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RECOVERY RATE OF NEW THALLUS IN Kappaphycus alvarezii SEAWEED TAKEN BY FISH IN BONE-BONE BEACH

Laju Recovery Thallus Baru Pada Rumput Laut Kappaphycus alvarezii yang Terpotong Bekas Gigitan Ikan di Perairan Pantai Bone-Bone

Andriana Putri Musdalifah*, Ma'ruf Kasim, Utama K. Pangerang

Department of Aquatic Resources Management Halu Oleo University, Indonesia

H.E.A Mokodompit Street, Anduonouhu, Kendari City, Southeast Sulawesi

*Coresponding author: i1a119030musdalifaap@student.uho.ac.id

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ABSTRACT

Thallus when eaten by fish will be physically damaged or cut off due to fish bites. Seaweed has the ability to recover from damage. For this reason, research will be conducted on the extent to which seaweed will carry out the recovery rate due to damage to the thallus that is cut off by fish-eaten bites. This study aims to determine the rate of thallus recovery due to being eaten by fish using the Horizontal Net method in the waters of Bone Bone Beach. Seaweed was put into the horizontal net with herbivorous fish (baronang). One week later the thallus was weighed at an initial weight of 50g. For observation of recovery used digital camera microscope magnification 1000x every 2 days sampling. For the growth rate of seaweed samples were weighed using analytical scales every 7 days. Water quality measurements during the study included salinity, temperature, brightness, current velocity, pH, nitrate and phosphate. The growth rate obtained is classified as good but has not reached the best level, a good growth rate is not less than 3%. The recovery rate maintained in the recovery horinet for 20 days during the maintenance period and the emergence of new thallus returns at the age of 15-20 days during maintenance. The results of the correlation between SGR and recovery rates with environmental factors show a strong correlation relationship so that environmental factors affect the rate of recovery of new thallus Kappaphycus alvarezii.

Keywords: Bone-Bone Beach, Horizontal Net, Kappaphycus alvarezii, Recovery

ABSTRAK

Thallus ketika dimakan ikan akan mengalami kerusakan fisik atau terpotong karena gigitan ikan. Rumput laut mempunyai kemampuan untuk memulihkan dirinya dari kerusakan. Untuk itu akan dilakukan penelitian tentang sejauh mana rumput laut akan melakukan laju *recovery* akibat dari kerusakan thallus yang terpotong bekas gigitan termakan ikan. Penelitian ini bertujuan untuk mengetahui laju *recovery* thallus akibat termakan ikan menggunakan metode Horisontal Net yang ada pada perairan Pantai Bone Bone. Rumput laut dimasukkan kedalam horisontal net bersama ikan herbivora (baronang). Satu minggu kemudian thallus ditimbang pada berat awal 50g. Untuk pengamatan *recovery* digunakan kamera digital mikroskop pembesaran 1000x setiap 2 hari pengambilan sampel. Untuk laju pertumbuhan sampel rumput laut ditimbang menggunakan timbangan analitik dilakukan setiap 7 hari. Pengukuran kualitas perairan selama penelitian meliputi salinitas, suhu, kecerahan, kecepatan arus, pH, nitrat dan fosfat. Nilai pertumbuhan yang didapatkan tergolong baik namun belum mencapai tingkat terbaik, laju pertumbuhan yang baik ialah tidak kurang dari 3%. Laju *recovery* yang dipelihara pada horinet pemulihannya selama 20 hari selama masa pemeliharaan dan munculnya thallus baru kembali pada umur 15-20 hari selama pemeliharaan. Hasil dari korelasi antara SGR dan laju *recovery* dengan faktor lingkungan menunjukkan hubungan korelasi yang kuat sehingga faktor lingkungan berpengaruh terhadap laju recovery thallus baru *Kappaphycus alvarezii*.

Kata Kunci: Horisontal Net, *Kappaphycus alvarezii*, Pantai Bone-Bone, Recovery

INTRODUCTION

Seaweed is one of the abundant natural resources in Indonesian waters, having the greatest diversity compared to other countries. Seaweed cultivation continues to increase and is popular with the community as the main livelihood because the cultivation technology used is simple and easily adopted by the community (Zainuddin, 2022). Seaweed cultivation is a fishery cultivation that has the potential to be developed in Indonesian waters. Seaweed is the main product of three fisheries rehabilitation programs that play an important role in improving people's standard of living (Rismawati, 2020).

Thallus growth in seaweed is an increase in cell size or a change in the number of cells that have different structures and functions. The growth pattern of seaweed causes an increase in the number of cell masses that make up the thallus (Darmawati, 2014). Internal factors that can affect seaweed growth are thallus and age, while external factors consist of physical factors (temperature, current, light and brightness) and chemical factors (salinity pH and nutrients) as well as biological factors such as the presence of parasitic organisms and natural predators for seaweed (Risnawati *et al*., 2018).

Seaweed is free from attacks by herbivorous fish and other herbivorous animals (Kasim *et al*., 2016). Cell regeneration in each explant to form a complete thallus only occurs if the explant lives in a medium that has a decent nutrient content (Fadel *et al*., 2013). Seaweed damage can also be caused by large waves and eaten by herbivores, such as rabbitfish and turtles. Efforts to avoid these predators can be done by fencing the seaweed block with a net (Anggadiredja *et al*., 2010).

To overcome this problem, it is recommended to maintain the algae species *Kappaphycus alverazii* or known by the trade name Euchema cottoni to be put in a cage that can prevent herbivores from attacking seaweed (Hurtado *et al*., 2013). Changing the use of cultivation tools from longlines to horizontal nets is expected to optimize seaweed growth. The use of horizontal nets can also increase seaweed production by preventing attacks by herbivorous fish pests. In addition, using this tool also looks better and cleaner than the longlines used by the surrounding community (Mustafa *et al*., 2020).

This study aims to determine the rate of thallus recovery due to being eaten by fish using the Horizontal Net method in the waters of Bone Bone Beach. This study is expected to be a source of information for the community, especially researchers and seaweed farmers in the waters of Bone Bone Beach, Bau Bau City, as well as a reference for further research and in the future.

METHODS

Place and Time

The research was conducted in November-December 2022, located in the waters of Bone Bone Beach, Batupoaro District, Bau Bau City, Southeast Sulawesi. Seaweed maintenance is at the coordinates -5° 27.91326’ LS – 122° 35.1091’ BT.

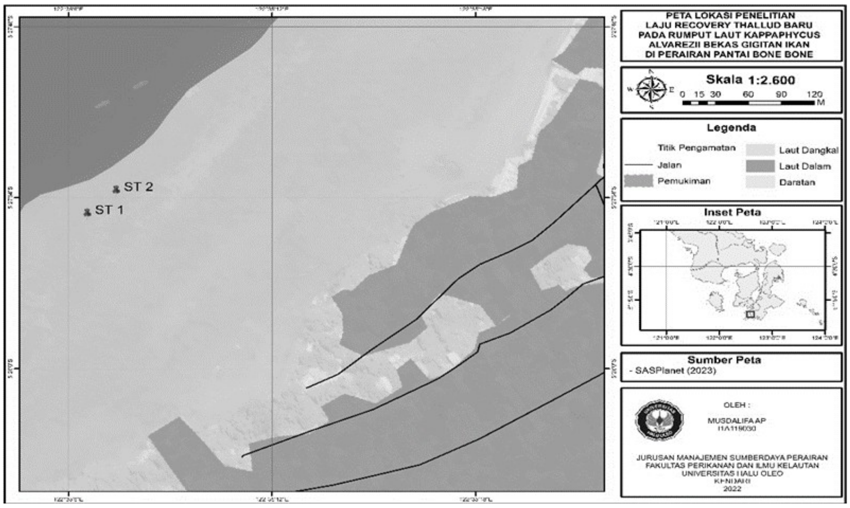


Figure 1. Research Map

Research Methods

Station selection is one of the factors that need to be considered in research on *Kappaphycus alvarezii* seaweed. The location prepared meets the requirements for cultivation. The location determined for the study is a location with a slightly muddy water base mixed with coral sand, has good ebb and flow, and other parameters that support the cultivation of *K. alvarezii* seaweed. The study was conducted in the coastal waters of Bone-Bone, Bau-Bau City, Southeast Sulawesi. The location determined is certainly free from community waste pollution so that it can support the growth of seaweed and the location is close to the seaweed cultivation efforts carried out by coastal communities and is easy to reach.

Seaweed is put into a horinet together with herbivorous fish (baronang). Within 1 week later, the thallus eaten by the fish is collected and then weighed at its initial weight of 50g for each observation thallus. Then the regeneration of the thallus is observed, the new thallus that appears as a result of being eaten by fish. The thallus that is the object of observation is marked and stored in the horinet. Data collection observations are carried out every 7 days for 5 observations for 35 days.

Floating raft method, seaweed is attached to several tools/materials that keep the seaweed floating; up and down, following the changes in the tide. With this method, make sure the seaweed is about 50 centimeters below the surface of the water. Floating tools can be a simple frame made of bamboo, PVC pipes, or other wood that is durable in seawater. This method is done by tying four bamboos 2.5 meters long in a frame. In a 2.5 meter square frame, up to 15 lines of ris rope can be stretched with a distance of 10 to 15 centimeters. Each row will carry 15 bundles of seaweed tied to a 3 millimeter ris rope with a tie rope.

Immediately after the seeds were placed in the horinet, recovery observations were carried out every 2 days. For recovery observations, a digital microscope camera with 1000x magnification was used every 2 days, observations and sampling of thallus growth were carried out, especially the surface of the injured thallus. The shooting position was carried out at the same distance and location for the same thallus every 2 days. The specific growth rate (SGR) of seaweed thallus that had undergone recovery was carried out by weighing thallus samples. A total of 10 thallus samples were weighed at each observation point. Weighing was carried out every 7 days for 5 observations, so that the total wet weight observation was 35 days.

The predetermined test plants were first cleaned of mud particles and attached plants attached to the test plants, the seaweed was weighed using an analytical scale to determine the initial weight. In the weighing process, the seaweed was continuously soaked in seawater to avoid drying out the seaweed. Observations were carried out every 2 days to observe thallus recovery and every 7 days the seaweed was weighed to determine weight gain.

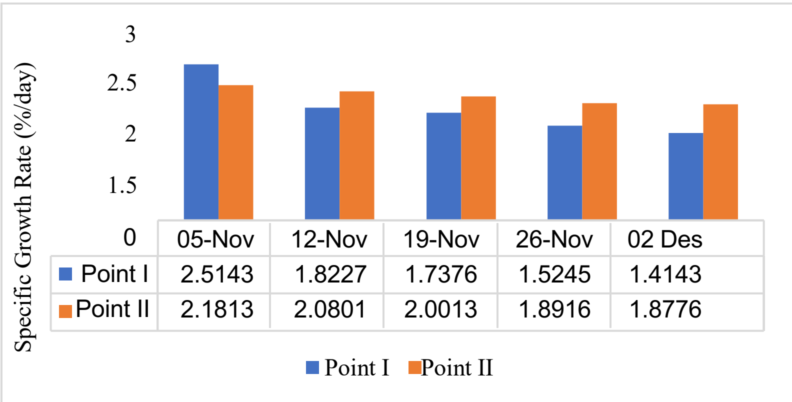
The data analysis technique used in this study is descriptive analysis. The data obtained is data sourced from the results of observations and observations during the study. SGR is calculated based on the equation formula of Penniman *et al*. (1986) as follows:

$$SGR = [(wt/w0)^{1/t} - 1] \times 100\%$$

Where:
SGR = Specific Growth Rate (%)
W0 = Initial weight (g)
Wt = Weight at the time of measurement (g)
t = Research time (days)

To determine the effect of seaweed growth with environmental factors tested using the t-test (independent sample t-test) with the help of statistical software (SPSS version 25.) with a confidence level of 95%. Analysis of the correlation relationship between the person specific growth rate (SGR) of seaweed and water quality with the help of (SPSS version 25.) with a confidence level of 95%.

RESULT



	05-Nov	12-Nov	19-Nov	26-Nov	02 Des
Point I	2.5143	1.8227	1.7376	1.5245	1.4143
Point II	2.1813	2.0801	2.0013	1.8916	1.8776

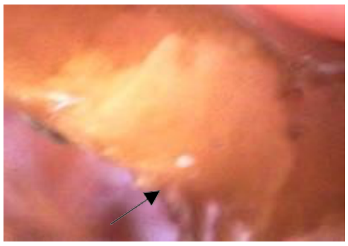
Figure 2. Specific Growth Rate (SGR) Graph of *Kappaphycus alvarezii*

Table 1. Results of Water Quality Parameter Measurements

Parameter		Observation Day					Comparative Literature
		7	14	21	28	35	
Temperature (°C)	Point I	29,6	29,3	30,3	31,6	28,3	26-33 (Aslan, 2011)
	Point II	29,8	30,1	30	31,8	26,6	
Brightness (%)	Point I	100	100	100	100	100	100 (Kasim *et al*., 2014)
	Point II	100	100	100	100	100	
Current Speed (m/s)	Point I	0,05	0,07	0,03	0,14	0,08	0,04-0,15 (Candra *et al*., 2018)
	Point II	0,05	0,04	0,04	0,16	0,06	
pH	Point I	7	7	7	7	7	7-8 (Rejeki *et al*., 2015)
	Point II	7	7	7	7	7	
Nitrat (mg/L)	Point I	0,14	0,13	0,14	0,16	0,14	0,1-0,7 (Cokrowati *et al*., 2018)
	Point II	0,14	0,14	0,17	0,15	0,13	
Phosphate (mg/L)	Point I	0,03	0,03	0,03	0,05	0,06	0,02-1,4 (Saifullah *et al*., 2015)
	Point II	0,03	0,02	0,04	0,05	0,06	

Parameter		Observation Day					Comparative Literature
		7	14	21	28	35	
Salinity (ppt)	Point I	35	35	35	35	35	32-35 (Ode, 2014)
	Point II	35	35	35	35	35	

Table 2. Recovery Rate of *Kappaphycus alvarezii* Thallus

Observation Time	Description	Picture
05-November-2022	Wounds caused by fish bites, the thallus is clear and produces mucus	
12-November-2022	Mucus begins to decrease on the wound, the thallus appears dry, the scar is still clearly visible	
19-November-2022	The scar begins to turn brownish in color, small bumps appear	
26-November-2022	The scar has healed and a protrusion has begun to appear in the center of the formed thallus	
02-December-2022	The lump is becoming more visible and bigger, it is thought that this is a new thallus that appears due to a fish bite	

DISCUSSION

The growth values obtained are classified as good but have not reached the best level, where a good growth rate is not less than 3%. A profitable growth rate is above 3% (Julizar *et al*., 2018). On the other hand, the growth rates achieved by both culture techniques in Kibuyuni showed the same pattern as those in Mkwiro, but with relatively lower growth rates. The highest RGR of 5.7 and 3.6% d^{-1} observed in the FR and MB techniques in Mkwiro in October decreased to 1.7 and 1.4% d^{-1} in the FR and MB techniques respectively in December (Kimathi *et al*., 2018).

Gujarat region, India where seaweed growth was studied in 3 different seasons. From the results of the study, it was found that the total high yields were in the Okha Mandal area (summer 19.2 and 2.2 kg, winter 17.39 and 1.86 kg, rainy season 15.37 and 1.33 kg) and the lowest was recorded in Miyani Village with NO_3-N nutrients 8.69 ± 0.40, total phosphate 1.28 ± 0.28. So this study shows that the coastal areas of Okha Mandal and Diu are suitable for *K. alvarezii* culture in summer, winter and rainy season. The most extensive growth is in summer. It can be seen that the lowest growth is in the rainy season, this indicates that growth is also influenced by the season (Makwana, 2011).

Based on the results of observations of the recovery rate of *K. alvarezii* seaweed maintained using the horizontal net method, it shows that the recovery rate is relatively fast but takes time to produce new thallus on seaweed. The recovery rate of *K. alvarezii* seaweed was found in the 3rd week of maintenance, which was marked by the fading of scars and the beginning of small protrusions. However, under certain conditions, thallus damage did not recover, but instead became more susceptible to infection by diseases, such as ice-ice disease (Tolanamy *et al*., 2017). Seaweed is able to cause antimicrobial effects against bacteria isolated from seaweed infected with ice-ice disease. Furthermore, *K. alvarezii* also produces antimicrobials to protect itself from ice-ice disease (Tokan, 2015). The results of the study showed that new thallus on scars emerged at the age of 15-20 days of maintenance. Shoots began to appear at the age of 9-15 days of maintenance (Redjeki *et al*., 2013). This is supported by the fact that the thallus began to develop after 2 weeks of maintenance, starting with the presence of small spots in the middle of the thallus explant, and the development of new shoots was marked by the presence of fresh greenish brown spots around the surface of the explant. These spots are potential new shoots through vegetative growth (vegetative phase) (Raihani *et al*., 2016).

Seaweed thallus that has been affected by disease or physical damage will require more strength for the recovery process, which also affects the growth rate of seaweed. Research in Tanzania on the growth rate ability of *K. alvarezii* reported that the gel strength of *K. alvarezii* in winter was significantly higher (211 ± 15.51 g cm^2) for healthy seaweed compared to infected seaweed (183.5 ± 3.19 g cm^2) ($p < 0.05$). Meanwhile, in summer, healthy *K. alvarezii* had higher gel strength, with an average value of 339.37 ± 41.87 g cm^2 compared to infected ones, which had an average value of 290.63 ± 11.8 g cm^2. Seaweed in the recovery period will affect the growth rate because healthy seaweed has a higher water content compared to infected seaweed (Ndawala *et al*., 2022).

The temperature during the study period ranged from 26.6°C-31.8°C. This condition is included in the good category so that the wound healing process on the seaweed thallus is not hampered and can be recovered properly.

The range of brightness values obtained illustrates that these conditions are still relatively good for the growth and recovery of *K. alvarezii*. The growth process and preparation of seaweed cells are highly dependent on the intensity of sunlight to carry out photosynthesis. In this process, seaweed cells can absorb nutrients to stimulate their development, cell division activity and the formation of new shoots (Julizar *et al*., 2018). The intensity of sunlight obtained is also one of the factors that determines the characteristics of the distribution, growth, morphology, and physiology as well as the productivity of seaweed.

The salinity obtained during the study was 35 ppt, which is still in the category suitable for the growth of *K. alvarezii* seaweed. Seaweed requires full salinity of 32-35 ppt to obtain optimal growth (Ode, 2014). The range of values obtained in this study is also the same as that obtained by the study, which is around 34-35 ppt (Dita, 2021). Other studies also obtained the same results in the Jenneponto seaweed cultivation area, namely the results of salinity measurements in both places ranged from 30-35 ppt (Atmanisa, 2020). In other studies, the average annual salinity values were 31.50 ± 1.88, 30.92 ± 1.88 and 31.75 ± 1.71 ppt in Vedalai, Munaikadu and Thoniturai, respectively (Periyasamy *et al*., 2014). Seaweed thallus recovery is supported by stable salinity conditions in waters that are good at supporting wound healing and seaweed growth.

The pH obtained from the research results is 7. Wounds on the thallus take 15 days to heal and 20 days for the seaweed to produce new thallus during the maintenance process so that the pH in these waters supports recovery for *K. alvarezii* seaweed. This value is comparable to that obtained in research in the Jenneponto seaweed cultivation area, namely the acidity level (pH) measured using a pH meter obtained the highest results with an average of 7.7, while the lowest pH value was an average of 7.6 (Atmanisa, 2020). Other studies have found that the pH value is at 6.3-7.3, where this value still meets the water quality standards according to Government Regulation Number 82 of 2001 (Sitepu *et al*., 2021).

The current speed obtained is in the range of 0.03-0.16 m/s. During the wound healing process on the thallus, seaweed is assisted by the current in terms of obtaining nutrients that are used as energy for growth and recovery from damage, but currents that are too high can worsen the damage to the seaweed thallus. A good current will bring nutrients to plants and plants will be clean because dirt and sediment that sticks will be washed away by the current. So it can be seen that the range of values obtained in this study is still within the criteria of physical and chemical parameters for the suitability of *K. alvarezii* seaweed cultivation waters.

The nitrate obtained from this study ranged from 0.13-0.17 mg/L. This nitrate level is still in the normal category where this value is the same as that obtained in the study of the average nitrate concentration obtained in these waters ranging from 0.013-0.015 mg/l. The good nitrate range for the growth of cultivated seaweed so that it can grow optimally is between 0.9 - 3.5 ppm (Asni, 2015). The phosphate obtained was in the range of 0.029-0.063 mg/L. The acquisition of this phosphate value was also the same as that obtained in the study, namely a phosphate level of 0.2-0.3 mg/L (Sitepu *et al*., 2021). In general, the average phosphate level in Jikumerasa waters ranges from 0.005-0.012 mg/l, indicating that these waters are quite fertile (Patty *et al*., 2015).

The results of nitrate and phosphate reported from other studies where the average annual nitrate content was 2.08 ± 1.52, 1.88 ± 1.12, and 1.42 ± 0.96 µM in Vedalai, Munaikadu, and Thonithurai while the average annual phosphate content was 1.42 ± 0.72, 1.61 ± 0.64, and 1.29 ± 0.64 µM in Vedalai, Munaikadu, and Thonithurai (Periayasamy *et al*., 2014). Nitrate and phosphate as nutrients in water are very necessary to support the wound healing process in seaweed thallus. During wound recovery, *K. alvarezii* requires energy to fade and stop damage to the thallus.

CONCLUSION

The recovery of wounds due to fish bites on the thallus of K. alvarezii seaweed maintained in horizontal nets showed a recovery rate of 20 days with the emergence of new thallus in the 3rd week, which was 15 days during the maintenance period.

From the results of the correlation between Specific Growth Rate (SGR) and environmental factors, it showed a strong correlation with supporting environmental factors, namely temperature, pH, salinity, brightness, nitrate and phosphate. Meanwhile, current speed did not affect the supporting factors for the growth and recovery of *K. alvarezii* seaweed.

Based on the Pearson correlation analysis, the relationship between water quality parameters and *K. alvarezii* recovery showed that temperature, pH, salinity and brightness were at optimum conditions with a moderate level of correlation. Nitrate and phosphate values outside the optimum conditions with a negative correlation indicated no relationship, but these conditions were still within the tolerance limits of *K. alvarezii*. Meanwhile, the results of current speed showed a relationship that did not support the growth of *K. alvarezii* seaweed.

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