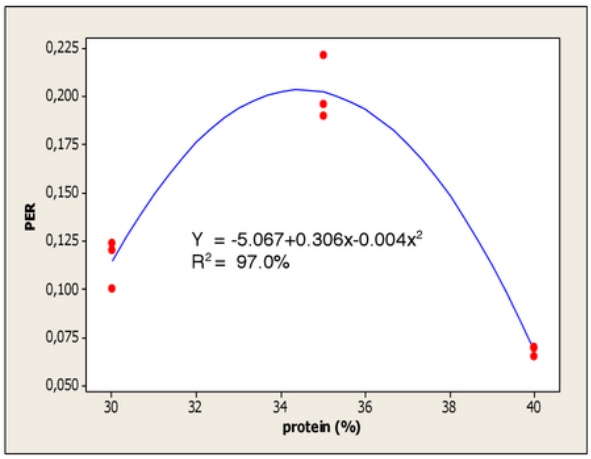

Figure 2 Polynomial orthogonal chart of protein efficiency ratio (PER) of spiral Babylon during the survey

The digestibility measurement during study shows that the highest levels of raw and protein digestibility were 69.542 % and 60.264 % respectively when the feeding was at the protein level of 35 % (treatment B). While at the protein content of 30 % (treatment A) raw and protein digestibility were 59.104 % and 54.747 % respectively, and at the protein level of 40 % (treatment C) were 62.615 % and 49.064 % respectively.

Prepared feed with high protein content did not guarantee to result in high digestibility. It was suspected that digestibility was affected by the availability of protein digesting enzyme in spiral Babylon. Fish digestibility depends on physical and chemical factors, type of feed, nutrient contents, type and amount of digesting enzyme, size and age of fish, type of physical and chemical property of water [14]. Moreover, protease enzyme functions as digesting catalyst to ease absorbing of protein [15]. It broke down protein to amino acid. Digestibility of protein also depends on the ability of the fish to absorb the nutrients [16]. It was also affected by density of fish population, the amount of feed availability and toxin content in the feed [17]. The higher feeding utilization of spiral Babylon was due to the higher digestibility of the feed that contained 35 % (treatment B) of protein than that of 30 % (treatment A) and 40 % (treatment C).

The value in the Table 2 shows that protein content in formulated feed did not affect ($P > 0.05$) on the

survival rate of spiral Babylon. The results were consistent with the study results on various fish and mollusk done by other researchers; such as *Babylonia aerolata* [3-6]. Survival rate was affected by biotic and abiotic factors [18]. The biotic factors include age and ability if the fish to adjust to the environment, while the abiotic factors include the availability of diet and the quality of the cultivation media. Enough feed for the spiral Babylon needs and water parameters during study were also in the optimum ranges for spiral Babylon cultivation, therefore, they were feasible for spiral Babylon survival.

Quality of water during the research is still on condition that overpass to the cultivation of spiral Babylon. The measurement of water parameter during spiral Babylon cultivation can be seen in Table 4.

Table 4 The value of water quality measurement

Parameters	Value	Literature benchmark	
Temperature (°C)	26–29.12	26–32	[19]
Salinity (ng · L^{-1})	31–32	26–31.67	[20]
pH	7–8	7.0–8.82	[20]
DO (mg · L^{-1})	3.9–5.27	4.5–7.0	[19]
Ammonia (mg · L^{-1})	Tt	< 0.05	[21]
Nitrate (mg · L^{-1})	0.005	< 0.05	[21]
Nitrite (mg · L^{-1})	0.011	< 0.05	[21]

4.0 CONCLUSION

The results show that different protein contents significantly affected the growth of spiral Babylon ($P < 0.01$) and protein digestibility, but not the survival of spiral Babylon ($P > 0.05$) and spiral Babylon needed 35 % protein in the formulated feed.

Acknowledgement

Appreciation expressed to those who already helped in this study, especially to: i) The head of BBPBAP (Center for Freshwater and Brackish Aquaculture), Jepara, Central Java; ii) The head of Formulated Feed Laboratory of BBPAP; and iii) The head of Fishery Technology Laboratory, Department of Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University, who has done proximate analysis of spiral Babylon and formulated feed preparation.

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