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Effectiveness of Different Macroalgae Species on the Growth and Survival Rate of Mangrove Snails (*Telescopium telescopium*) in the Coastal Area of Lewoleba

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ABSTRACT

Lewoleba is one of the villages in Nubatukan Sub-district, Lembata Regency, East Nusa Tenggara, which has a coastal area and a mangrove ecosystem with a muddy substrate that is suitable as a habitat for *Telescopium telescopium*. This study aimed to evaluate the effect of different macroalgae diets on the growth and survival rate of mangrove snails, *T. telescopium*, cultivated in the coastal area of Lewoleba. The experiment was conducted for three months using a completely randomized design (CRD) consisting of four treatments with three replicates each: A (*Ulva lactuca*), B (*Padina* sp.), C (*Gracilaria corticata*), and D (a combination of the three macroalgae species). Parameters observed included absolute weight growth, absolute length growth, survival rate, and water quality. The results showed that the treatments significantly affected absolute weight gain, with the highest growth recorded in treatment D (1.34 g) and the lowest in treatment A (0.59 g). The highest absolute length growth was also observed in treatment D (0.84 cm), although it was not significantly different from the other treatments. Survival rates ranged from 76.67% to 83.33% and did not differ significantly among treatments. Water quality parameters throughout the study remained within suitable ranges for mangrove snail cultivation. In conclusion, feeding with combination of macroalgae (*Ulva lactuca* + *Padina* sp. + *Gracilaria corticata*) produced the best results in promoting the growth of mangrove snails (*T. telescopium*) compared to feeding a single type of feed.

INTRODUCTION

Coastal ecosystems are among the most productive ecosystems because they support various aquatic organisms, including gastropods such as the mangrove snail *Telescopium telescopium*, which lives and thrives in mangrove ecosystems (Husein *et al*., 2017). Mangrove snails play an important ecological role as decomposers and part of the food chain, and are of economic value to coastal communities. In addition, previous studies have shown that

mangrove snails contain nutrients and bioactive compounds such as alkaloids and flavonoids, making them a potential source of food and a commodity for cultivation (Fadli *et al*., 2020). However, their utilization and cultivation are still limited, mainly due to a lack of information on suitable and effective feed to support their growth.

Macroalgae have great potential as a natural feed source due to their nutritional content, such as protein, minerals, fiber, and bioactive components required by herbivorous organisms (Handayani & Kadi, 2019). Several studies have shown that macroalgae can be associated with gastropod communities in the intertidal zone and act as an easily available natural food source (Ohorella, 2018). The diversity of macroalgae in Indonesian waters allows for their use as an alternative feed in *T. telescopium* cultivation. However, the effect of each type of macroalgae on the growth and survival of mangrove snails has not been widely studied, including feeding preferences, consumption rates, and the morphometric response of organisms to different types of feed (Widodo *et al*., 2021).

The coastal area of Lewoleba, Lembata Regency, is one of the natural habitats of *T. telescopium* and has a fairly high diversity of macroalgae. Previous bioecological studies have shown that mangrove snail populations in several regions of Indonesia, including Kupang and Mangunharjo, are greatly influenced by mangrove forest conditions, organic material availability, and macrozoobenthos community structure (Sanger *et al*., 2019; Pratama *et al*., 2021). Therefore, this location has the potential to be an ideal area for research on cultivation and development of macroalgae-based feed. However, scientific studies related to the use of macroalgae as mangrove snail feed in Lewoleba are still limited and have not been academically documented.

Based on these conditions, this study aims to evaluate the effect of feeding various types of macroalgae on the growth and survival of mangrove snails (*T. telescopium*) on the coast of Lewoleba Beach. The results of this study are expected to serve as scientific reference in the development of cultivation techniques, increasing the economic value of commodities, and the sustainable use of coastal resources. In addition, this study is expected to provide a scientific basis for the integration of local macroalgae as an environmentally friendly and efficient alternative feed in mangrove gastropod aquaculture.

METHODS

This research was conducted over a period of three months, from June 5 to August 5, 2024, located in the intertidal zone of Lewoleba Beach, Nubatukan District, Lembata Regency, East Nusa Tenggara. Geographically, the research area is located at coordinates 8°22'15" S and 123°24'42" E. This area has muddy substrate characteristics and a mangrove ecosystem that supports the existence of gastropods, including *Telescopium telescopium*.

The test animals, mangrove snails, were obtained from their natural habitat around the research site. The macroalgae used as feed consisted of *Ulva lactuca*, *Padina* sp., and *Gracilaria corticata*, which were also collected from the local coastal area. The research design used a completely randomized design (CRD) with four treatments and three replicates. The treatments given included:

A = *Ulva lactuca*
B = *Padina* sp.
C = *Gracilaria corticata*
D = the combination of all three (*Ulva lactuca* + *Padina* sp. + *Gracilaria corticata*)

The differences among treatments in this study were based on the nutritional characteristics and bioactive compound contents of each macroalgae species reported in previous studies. *Ulva lactuca* is known to contain proteins, minerals, and bioactive compounds that can support the growth of aquatic organisms (Abdullah et al., 2023). Meanwhile, *Padina* sp. has been reported to contain nutrients and secondary metabolites beneficial as feed ingredients in aquaculture (Kumar et al., 2024), whereas *Gracilaria corticata* possesses good nutritional value and has been widely utilized in aquaculture activities due to its ability to support the growth of cultured organisms (Rameshkumar et al., 2021). Therefore, the treatments in this study were designed to evaluate the effects of single and combined macroalgae administration on the growth and survival rate of mangrove snails, *Telescopium telescopium*.

Each treatment group contained 10 mangrove snails (*T. telescopium*) collected from the research site with an initial weight of 2.5–2.8 g and an initial length of 4.8 – 8.8 cm. They were placed in 20 × 30 cm baskets attached to a muddy substrate. There were 12 baskets in total, with 6 baskets tied to the left side and 6 baskets tied to the right side. Each basket was tied using wire to 4 bamboo sticks. At the bottom of the bamboo sides, 4 stones were attached to serve as weights so that the baskets would not shift during high tide. Feed was given once a week, 75 g per container, after being finely chopped and mixed with mud to make it easier to consume.

The observed parameters included absolute weight growth, absolute length growth, and survival rate of mangrove snails (Effendie, 1997), *Telescopium telescopium.* Absolute weight growth was determined by calculating the difference between the final average weight and the initial average weight of the snails using the formula $W = W_t - W_0$ (Effendie, 1997), where W is absolute weight growth (g), W_t is the final average weight (g), and W_0 is the initial average weight (g). Weight measurements were conducted using a digital balance with an accuracy of 0.01 g. Absolute length growth was measured by calculating the difference between the final and initial shell lengths using a caliper (Effendie, 1997). Survival rate was calculated based on the percentage of surviving individuals at the end of the experiment (Effendie, 1997). All measurements were carried out at the beginning and the end of the experimental period. Water quality parameters, including temperature, pH, and salinity, were monitored every two weeks using a water thermometer, portable pH meter, and refractometer, respectively.

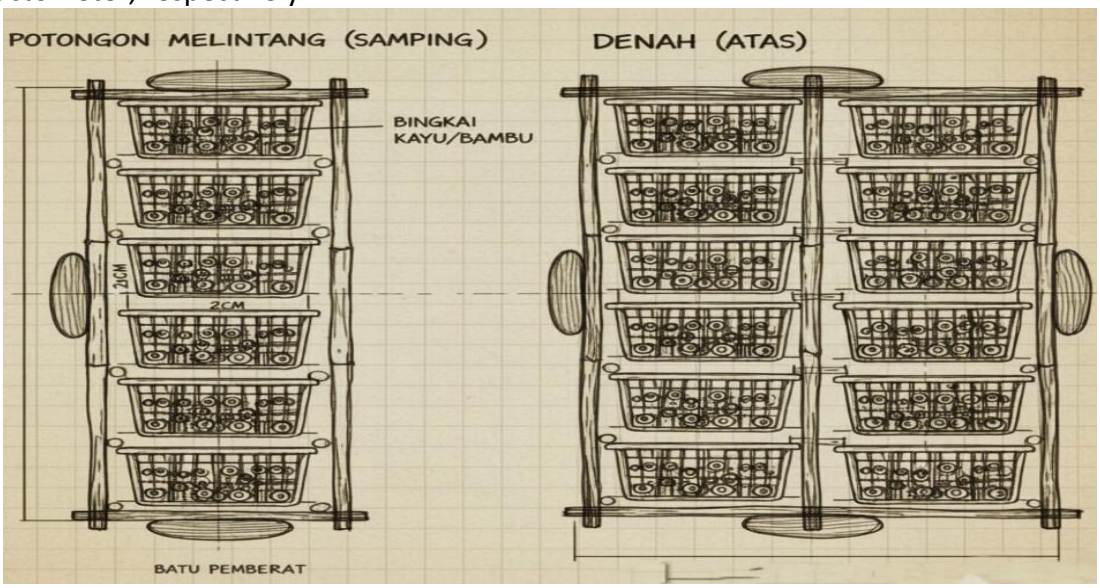

Figure 1. Construction of the Mangrove Snail Maintenance Basket

The data obtained were analyzed using analysis of variance (ANOVA) at a 5% confidence level. If significant differences were found between treatments, a follow-up test using the Least Significant Difference (LSD) was performed.

RESULTS

Absolute Weight Growth of Mangrove Snails (*Telescopium telescopium*)

The results of absolute weight growth in mangrove snails during the study are presented in Figure 2 as follows.

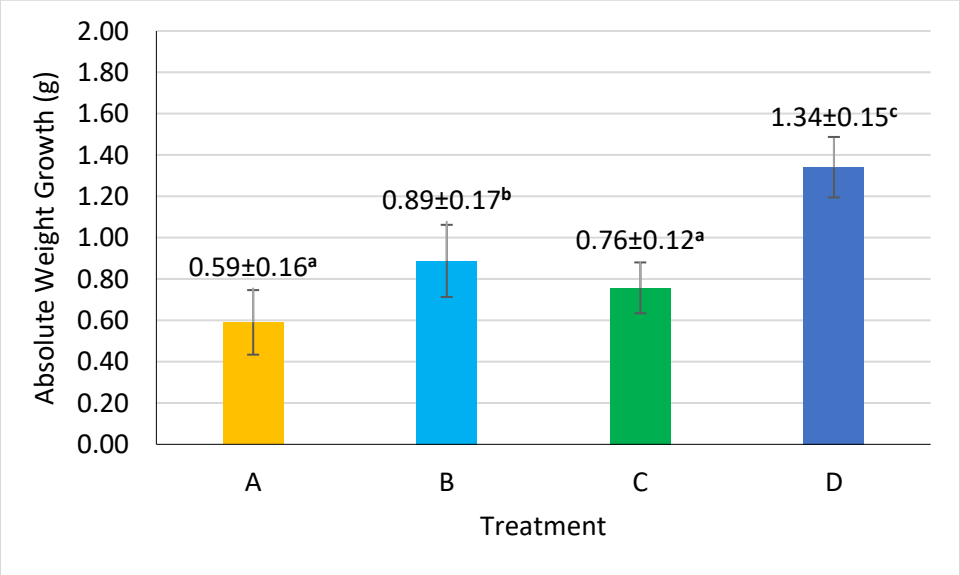

Figure 2. Absolute Weight Growth of Mangrove Snails During the Study Period

Based on the comparative analysis between treatments, treatment D (combination of *U. lactuca*, *Padina* sp., and *G. corticata*) produced the highest growth with an average value of 1.34 g, while the lowest growth was found in treatment A (*U. lactuca*) with an average of 0.59 g. A comparison of the average differences showed that the difference in growth between treatment D and the other treatments (A, B, and C) was statistically significant. This indicates that feeding a combination of three types of macroalgae had a positive synergistic effect on the growth rate of mangrove snails. The feed combination tends to provide a variety of nutrients, including protein, crude fiber, and other bioactive compounds that can support more optimal biomass growth. Conversely, the comparison between treatment B (*Padina* sp.) and C (*G. corticata*) with A shows a significant difference, while the comparison between B and C shows no significant difference, with a relatively small growth difference (0.13 g).

Absolute Length Growth of Mangrove Snails (*Telescopium telescopium*)

The results of absolute length growth in mangrove snails during the study are presented in Figure 3 as follows.

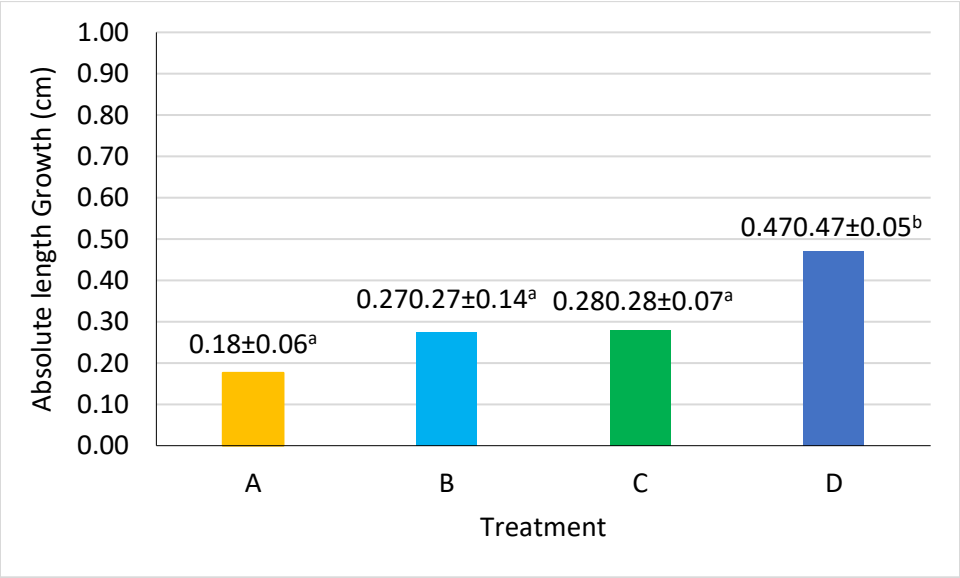

Figure 3. Absolute Length Growth of Mangrove Snails

Based on Figure 3. the absolute length growth (cm) in each treatment shows that the treatments have different effects on growth. Treatment A showed the lowest absolute length growth value of 0.18 ± 0.06 cm. Treatments B and C had relatively higher growth values than treatment A, at 0.27 ± 0.14 cm and 0.28 ± 0.07 cm, respectively. Meanwhile, treatment D showed the highest absolute length growth value of 0.47 ± 0.05 cm. This indicates that treatment D had the most optimal effect in increasing absolute length growth compared to the other treatments.

Survival Rate of the Mangrove Snail (*Telescopium telescopium)*

The survival rate of mangrove snails during the study is presented in Figure 4 as follows.

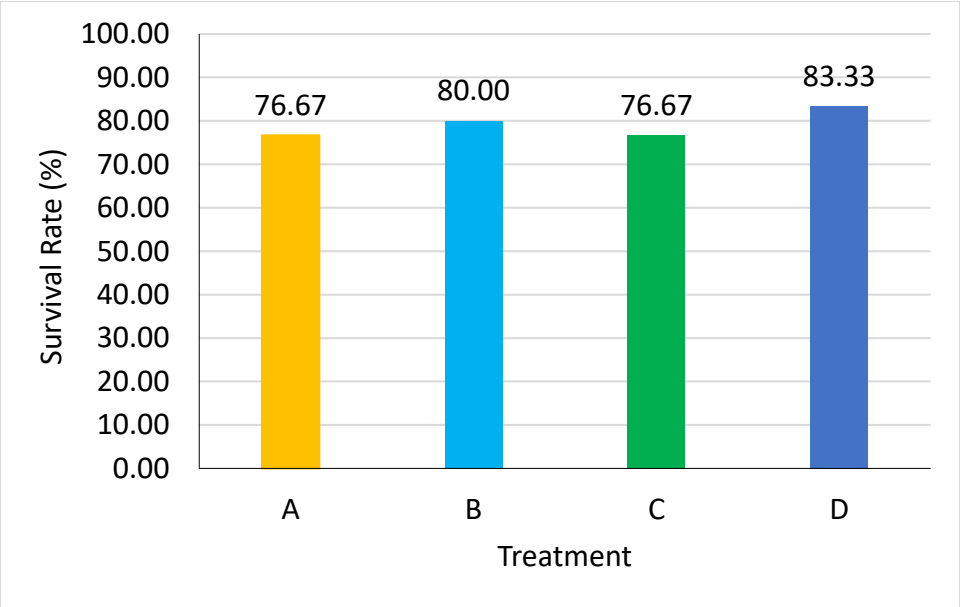

Figure 4. Survival Rate of Mangrove Snails During Maintenance

Based on Figure 4, the survival rate for each treatment shows that the survival rate of the test organisms ranged from 76.67% to 83.33%. Treatments A and C showed the same survival rate, namely 76.67%, which was the lowest value compared to the other treatments. Treatment B had a higher survival rate than A and C, namely 80.00%. Meanwhile, treatment

D showed the highest survival rate, namely 83.33%. In general, the graph shows that all treatments were still able to maintain a relatively high survival rate. However, treatment D provided the most optimal results in increasing survival compared to treatments A, B, and C.

DISCUSSION

The difference in biomass growth between treatments shows that feeding a combination of feeds has a much greater synergistic effect than feeding a single feed. Each type of macroalgae used in this study has a different nutritional composition and has the potential to complement each other. *U. lactuca* is known to be rich in protein and essential amino acids that play an important role in the formation of aquatic organism body tissue (Fidriana *et al*., 2021). Meanwhile, *Padina* sp. has a high mineral content, such as calcium, magnesium, and iodine, which play a role in the biomineralization process and shell structure strengthening (Ludi *et al*., 2022). *G. corticata*, on the other hand, contains complex polysaccharides, agar, fiber, and carbohydrates that can provide a stable energy supply during the maintenance process (Pereira *et al*., 2020). The combination of these three macroalgae has the potential to create a complete nutritional profile, enabling mangrove snails to obtain various essential nutritional components simultaneously.

The synergistic phenomenon observed in biomass growth in the combined feed treatment is also consistent with previous studies on other mollusk organisms. Fitriana *et al*. (2020) reported that feeding a combination of macroalgae significantly increased the growth rate of *H. asinina* compared to single feed, as nutritional diversity helped improve metabolic efficiency. Additionally, Supriyono *et al*. (2019) demonstrated that feed variation expands the range of digestible substrates, thereby providing the digestive system with more options for energy and protein sources. This is further explained by Mahendra & Yusuf (2021), who found that feed diversity in aquaculture systems can increase the activity of digestive enzymes such as protease, amylase, and lipase, thereby improving nutrient utilization efficiency. Thus, the increase in biomass observed in the combination treatment is a manifestation of the concept of nutrient complementarity, which is a condition where two or more types of feed can complement each other and have a better physiological impact than a single feed.

Physiologically, the combination of macroalgae is thought to increase the availability of essential amino acids needed for the growth of soft tissue in snails, as well as minerals such as calcium and magnesium, which play a role in the formation of the shell layer. Research by Wang *et al*. (2022) shows that gastropods fed the combination experienced increased digestive enzyme activity and nutrient absorption efficiency, which directly impacted an increase in body biomass. The feed combination is also thought to help reduce nutritional imbalances that may occur if organisms only receive a single macroalgae with limited nutritional content. Therefore, the high biomass growth in the combination treatment can be seen as strong evidence that feed diversification is very important in gastropod cultivation development strategies, especially for species living in mangrove ecosystems with fluctuating nutritional conditions.

The insignificant growth between single feedings indicates that the three types of macroalgae provided are still able to meet the basic nutritional requirements for linear growth of mangrove snails. This shows that Ulva, Padina, and Gracilaria are still able to provide the essential minerals needed for shell structure formation. Sari *et al*. (2017) explain that minerals such as calcium and magnesium from macroalgae play an important role in the biomineralization process of gastropods, although an unbalanced nutritional content can limit

the optimal growth rate. Thus, single feed still allows growth to occur, although not as optimally as a combination that provides a more complete nutritional profile. These findings also indicate the physiological adaptation of *T. telescopium* in utilizing various types of macroalgae as natural feed, consistent with its natural habitat in mangrove areas.

From an ecological and physiological perspective, *T. telescopium* is a gastropod with high tolerance to natural food variation. Saputra *et al*. (2019) reported that mangrove snails are opportunistic omnivores capable of utilizing various nutrient sources such as detritus, microalgae, and macroalgae available in mangrove substrates. Therefore, it is not surprising that all feeds in this study were able to support survival. However, this study also showed that although feed type had an effect on growth, environmental factors, especially salinity, appeared to have a more dominant effect on survival rates. Salinity fluctuations reaching 35 ppt during maintenance were close to the physiological tolerance limit of mangrove snails. KLHK (2004) states that estuarine organisms are sensitive to extreme salinity changes, which can cause osmotic stress.

The osmotic stress mechanism occurs when organisms have difficulty maintaining internal ionic balance, so that metabolic energy that should be allocated for growth is instead directed towards osmoregulation. Yuliana *et al*. (2018) explain that gastropods are sensitive to changes in salinity exceeding 30–35 ppt, which can cause physiological disorders such as decreased filtration rates, electrolyte imbalance, and even death. Haryono *et al*. (2021) also found that environmental fluctuations such as salinity and temperature can exacerbate stress levels in aquatic organisms and potentially reduce survival rates significantly. This is consistent with the findings of this study, where the death of some individuals was thought to be more influenced by environmental changes than differences in feed type.

Overall, the results of this study confirm that the use of a combination of macroalgae is a more effective approach than single feed in increasing the biomass growth of *T. telescopium*. However, the success of cultivation is not only determined by feeding strategies, but also by environmental stability, especially in terms of salinity. Thus, water quality management is a critical aspect that needs to be considered in the development of sustainable mangrove snail cultivation techniques.

CONCLUSION

This study shows that treatment has a significant effect on the growth of mangrove snails (*T. telescopium*). The best treatment was obtained from the combination of *U. lactuca*, *Padina* sp., and *G. corticata* (treatment D), which produced the highest absolute weight growth of 1.34 g and the highest absolute length growth of 0.84 cm. The combination of these three macroalgae was able to provide a more diverse and balanced nutritional composition, thereby increasing nutrient utilization efficiency and supporting biomass growth and shell length increase more optimally than the provision of a single macroalgae. Survival rates did not show significant differences between treatments, indicating that all types of macroalgae were still able to support the survival of mangrove snails, while environmental factors such as salinity fluctuations were thought to have a more dominant effect on the physiological response of the organisms.

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