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EFFECT OF NATURAL FEEDS ON THE GROWTH PERFORMANCE, SURVIVAL RATE AND FEED UTILIZATION OF THE TROPICAL SHORTFIN EEL *ANGUILLA BICOLOR* MCCLELLAND 1844 (PISCES: ANGUILLIDAE) LARVAE

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Key words: rebon-shrimp, bloodworm, golden apple snail, sardine fish, sidat.

Abstract

The high mortality of eels larvae usually occurs during the acclimatization process before growth, probably due to the unsuitable feed intake. Therefore, this study aimed to find suitable natural feed for tropical shortfin eel *Anguilla bicolor* larvae. The complete randomized experimental design with four treatments and four replications was used. Four natural feeds were tested, namely bloodworm *Tubifex* sp., golden apple snail *Pomacea canaliculata*, sardine fish *Decaptersus macarellus,* and sergestid shrimp *Acetes* sp. The initial total length and body weight of the samples were 5.0–7.0 cm and 0.15–1.78 g, respectively, while the experimental fish was reared at a density of 10 fish tank^{-1}. The eel larvae were raised in plastic containers volume 22 L, while natural feeds were given at a feeding ration of 10% body weight a day for 60 days. The results showed that the natural feeds produced significant effects ($P < 0.05$) on weight gain, specific growth and survival rate, as well as feed efficiency and conversion ratio. The sardine feed yielded a better result compared to other tested feeds, but the values were not significantly different from bloodworm. Based on the results, sardine fish and bloodworm feed are suitable for eel *A. bicolor* larvae.

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Introduction

Eels are commercial fish found worldwide with Indonesia having at least 7 species (SUGEHA et al. 2006, SYAIFULLAH et al. 2019) where 3 were reported from the Aceh waters, namely *Anguilla bicolor bicolor, A. marmorata,* and *A. bangelensis bangelensis* (MUCHLISIN and SITI-AZIZAH 2009, MUCHLISIN et al. 2015, MUCHLISIN et al. 2016a, MUCHLISIN et al. 2017). According to WATANABE et al. (2014), there are two subspecies of shortfin eel, namely *Anguilla bicolor bicolor* native to the Indian Ocean and distributed in the surrounding rivers, as well as *A. bicolor pacifica* from the Pacific ocean.

The bioecology and genetics of the eel *A. bicolor* from Indonesia especially Aceh waters have been reported by several studies (SIDQI et al. 2018, MUCHLISIN et al. 2017, MUCHLISIN et al. 2018, BATUBARA et al. 2021). Presently, this species has been cultured in Indonesia where the larvae were collected from the wild and acclimatized for several weeks indoors before rearing in the outdoor pond (THAMREN et al. 2018, MUCHLISIN et al. 2021). The fish fed on trashfish and commercial feed during this process, but the local farmers claimed that the eel larvae grow slowly with high mortality during acclimatization, this is probably due to the unsuitable stocking density and feeding. However, MUCHLISIN et al. (2021) has been examined that the maximum stocking density for eel larvae and found that the best value is 3 fish L^{-1}. However, the problem of the feeding eel larvae has not been solved. According to MUCHLISIN (2017), the alimentary tract of the larvae is underdeveloped and the activity of the digestive enzymes is low, hence, they are unable able to digest the feed optimally. At this phase, it is recommended that the fish should be given natural feeds (MUCHLISIN et al. 2003, FIRDUS and MUCHLISIN 2005).

Larvae is a critical phase of the fish, hence, they require intensive attention and proper handling, specifically in relation to feeding. Currently, there is no information on the best natural feed for eel larvae during the acclimatization process. This study was conducted to evaluate four potential natural feeds for eel larvae namely bloodworm (*Tubifex* sp.), golden apple snail (*Pomacea canaliculata*), sergestid shrimp (*Acetes* sp.) or locally known rebon-shrimp, and sardine *(Decaptersus macarellus).* These potential feeds have higher crude protein content, for example, the bloodworm has 57% crude protein and 13% lipid (TARIGAN 2014), the golden apple snail has 51% and 13.16%, respectively (ANDERSON et al. 2004), while sergestid shrimp and sardine have 52.35% and 57.48%, respectively (SHOLICHIN et al. 2012), indicating that these feeds are very promising for eel larvae. Therefore, this study aims to explore the suitable natural feed for eel *A. bicolor* larvae during the acclimatization process.

Materials and Methods

Experimental design

This study was conducted at the Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh, Indonesia. The complete randomized experimental design method was used. Four types of natural food was tested, namely bloodworm (*Tubifex* sp.), golden apple snail (*Pomacea canaliculata*), sergestid shrimp (*Acetes* sp.), and sardine (*Decapterus macarellus*) with four replications.

Experimental fish

A total of 16 plastic containers (Vol. 22 L) were used, each was filled with 10 L and aerated continuously. The initial size of the experimental fish ranged from 0.15 g to 0.178 g and the total length of 5.0 cm to 7.0 cm. There is no commercial breeding technology for eels in Indonesia, hence, the fish larvae were collected from Beurenut River in Aceh Besar District. The larvae collection was performed at high tide from 06.00 PM to 05.00 AM at the water temperature regime of 26–28°C. Acclimatization was then performed for five days before the administration of the experimental diet, and no feed was given during this process.

Feed preparation

The frozen silk worms were purchased from ornamental fish vendors in Banda Aceh, immersed for 5–10 min in warm water, and given to the experimental fish when the ice was melted. The golden snails were collected from rice fields in the Aceh Besar District, the snail meat was removed from the shell and the innards were removed, then the meat was washed with salt water to remove the mucus and finely chopped. Meanwhile, sardine and sergestid shrimp were purchased from local suppliers in Banda Aceh City, and further washed and chopped into small pieces. The feeds were given to the experimental fish in wet conditions.

Stocking and feeding

The experimental fish was measured and weighed for initial body length [cm] and total body weight [g]. A total of 10 larvae were stocked into every container. The experimental fish was fed on natural feed twice a day on 08.00 AM and 16.00 PM at a feeding ration of 10% body weight for 60 days. The unconsumed feed was discharged by siphoning 30 minutes

after feeding, while the water quality was monitored every day to maintain the optimum condition for eel larvae. Approximately 25% of the waters were discharged and replaced every two days interval.

Parameters and data analysis

The weight gain was calculated using the formula:

$$WG = Wt - Wo,$$

where:
WG – weight gains [g]
Wt – the weight of the fish at the end of the experiment [g]
Wo – the body weight at the start of the experiment [g].

The specific growth rate was calculated based on MUCHLISIN et al. (2016*b*; 2016*c*) as follows:

$$SGR = [(Ln\ Wt - Ln\ Wo)/\ t] \cdot 100,$$

where:
SGR – the specific growth rate [% day^{-1}]
Wt – the body weight at the end of the experiment [g]
Wo – the body weight at the start of the experiment [g]
t – the feeding duration (days).

The feed conversion ratio and efficiency were calculated based on TACON (1987):

$$FCR = F/(Wt - Wo),$$

where:
FCR – feed conversion ratio
F – the total of feed taken during the experiment [g]
Wt – the body weight at the end of the experiment [g]
Wo – the body weight of the fish at the start of the experiment [g].

Feed efficiency [%] = 1/FCR · 100. Meanwhile, the survival rate was examined based on MUCHLISIN et al. (2016*b*; 2016*c*):

$$SR = [(No - Nt)/No] \cdot 100,$$

where:
SR – survival rate [%]
No – total fish at the start of the experiment
Nt – the total fish mortal during the experiment.

The data were subjected to One-way Analysis of Variant (ANOVA) followed by Duncan's multiple ranges test using SPSS ver. 20.0 software. Percentage data were transformed before analysis (MUCHLISIN et al. 2004).

Results

The results showed that the weight gain, specific growth rate, and the survival rate ranged from 0.08 to 0.13 g, 0.64% day^{-1} to 1.02% day^{-1}, and 63.33% to 80.00%, respectively. Meanwhile, the feed conversion ratio and efficiency ranged from 4.65 to 7.19 and 13.98% to 21.52%, respectively, as shown in Table 1.

Table 1

Growth performance, survival rate and feed utilization of Tropical shortfin eel *Anguilla bicolor* larvae fed on several types of natural feeds for 60 days. The average±SD value in the same row with different superscripts are significantly different ($P < 0.05$)

Parameters	Natural feed			
	bloodworm (*Tubifex* sp.)	apple golden snail (*Pomacea canaliculata*)	sardine fish (*Decaptersus macarellus*)	sergestid shrimp (*Acetes* sp.)
Average of the initial body weight [g]	0.163±0.009	0.150±0.005	0.155±0.005	0.178±0.006
Average of body weight at the end of the experiment [g]	0.261±0.014	0.249±0.022	0.281±0.009	0.243±0.028
Weight gain [g]	$0.09±0.022^{ab}$	$0.08±0.023^{a}$	$0.13±0.008^{b}$	$0.08±0.034^{a}$
Specific growth rate [% day^{-1}]	$0.77±0.19^{a}$	$0.71±0.15^{a}$	$1.02±0.03^{b}$	$0.64±0.20^{a}$
Survival rate [%]	$80.00±8.16^{b}$	$72.50±9.57^{ab}$	$77.50±5.00^{b}$	$63.33±5.77^{a}$
Feed conversion ratio (FCR)	$4.65±0.18^{a}$	$5.84±0.73^{b}$	$5.39±0.35^{ab}$	$7.19±0.73^{c}$
Feed efficiency [%]	$21.52±0.86^{c}$	$17.30±1.95^{b}$	$18.59±1.28^{b}$	$13.98±1.34^{a}$

The One-way ANOVA test revealed that the natural feed produced a significant effect on the body weight, specific growth rate, survival rate, feed conversion ratio and efficiency with $P < 0.05$. Furthermore, the Duncans test showed that the highest weight gain was recorded in fish fed with sardine, but the value was not different significantly from those fed using bloodworm. The specific growth rate in those fed with sardine was different significantly from other feeds. A high survival rate was also found in this group, but this value was not different significantly from those fed with bloodworm and golden apple snail. The better feed conversion ratio was recorded in eel fed with bloodworm (FCR 4.65), but this value was not significantly different from those fed using sardine (FCR 5.39). A good feed efficiency was also recorded with bloodworm (21.52%), and this value was significantly different from other tested feeds. Moreover, the results revealed that the body weight increased after 10-days of feeding and a high body weight gain was found on fish fed with sardine. The weight gain exceeded the other feed treatment starting from 20-days feeding (Figure 1).

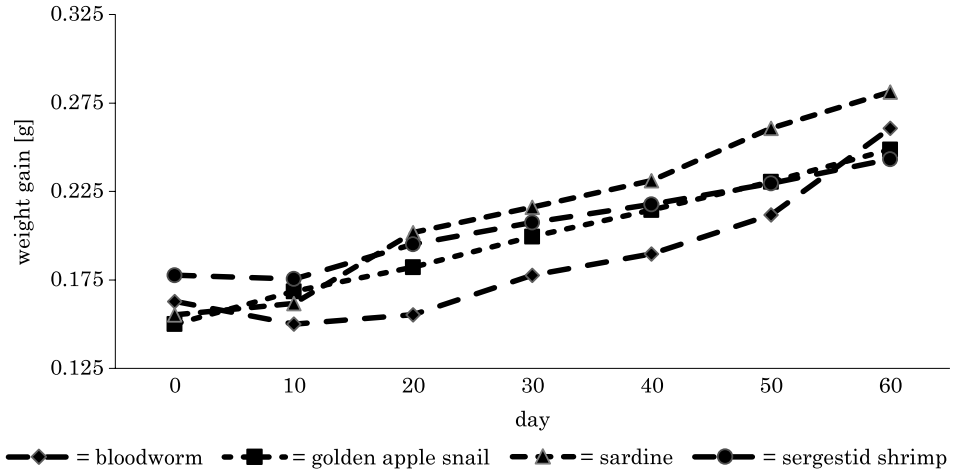

Fig. 1. The body weight gain trend of Tropical shortfin eel *Anguilla bicolor* larvae fed on natural feed for 60 days

The main water quality data showed that the temperature, pH, and Dissolved oxygen ranged from 27°C to 28.3°C, 7 to 8, 4.27 ppm to 6.50 ppm, respectively.

Discussion

Based on the results, the best weight gain and specific growth rate were recorded on fish fed with sardine, whe a good feed conversion ratio and efficiency were found in the treatment with the bloodworm feed. In addition, the highest survival was recorded on fish fed with bloodworm, but these values were not significantly different with sardine feed. In general, sardine produced faster growth compared to other natural feeds.

The growth performance of the fish is strongly related to the protein, lipid, and vitamin contents in the feed, as well as the fatty acid profile (Prusińska et al. 2020, Muchlisin 2017) where protein and lipid are the important energy source. However, the growth performance is not only influenced by protein levels but also affected by the amino acid compositions that build the protein. In general, fish requires protein ranging 40% to 77% (Cuzon 1988, Maigualema and Gernat 2003, Muchlisin 2017), where carnivorous fish require higher levels than herbivores or omnivores fishes (Krogdahl et al. 2005, Panserat et al. 2009). The presence of fatty acids is also crucial in the feed (Ridwanudin et al. 2021) because fish are quite effective in digesting lipids, but their content must not exceed the

maximum need. In general, fish requires lipids ranging from 4.90% to 16% (CUZON 1988, GIRI 2003). The results showed that sardine provided a better growth rate for eel larvae. This might be related to the nutritional contents of sardine, comprising 57.48% of proteins, 4.90% lipids, 0.45% fiber and 5.39% ash (MUNTAZIANA et al. 2013). Besides, sardine emits a fishy odor typical of the favored fish and stimulates the appetite of eel (HANY 2015).

The bloodworm feed produced a high growth performance close to sardine. This is because the bloodworm has high protein content 57% almost equivalent to sardine, but this feed has higher lipid and fiber contents of 13% and 2.9%, respectively (SUBEKTI et al. 2011). Therefore, it is presumed that eel larvae can not digest high lipid and fiber effectively. This is because the digestive tract of the larvae is underdeveloped (MUCHLISIN 2017). In general, sardine and bloodworms gave a better feed utilization compared to golden apple snail and sergestid shrimp. This indicates that sardine and bloodworm are suitable as natural feed for the eel larvae.

A low feed utilization was recorded in fish fed with sergestid shrimp compared to other natural tested feeds. This is probably because the sergestid shrimp has chitin (MATHUR and NARANG 1990), which is difficult to digest by fish, particularly during the larvae stage (GUTOWSKA et al. 2004). In general, the feed digestibility is strong depending on the balance in nutrition contents (AMIRKOLAIE 2005, AGUSTONO 2014), fish age or size (MUCHLISIN 2018), enzymes activities (KLEIN et al. 1988, GRISHAM and REGINALD 1999) and environmental factors such as temperature, pH, and dissolved oxygen (SETIAWATI et al. 2014, OOI and CHONG 2011).

Conclusions

The natural feed produced significant effects on weight gain, specific growth rate, survival, feed conversion ratio and efficiency. Based on the results, sardine and bloodworms are the most suitable feed for the eel larvae.

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