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Pertumbuhan Abalon Tropis (*Haliotis squamata*) pada Pemberian Pakan Dua Makroalga yang Berbeda di Wadah Pemeliharaan

Growth performance of tropical abalone (*Haliotis squamata*) fed with two differentmacroalgae in captivity

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ABSTRACT

Macroalgae *Gracilaria* sp. and *Ulva* sp. are commonly found, cultivated, and utilized to feed abalone in captivity.This study was aimed to evaluate the effect of two different macroalgae diet (*Gracilaria* sp. and *Ulva* sp.) on tropical abalone (*Haliotis squamata*). Two treatments of macroalgae diet (*Gracilaria* - Gra and *Ulva* - Ulv) with six replications were performed at Research Center for Marine and Land Bioindustry, North Lombok. In this study, 300 tropical abalone (49.40 ± 0.21 mm) were kept indoor in 60-l rearing tank at 25 abalone per tank of stocking density for 90 days between September to December. Macroalgae *Gracilaria* sp. outperformed *Ulva* sp.on specific growth rate body weight (SGR_{BW}) (0.18 ± 0.15), food conversion ratio (FCR) (7.14 ± 5.72) and survival rate (SR) (75.20 ± 15.34 %) of tropical abalone.

Keywords: abalone, *Haliotis squamata*, macroalgae, *Gracilaria*, *Ulva*, growth performance.

Introduction

Abalone is highly trade seafood commodity that can be found in the rocky substrate of coastal water around the globe (Cook, 2014, 2016). One of them is tropical abalone *Haliotis squamata* that can be found in Indonesia region (Geiger, 1999). This species has been successfully farmed in various scale that contributed to regional and state income (Abdi et al.,2021; Latuihamallo, 2014; Maulidya et al., 2021; Sahetapy & Latuihamallo, 2014). Moreover,tropical abalone aquaculture has been suggested to provide sustainable livelihood in rural fisheries areas (Gonzales, 2015; Taridala et al., 2021).

Sufficient feed supply is essential for the abalone farm practices in order to promote fairgrowth performance (Bansemer et al., 2016; Capinpin & Corre, 1996). Studies on feed development on *H. squamata* husbandry revealed that fresh red algae *Gracilaria* sp. and greenalgae *Ulva* sp. were sufficient to support fair growth performance due to their nutritional content (Latuihamallo, 2014; Yusup et al., 2020). These two macroalgae are widely distributedin Indonesia coastal water (Setyorini et al., 2021). Moreover, *Gracilaria* sp., have been successfully cultivated and readily available (Diatin et al., 2020; Pambudi et al., 2010). However, nutritional content of these two macroalgae are varied and altered by the environmental conditions.

To date, throughout the time, growth performance of abalone can be varied. Although tropical abalone requires less time than subtropical abalone to reach marketable size, it is unclear whether the smaller size abalone grew faster or the larger abalone (Capinpin & Corre,1996; Mgaya & Mercer, 1995; Steinarsson & Imsland, 2003; Wu et al., 2009). Previous studieshave been described growth performance on smaller size juvenile ranging from 25 to 40 cm (Giri et al., 2014; Prihadi et al., 2018; Yusup et al., 2020). This study would like to describe the growth performance of larger size *H. squamata* (49 mm) fed a single-species algal diet of two macroalgae over 90-days rearing period.

Materials and Methods

Animal and Macroalgae Source

In this study, 300 tropical abalone *Haliotis squamata* with initial shell length (SL) and body weight (BW) of 49.40 ± 0.21 mm and 19.34 ± 0.14 gram, respectively were obtained from the abalone hatchery unit of Marine Aquaculture Development and Centre Lombok – Ministry of Marine Affairs and Fisheries (KKP) at Sekotong, Lombok Barat, NTB. Those abalones were produced from natural spawning and were fed with macroalgae *Gracilaria* sp. Prior to the experiment, abalone were maintained indoor in two separate 500-l concrete tanks of the abalone rearing facility of Research Center for Marine and Land Bioindustry - National Research and Innovation Agency (BRIN) at Pemenang, Lombok Utara, NTB for a week. During this acclimation period, animals were fed with fresh *Gracilaria* sp. in *ad libitum* as well, as previously performed in the hatchery. There were two species of macroalgae that were employed in this study to feed abalone. Macroalgae *Gracilaria* sp. were obtained from the traditional seaweed pond at Sekotong, Lombok Barat, NTB. Meanwhile, macroalgae *Ulva* sp.were obtained from the macroalgae rearing facility unit of Research Center for Marine and Land Bioindustry.

Animal Husbandry

Current study was performed inside rearing facility building of Research Center for Marine and Land Bioindustry. Approximately 300 abalones were distributed into twelve 60-l plastic rearing tanks containing 50 l of filtered seawater with stocking density 25 abalones pertank. A 20 cm length of 4-inch half round plastic gutter were placed into rearing tank to providesuitable shelter. An air stone was put as well to provide generous aeration for abalones. Filteredseawater with 1 µm and UV sterilization was utilized to rear abalones. Seawater then was recirculated into protein skimmer and were replaced every 2-3 days during faecal and excess feed removal. Salinity varied from 33 to 34 ppt and temperature ranged from 26 to 27ºC. Meanwhile, dissolved oxygen varied between 5.0 to 5.5 mg/l.

Macroalgae Feeding Experiment

300 abalones in 12 tanks were divided into two experimental groups for feeding (*Gracilaria* and *Ulva*), each with six replicates. Feeding treatments were randomly assigned toeach tank. Throughout the experiment, the abalones were fed with its allocated fresh diet seaweed in *ad libitum*.

Observed Parameters

Body weight (BW) and shell length (SL) of abalones were measured prior and after 90- days feeding experiment. Abalones were carefully removed from the tank or shelter using a thin flexible spatula. The detached abalone were blot dried and then weighed on 0.01 g electronic balance. Shell length measurement then was performed using digital vernier calliperto the nearest 0.01 mm. Then, weight gain (WG) and specific growth rate (SGR) wasdetermined according to the following formula (Amin et al., 2020):

$$WG = W_t - W_0$$

$$LG = L_t - L_0$$

$$SGR_{BW} = 100 \left(\frac{\log(\frac{Wt}{W0})}{t}\right)$$

$$SGR_{L} = 100 \left(\frac{\log(\frac{Lt}{L0})}{t}\right)$$

where WG = weight gain (g), W_t = final weight (g), W_0 = initial weight (g), LG = length gain (mm), L_t = final shell length (mm), L_0 = initial shell length (mm), SGR_{BW} = specific growth rate (% body weight per day), SGR_L = specific growth rate (% shell length per day), and t = time (day).

Every 2-3 days in the morning, fresh and uneaten macroalgae were estimated during excess feed removal. Seaweed was blot dried before weighing to the nearest 0.01 g electronic balance. Feed intake and feed conversion ration were calculated according to the following formula (Amin et al., 2020; Capinpin et al., 1999):

$$FCR = \frac{(\text{Feed given} - \text{Uneaten feed})}{WG}$$

where FCR = feed conversion ratio.

Survival rate (%) of 25 abalones per tank was determined from the beginning of the experiment. Any dead abalone was discarded from the tank every day in the morning. The number of surviving abalones in each rearing tank then was determined after 90 days of the experiment.

Statistical Analysis

The collected data of growth performance, feed efficiency and survival rate were analysed statistically by T-test to compare differences between two feeding regimes.

Result and Discussion

In this study, *Gracilaria* sp. tended to have better growth performance of abalone than *Ulva* sp. after 90-days feeding experiment. Growth performance in terms of shell length and body weight were higher in abalone with *Gracilaria* sp. diet than *Ulva* sp. (Table 1). Current result is comparable to previous studies that revealed better growth performance of abalone on*Gracilaria* sp. than *Ulva* sp. (Prihadi et al., 2018). Although in this study, both *Gracilaria* sp. and *Ulva* sp. chemical composition was not determined, it was more likely that *Gracilaria* sp. had better nutrient content that met nutritional requirements of *H. squamata*. Abalone feed withhigher dietary protein intake promoted to higher protein deposition in tissue which eventuallyincreased its body size (Britz & Hecht, 1997). Thus, abalone feed with *Gracilaria* sp. had higher growth performance than *Ulva* sp. in this study. However, nutritional content of macroalgae can be varied within species (Table 2). It has been suggested that this variation washighly affected by the environmental condition during cultivation (Wan et al., 2019; Yusup etal., 2020).

Table 1 Growth and feeding performance of abalone *H. squamata* feeding with two different macroalgae.

No	Observed Parameter	Treatment	
		Ulva sp.	Gracilaria sp.
1	Initial shell length (mm)	49.39 ± 0.82	49.40 ± 0.72
2	Final shell length (mm)	51.54 ± 0.95	52.96 ± 0.98
3	Length gain (mm)	2.15 ± 0.45	3.56 ± 1.97
4	SGRL (%SL/day)	0.05 ± 0.01	0.08 ± 0.04
5	Initial body weight (g)	19.33 ± 0.64	19.36 ± 0.36
6	Final body weight (g)	20.70 ± 0.73	23.03 ± 3.39
7	Weight gain (g)	1.37 ± 0.38	3.67 ± 3.19
8	SGRBW (%BW/day)	0.08 ± 0.02	0.18 ± 0.15
9	FCR	12.98 ± 3.80	7.14 ± 5.72
10	SR (%)	72.67 ± 6.89	75.20 ± 15.34

Table 2 Chemical composition of *Gracilaria* sp. and *Ulva* sp. from previous studies.

Reference	(Latuihamallo et al., 2016)		(Prihadi et al., 2018)		(Giri et al., 2014)	
Macroalgae	U	G	U	G	U	G
Water (%)	82.00	92.50	38.08	45.55	81.80	88.20
Ash (%)	25.70	50.30	34.49	24.80	NA	NA
Protein (%)	3.50	2.00	6.77	8.01	17.70	9.50
Carbohydrate (%)	NA	NA	21.30	22.56	NA	NA
Lipid (%)	1.70	1.20	0.19	0.10	2.70	1.50
Crude fibre (%)	4.80	4.40	3.71	5.15	NA	NA

U = *Ulva* sp.; G = *Gracilaria* sp.

However, growth performance in this study were lower than previous studies that utilizedsimilar dietary seaweed (Table 3). Current study employed 49.40 ± 0.21 mm length of abalone

H. squamata which was larger than previous study. It was suggested that body size was anotherfactor on abalone that affected its growth performance (Steinarsson & Imsland, 2003; Wu et al., 2009). Similarly, other study suggested that smaller abalone grew faster than larger abalone(Mgaya & Mercer, 1995). Meanwhile, protein requirement of larger animal was higher than smaller animal (Britz & Hecht, 1997). Thus, limited dietary protein severely hindered growth performance of larger abalone.

Table 3 Growth performance of abalone *H. squamata* from previous studies.

Reference	Current study		(Prihadi et al., 2018)		(Giri et al., 2014)
Macroalgae	U	G	U	G	G
Time (days)	90		120		120
Initial shell length (mm)	49.39	49.40	38.90	40.32	25.00
Initial body weight (g)	19.33	19.36	10.22	10.91	26.00
SGR_L (%SL/day)	0.05	0.08	0.12	0.13	0.18
SGR_{BW} (%BW/day)	0.08	0.18	0.27	0.30	0.53

U = *Ulva* sp.; G = *Gracilaria* sp.

Both red algae *Gracilaria* sp. and green algae *Ulva* sp. were commonly found to be employed in tropical abalone aquaculture as its natural diet (Ardi et al., 2020; Latuihamallo et al., 2016; Prihadi et al., 2018; Yusup et al., 2020). It is suggested that these two macroalgae were more palatable to abalone than other seaweeds due to its thin and soft texture (Yusup et al., 2020). In addition, phenolic content in these macroalgae were comparably lower than other seaweeds, such as *Halymenia* sp. (Sanger et al., 2019). Phenolic content that is commonly found in macroalgae was considered to be anti-nutritive. It also caused detrimental effect on voluntary feed intake from the animal (Wan et al., 2019). However, *Gracilaria* sp. was recognized to have higher polyphenol than *Ulva* sp. that hindered its feed efficiency (Sanger et al., 2019). Meanwhile, current study revealed that FCR value of *Gracilaria* sp. treatment were lower than *Ulva* sp. (Table 1). Previous study suggested that the low FCR indicated high feed efficiency of abalone in order to gain its body mass. Higher dietary nutrition of *Gracilaria* sp. already met nutritional and energy requirements of abalone to grow (Bautista-Teruel & Millamena, 1999).

This study revealed that, dietary macroalgae *Gracilaria* sp. had slightly higher survival rate than *Ulva* sp. However, the value of survival rate of the current study had similarity with previous studies that utilize *Gracilaria* sp. to feed tropical abalone *H. asinina*. The study found that survival rate of tropical abalone feed with *Gracilaria* sp. was 72.00% (Amin et al., 2020) which was slightly below than current study that reached up to 75.20% with *Gracilaria* sp. as well. Thus, it is suggested that mortality in this current study occurred due to handling, such as weighing and shell length measurement (Bansemer et al., 2016; Mgaya & Mercer, 1995).

Conclusion

Current study was designed to determine the effect of two different dietary macroalgae on growth of adult tropical abalone *H. squamata*. This study has found that *Gracilaria* sp. promoted growth performance, feed efficiency and survival rate on the large size abalone. However, the major limitation of this study was the short experimental period that might not long enough to represent abalone cultivation period. Additionally, the large abalone size in this study was considered to be adult that limited its response on growth performance. Despite its limitations, the study certainly adds to our understanding growth performance of the adult tropical abalone *H. squamata*. Further work is needed to fully understand the implication of dietary seaweed on growth performance and reproductive output as well of the adult.

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