The Seaweed *Kapppaphycus alvarezii* cultivation from different aquatic activity locations

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DOI: 10.29322/IJSRP.11.07.2021.p11503
http://dx.doi.org/10.29322/IJSRP.11.07.2021.p11503

Abstract- This research was conducted to analyze the growth rate at different locations, namely residential areas, estuary area and ports. The research was conducted in the coastal waters of Bantaeng Regency. The research was conducted by growing *K. alvarezii* in different environments, namely the long line planting method. In each of these environments, 50 grams of seed was tied to the tiller rope, the length of the tiller rope was 15 cm, the distance between the tiller points was approximately 20 cm with a length of 5 m each rope as many as 3 replications. The results showed the highest daily and absolute growth rates were 1.31% and 14.72 g in the estuary area.

Key Word- *Kappaphycus alvarezii*, location, growth rate

I. INTRODUCTION

Seaweed of *K. alvarezii* is widely cultivated by coastal communities because it can increase the level of community income and the need for raw materials increases so that it can become a source of foreign exchange due to the large demand for seaweed for export. Seaweed is a leading export commodity from South Sulawesi Province, where 70% is exported to China (Suryawati, 2018). *K. alvarezii* is a type of seaweed that is widely used because of its carrageenan content which is widely used as raw material, cosmetics and food needs at home and abroad (export). Carrageenan contained in *K. alvarezii* is a type of kappa carrageenan.

The Regency of Bantaeng is a coastal area that has a 21 km coastline, making this area one of the seaweed producers in South Sulawesi. In general, the people who live around the coast are not only fishermen but also seaweed cultivators because the results obtained can significantly increase their income. Almost along the coastline is filled with seaweed cultivation. The success of *K. alvarezii* cultivation is influenced by several factors, one of which is the location. According to Doty (1988, in Yusuf, 2004) site selection is one of the conditions for success in seaweed cultivation. The ecological factors of seaweed cultivation include physical, chemical and biological environmental conditions.

Coastal areas in Bantaeng Regency can be in the form of residential areas, river estuaries or ports which are suspected of having different environmental quality conditions. To increase seaweed production in Bantaeng Regency, it is necessary to research the potential of seaweed maintenance in the three coastal areas.

II. RESEARCH METHOD

The research was conducted from September to November 2019 in the coastal waters of Bantaeng Regency. Analysis of water quality parameters was carried out at Water Quality Laboratory, Hasanuddin University, Makassar.

The research location consists of three locations with different waters conditions, namely around:

1) Settlements (Station 1) ±400 m from the beach
2) River estuary (Station 2) ±400 m from the beach
3) Ports (Station 3) ±500 m from the beach

The distance between settlements to the estuary area is ±10 km, the estuary area to the port is ±5 km.

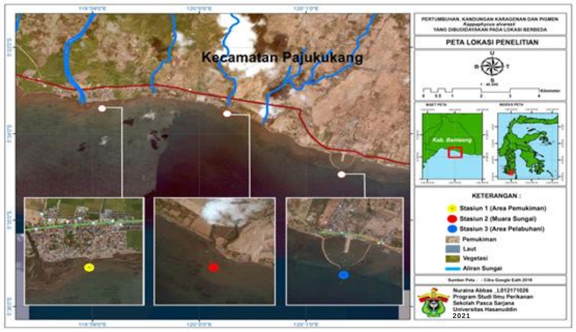

Figure 1. Research Location

The research was conducted by growing *K. alvarezii* with the long line planting method (Figure 2). Seedlings of 50 grams were tied to a tie rope, the length of the rope was 15 cm from the ris rope, the distance between the ties of the seeds was approximately 20 cm with the length of the ris rope of 5 m and as many as 3 repetitions. Where the repetitions of each of the 3 ris ropes, namely the right end, middle and left end, in 1 ris rope there are 25 ties of seeds, the distance between the ris ropes is 90 cm. Each neighborhood has 75 ties in one raft.

Growth data was collected by weighing the wet weight of seaweed every week that was cultivated for 45 days. Bond samples were weighed one bond each in each replication/week. Growth rate parameters include daily growth rate and absolute growth of seaweed.

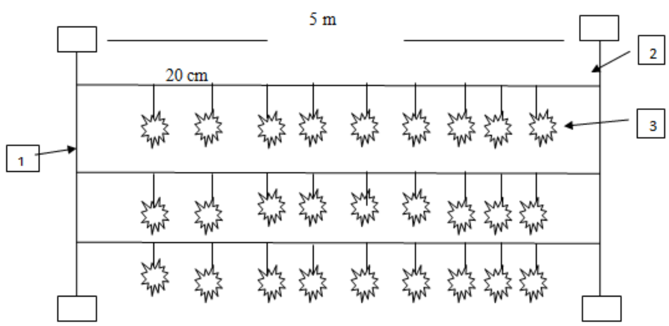

Figure 2. Long line Method

Description:

: Ballast

1 : Main rope

2 : Ris rope

3 : Seaweed seeds

1) The daily growth rate is calculated using the formula of Dawes et al. (1994) as follows:

$$SGR = \frac{\ln Wt - \ln Wo}{t} \times 100\ \%$$

Where:
SGR = Specific growth rate (%/day)
Wo = Weight of the test plant at the beginning of maintenance (g)
Wt = Weight of the test plant at the end of maintenance (g)

t = Maintenance time

2) The absolute growth rate of seaweed is calculated using the following formula (Effendi, 1997):

$$G = Wt - Wo$$

Where:
G = Absolute growth (g)
Wt = Final weight (g)
Wo = Initial weight (g)

3) Water Quality Parameters

The observed water quality parameters, tools or methods of measurement and measurement time can be seen in Table 1.

Table 1. Water Quality Parameters, Tools or Methods of Measurement and Measurement Time at Different Locations

Parameters	Tool/Method	Measurement
Temperature	Thermometer	Initial, Middle and End
Salinity	Handrefractometer	Initial, Middle and End
Current Velocities	Current Flyflow	Initial, Middle and End
pH	pH meter	Initial, Middle and End
Total Suspended Solid	Gravimetric	Initial, Middle and End
Nitrate	Spectrophotometer	Initial, Middle and End
Phosphate	Spectrophotometer	Initial, Middle and End
Ammonium	Spectrophotometer	Initial, Middle and End
Sulfate	Spectrophotometer	Initial, Middle and End
Magnesium	Spectrophotometer	Initial, Middle and End
Calcium	Spectrophotometer	Initial, Middle and End

ANOVA testing was carried out to determine the growth rate of seaweed *K. alvarezii* at different locations at a significant level of 95% (Steel and Torrie, 1980), as a tool for statistical analysis used SPSS version 16. Parameters data for water quality analyzed descriptively.

III. RESULTS

1) Daily Growth Rate and Absolute Growth Rate

. The location of the river estuary shows a relatively higher daily growth rate of 1.31% compared to the residential location of 1.21% and the port of 1.08%. Growth around the port provides the lowest growth (Figure 3).

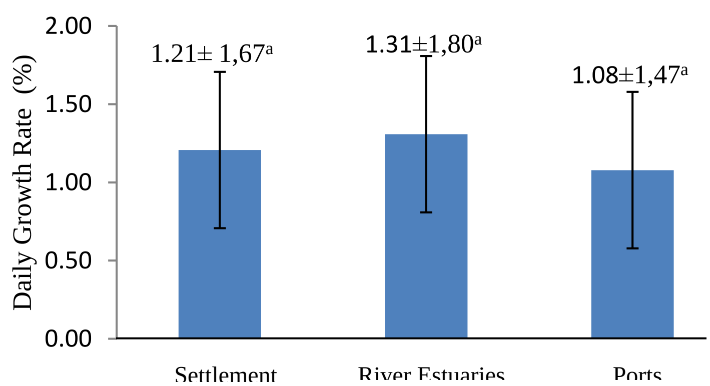

Figure 3. Graph of the Daily Growth Rate (%) of *K. alvarezii* at Settlement Locations, River Estuaries and Ports

The location of the river estuary shows a relatively higher absolute growth rate of 14.72 g compared to the residential location of 12.11 g and the port of 9.83 g (Figure 4).

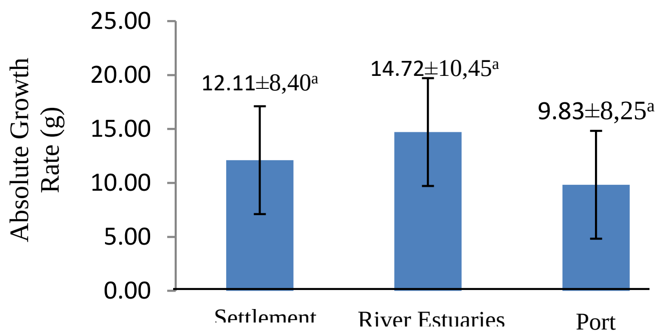

Figure 4. Graph of the Absolute Growth Rate (g) of *K. alvarezii* at Settlement Locations, River Estuaries and Ports.

2) Water Quality Parameters

Water quality parameters measured at each aquaculture location can be seen in Table 2 below:

Table 2. Water Quality Parameters of Seaweed, *K. alvarezii* at Different Locations

Parameters	Settlements		River Estuaries		Ports	
	Range	Average	Range	Average	Range	Average
Temperature (^{0}C)	22-25	24	22-25	24,22	21-26	24,11
Salinity (ppt)	35-37	36,22	35-37	35,89	35-39	36,22
Velocities(cm/second)	1,62-2,00	1,79	1,76-2,14	1,95	1,76-2,00	1,85
TSS (ppm)	2,62-4,04	3,01	2,18-3,94	2,90	2,47-4,02	3,01
pH	7,65-8,14	7,93	7,66-8,18	7,98	7,57-8,05	7,82
Nitrate (ppm)	tt-0,174	0,085	tt-0,167	0,092	tt-0,170	0,060
Phosphate (ppm)	0,093-0,859	0,500	0,066-0,968	0,546	0,011-0,995	0,570
Ammonium (ppm)	0,0013-0,0417	0,0221	tt-0,0545	0,0261	tt-0,1481	0,0493
Sulfate (ppm)	1361,6-1781,5	1596,8	1314,9-1797,9	1594,2	1533-1721,4	1618,6
Magnesium (ppm)	1189,3-1599,3	1423	1337,3-1546,5	1443,8	1278,5-1627,6	1618,6
Calcium (ppm)	141,8-280,7	226,9	203,1-295,9	243,5	215-338,5	265,6

IV. RESULTS

1) Daily Growth Rate and Absolute Growth Rate

According to Atmaja, et al. (1996), the optimum daily growth rate for seaweed of *K. alvarezii* is 3 %/day. The results of the research of Rusdani (2013) showed a daily growth rate of 3.71 to 5.52 %/day. The low growth of seaweed is due to several physical, chemical and ecological conditions that adversely affect the growth of seaweed (Cokrowati et al., 2018). The low concentration of nitrate in all locations is thought to be the cause of the low growth rate, this is also the case in research of Fachruddin and Yaqin (2015) that the low growth rate of seaweed cultivated in Bantaeng waters may be caused by low nitrate content. According to Kamlasi (2008) nitrate is a limiting factor if the concentration is <0.1 ppm and >4.5 ppm. Hayashi et al. (2008) stated that nitrate affects seaweed production because nitrate is the main nutrient for plant and algae growth. Seaweed growth increases with increasing levels of nitrate in the waters. According to Yusuf (2004) the range of nitrate concentrations in water suitable for seaweed fertility is 0.1-3.50 ppm. Aslan (1998), stated that the lowest nitrate levels for algae growth ranged from 0.3-0.9 ppm. According to Badraeni (2020) the decrease in seaweed growth in the dry season is thought to have lower nitrate concentrations (0.1-0.2 ppm). The ammonium range of the three locations was optimum. Zatnika (2009) stated that the optimal concentration of ammonium in water for seaweed growth ranged from 0.01-3.50 ppm.

The absolute growth rate of the seaweed of *K. alvarezii* at three locations indicated that the location of settlements and ports was relatively lower than the location of the estuary areas because the TSS value of the settlement and port locations was higher than the location of the estuary area. This is presumably due to household activities and the way in and out of ships, each of which generates household waste and bottom-waters sediment that is lifted to the surface water layer when ships and boats start sailing out of the port. TSS (Total Suspended Soil) is the main factor causing water turbidity (Syamsuddin, 2014). Household waste can increase the turbidity of water (Doty, 1988 in Yusuf, 2004). The lowest TSS is at the estuary location, at the three locations it is still below the water quality standard threshold based on the Decree of the State Minister of the Environment No. 51 of 2004 for Marine Biota 20 mg/l.

The current velocity at the estuary area is higher than the location of settlements and ports. Mubarak (1981, in Syahputra, 2005) stated that good water currents can ensure the availability of nutrients for seaweed. Nitrogen can be absorbed by *K. alvarezii* in the form of ammonium and nitrate, but ammonium is preferred over nitrate (Yang et al., 2006; Syamsuddin, 2014; Syamsuddin, 2018). The ammonium concentration is still in the reasonable range, which is around 0.1024-1.0219 ppm. Widiatmoko (1984, in Pariakan, 2012) states that the ammonium content that is still feasible for marine organisms is 0.5 ppm.The highest ammonium range value (0.1481 ppm) at the port location. Wheeler and Srivastava (1984 in Syamsuddin, 2018) suggested a closer correlation of ammonium concentration when compared to nitrate on growth and higher ammonium absorption by seaweed in comparison with nitrate uptake.

According to Syamsuddin (2018), phosphate is a constituent of protoplasm (an essential part of living cells) which plays a role in reducing abortion (cessation of organ growth), plays a role in the formation of meristem tissue, stimulates cell division and repairs damaged tissue. Phosphate concentrations at the three locations did not show significant differences, including the optimum. The optimum phosphate range for seaweed growth was 0.051-1.00 ppm (Indriani and Sumiarsih, 2003).

According to Ateweberhan et al. (2014), in general the growth rate was higher during winter (April - August, 5.04%/day±0.31) than in summer (3.90%/day±0.28). Ohno et al. (1996) stated that the average daily growth rate was 6.14-6.26%/day in winter and in summer, the average decreased to 3.95-5.62%/day, the plants turned pale. and fragile. According to Periyasamy et al. (2014), variations in environmental parameters such as temperature, salinity, nitrate and phosphate affect seaweed growth. Minimum growth temperature 33-35 ^{0}C. The maximum salinity growth was in the range of 29-34 ppt. According to De Goes and Reis (2011), seawater temperature and salinity are other factors that affect daily growth rates. The maximum daily growth rate is at a temperature of 28-32 ^{0}C (SubbaRao et al., 2008; Periyasamy et al., 2014).

The waters temperature at the three locations is still suitable for seaweed growth, which is in the range of 21-26 ^{0}C. This is not much different as revealed by Anggadiredja et al. (2006), that a good temperature range for the growth of *K. alvarezii* is 27-28 °C. According to Parenrengi et al. (2010), a good temperature range for seaweed growth is 20-28 °C. The salinity of the waters was quite high at the three locations, but the locations of settlements and ports were the highest, this was due to the dry season which further affected the growth of seaweed. According to Trono and Ohno (1987, in Asni, 2015) high water salinity causes seaweed thallus to not grow well. According to Atmadja et al. (1996), a good salinity range for the growth of *K. alvarezii* is 28-34 ppt. The optimum salinity for growth of *K. alvarezii* ranged from 28-34 ppt. High salinity fluctuations can affect physiological processes, including in this case, the rate of photosynthesis of *K. alvarezii* (Dawes, 1981). According to Atmadja et al. (1996), the current velocity that can support optimal growth rate of the seaweed of *K. alvarezii* is 20-40 cm/second. The current velocity at the three locations is the highest at the estuary location but is still low below 20 cm/second. The low current velocity is thought to affect growth due to lack of nutrients, the same thing according to Badraeni (2020) the current velocity in the dry season is relatively slow, where currents play an important role in the movement of nutrients in the waters.

The pH at the three locations did not differ much, including the optimum. The optimum pH range to support the survival of *K. alvarezii* is 7-8.5 (SNI, 2010). According to Kadi and Atmadja (1988, in Armita, 2011) a good pH value for the growth of *Eucheuma sp.* species ranged from 7-9 with an optimum range of 7.9-8.3. Luning (1990) states that increasing the pH value will affect the life of seaweed and the tendency of the waters to have a high acidity level due to the entry of large amounts of organic waste. The concentration of phosphate at the three locations did not show a significant difference, including the optimum. The optimum range of phosphate for seaweed growth is 0.051-1.00 ppm (Indriani and Sumiarsih, 2003), the value in the range of 0.011-0.995 ppm is slightly lower. Wetzel (1975) stated that orthophosphate is a form of phosphorus that is utilized directly by aquatic plants. The higher concentration of phosphate in the dry season compared to the rainy season is due to the higher weathering process in the dry season, besides that in the dry season there is a process of stirring the water mass from bottom to top (upwelling) (Edward and Tarigan, 1997 in Nursidi et al., 2012) . The three locations are classified as high fertility levels, during the dry season of the study.

The sulfate concentration at the three locations did not show a significant difference. According to Baracca (1999, in Prasetyo, 2007) sulfate is needed for protein synthesis in the form of sulfate bonds and the production of sulfated polysaccharides (carrageenan). The concentration of magnesium at the three locations did not show a significant difference, it was suspected that this had an effect on chlorophyll a. Magnesium concentrations ranged from 4054,1-6456.1 ppm (Akmal et al., 2012) which was higher than Kune (2007, in Akmal et al., 2012) in the range of 1280-1290 ppm. The chlorophyll concentration at the port location is lower than the estuary location, possibly because the port is a transportation route which affects TSS which inhibits light intensity for photosynthesis of chlorophyll formation and also high salinity. The concentration of calcium at the three locations, the range of port locations was higher (215-338.5 ppm). Baracca (1999, in Prasetyo, 2007) states that calcium is for the formation of cell membranes and walls.

CONCLUSION

Based on the research results obtained, it can be concluded that the best daily growth rate and absolute growth rate of *K. alvarezii* are at the river estuary area 1.31% and 14.72 g.

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