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Analysis of Location Suitability in Lombok Island Waters for The Development of *Gracilaria* sp Seaweed Cultivation

Analisis Kesesuaian Lokasi Di Perairan Pulau Lombok Untuk Pengembangan Budidaya Rumput Laut (*Gracilaria* sp.)

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ABSTACT

Seaweed is a biological resource that has been used by the Indonesian people as a livelihood. Types of *Gracilaria* sp. is one of the widely cultivated seaweeds, including on the island of Lombok, West Nusa Tenggara. Seaweed (*Gracilaria* sp.) is a leading commodity in the fishery sector which has considerable opportunities in the field of cultivation. The quality of the waters in the waters that are still extensive and suitable for aquaculture will support the production of seaweed. Gracilaria sp. seaweed cultivation activities. has been done for a long time but has not yet studied the suitability of water quality as a condition for supporting growth. This research was conducted in April-May 2022 to analyze water quality (temperature, salinity, brightness, depth, dissolved oxygen, pH, nitrate, phosphate, chlorophyll. The results of the research is expected to be a source of information on the influence of gracilaria seaweed cultivation on appropriate water quality. This study aims to determine the level of suitability of waters based on physical and chemical conditions for seaweed cultivation locations in the waters of Ekas Bay, Malacca Bay and West Sekotong. The results are expected to be a source of information and can used as a reference by the community or local government in the development of seaweed cultivation activities.The results showed that the waters of Ekas Bay, Malacca Bay and West Sekotong were included in the category according to the score obtained in the range of 66-78.

ABSTRAK

Rumput laut adalah sumber daya hayati yang telah dimanfaatkan masyarakat Indonesia sebagai mata pencaharian. Jenis *Gracilaria* sp. adalah salah satu rumput laut yang banyak dibudidayakan, termasuk di pulau Lombok, Nusa Tenggara Barat. Rumput laut (*Gracilaria* sp.) adalah komoditi unggulan di sektor perikanan yang memiliki peluang cukup besar di bidang budidaya. Kualitas perairan serta lahan yang masih luas menunjang hasil produksi rumput laut. Kegiatan budidaya rumput laut jenis *Gracilaria* sp. telah lama dilakukan namun belum belum mengkaji kesesuaian kualitas air sebagai syarat pendukung pertumbuhan. Penelitian ini dilakukan pada bulan April-Mei 2022 untuk menganalisis kulaitas air (suhu, salinitas, kecerahan, kedalaman, oksigen terlarut, pH, nitrat, fosfat, klorofil. Hasil penelitaian diharapkan menjadi sumber informasi pengaruh budidaya rumput laut gracilaria pada kulaitas perairan yang sesuai. Penelitian ini bertujuan mengetahui tinngkat kesesuaian perairan berdasarkan kondisi fisik kimia untuk lokasi bididaya rumput laut di perairan Teluk Ekas, Teluk Malaka dan Sekotong Barat. Hasil penelitian diharapkan menjadi sumber informasi serta dapat dijadikan bahan acuan oleh masyarakat atau pemerintah daerah dalam pengembangan kegiatan budidaya rumput laut. Hasil penelitian menunjukan bahwa perairan Teluk Ekas, Teluk Malaka dan Sekotong Barat termasuk dalam kategori sesuai dengan diperoleh skor berada pada kisaran 66-78.

Kata Kunci *Rumput Laut (Gracilaria* sp.)*, In Situ, Kualitas Air*

Keywords *(Gracilaria* sp.) *Seaweed, In Situ, Water Quality*

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INTRODUCTION

Seaweed is a type of marine organism which is generally used as a basic ingredient for making various kinds of food or cosmetic products. Several types have been attempted to be cultivated by coastal communities because they have important economic value, such as Gellidium sp, Hypnea sp, Eucheuma sp, *Gracilaria* sp and *Sargasum* sp. The five genera that have economic value, Eucheuma and Gracilaria, have the potential to develop cultivation businesses because they can grow well using stems vegetatively. The presence of seaweed throughout Indonesian waters is very abundant, especially on beaches that have flat coral reefs (Istiana, 2016). Seaweed Gracilaria sp. is a type of red algae seaweed that has been developed in Indonesia. This type of seaweed has environmental tolerance, and can grow in marine and brackish waters, so it has great potential for cultivation in ponds (Anton, 2017). Seaweed (*Gracilaria* sp.) is a leading commodity in the fisheries sector which has quite large opportunities in the field of cultivation. Water quality in ponds that is suitable for cultivation will support increased seaweed production. Gracilaria sp seaweed cultivation activities. It has been carried out for a long time but has not yet studied the suitability of water quality as a condition for supporting growth.

METHODS

Research sites

This research was carried out in April - May 2022 at several water locations, namely Ekas Bay (East Lombok), Malaka Bay (North Lombok) and West Sekotong (West Lombok).

Tools and materials

The tools used in this research include a probe to measure depth, a GPS to determine location accuracy, a sechidisk to measure water brightness, a refractometer to measure water salinity, a thermometer to measure water temperature for storing samples, a cool box for cooling samples, sample bottles for water sample containers, spectrometers for measuring chlorophyll levels.

The materials used in this research include *Gracilaria* sp seaweed as research test material, distilled water as a solvent, sample preservative ice cubes, pH kit to measure water pH, DO kit to measure dissolved oxygen in water, nitrate kit to measure nitrate content in water, phosphate kit to measure the phosphate content in water.

Research design

Determination of stations based on environmental characteristics around water areas: Station I, marine waters located in East Lombok; station II, Marine waters located in North Lombok; station III Marine waters located in West Lombok. Field data collection is carried out by measuring the quality of pond waters. The field data taken was 3 stations, where each station was taken at 3 points with water quality taken in the morning at 09:30 WIB and in the afternoon at 17:00 WIB. This research was carried out in several stages, including the following: (1) Preparation of tools for field surveys to determine the waters to be surveyed, the tools used for field surveys were hand GPSmap, digital camera. (2) Preparation of tools to measure land suitability, tools used to measure land suitability for seaweed cultivation, namely pH meter, DO meter, refractometer, Secchi disc, current meter.

Procedure

The data collected consists of primary data in the form of water quality data and secondary data from various existing documents and literature that can support this research. Data collection is carried out by first determining the research station. The water quality parameters observed were physical parameters (brightness, temperature and depth), chemical parameters (salinity, pH, nitrate, phosphate, chlorophyll and dissolved oxygen). Parameters of brightness, temperature, depth, salinity, pH, dissolved oxygen, nitrate and phosphate were measured directly in the field while chlorophyll levels were analyzed in the Sekotong laboratory.

Research Parameters

The research parameters measured were physical water quality parameters, chemical water quality parameters, and the chlorophyll pigment content of Gracilaria sp found in the waters.

Data Analysis

Analysis of water quality parameters includes the preparation of a suitability matrix prepared through literature study so that the limiting parameters required for Gracilaria sp seaweed cultivation activities can be identified. In the research, each parameter is divided into four classes, namely very suitable, suitable, quite suitable and not suitable. The very suitable class is given a score of 4 (four), the suitable class is given a score of 3 (three), the quite suitable class is given a score of 2 (two), and the unsuitable class is given a score of 1 (one). Parameters that can have a stronger influence are given a higher weight than parameters that have a weaker influence (Neksidin et al, 2013).

The total score obtained from multiplying the score by the weight is then used to determine the suitability class for the water quality parameters of Gracilaria sp seaweed cultivation. The maximum score is 80, obtained from the maximum score times the weight. Meanwhile, the minimum score is 20, obtained from the minimum score times the weight. Determining class intervals and suitability values for water quality parameters for seaweed cultivation uses the formula proposed by Aryati et.al (2007) as follows:

$$I = \frac{N\ maks - N\ min}{\sum K}$$

Note :
I = Class intervals
K = Number of desired land suitability classes
N maks = Maximum final value
N min = Minimum final value

Based on the formula and calculations above, class intervals and suitability values are obtained as in Table 4 and Table 5.

Table 4. Criteria for Suitability of Water Quality for Seaweed Cultivation (*Gracilaria* sp.)

Parameter	Class	Score	Weight
Brightness (%)	90 - 100	4	
	80 – 89	3	3
	70 – 79	2	
	<70	1	
Temperature (°C)	27 – 30	4	
	25 – 26,9 atau 30,1 - 32	3	2
	23 – 24,9 atau 32,1 –	2	
	35<23 dan >35	1	
Depth (cm)	30 – 100	4	
	101 – 120	3	2
	121 – 140	2	
	>140	1	
Salinity (ppt)	21 – 25	4	
	10 – 20 atau 26-30	3	
	5 – 9 atau 31-35	2	2
	<5 atau >35	1	
pH	7 – 8	4	
	5,1 – 6,9 atau 8,1 – 9	3	2
	4,1 – 5 atau 9,1 – 10	2	
	<4 atau >10	1	
CO2 (mg/l)	2,6 – >3,5	4	3
	1,1 – 2,5	3	
	0,5 – 1	2	
	<0,5	1	

Source: Dimodifikasi dari Alam (2015); Hasan et al, (2015); (Khasanah, 2013); Papalia dan Hairati (2013); Hayati (2011); Widyorini (2010); Neksidin et al, (2013); Suparjo (2008); Ariyanti et al, (2007); Poncomulyo (2006) Anggadireja, et al, (2006); Ahda, et al, (2005); (Effendi, 2003); Malingkas (2002); Aslan (1999); (Boyd, 1990).

Table 5. Criteria for Suitability of Water Quality Parameters for Seaweed Cultivation (*Gracilaria* sp.)

NO	Score	Criteria	Code
1	65 - 80	Sangat Sesuai	SS
2	50 - 56	Sesuai	S
3	35 - 50	Cukup Sesuai	CS
4	25 – 35	Tidak Sesuai	TS

RESULT AND DISCUSSION

Physics parameters

Temperature

The temperature observation results obtained from each station ranged from 32 - 33.6 °C with the average water temperature for each station (St), including St.1 which is located in Ekas Bay, Kab. East Lombok with three points, namely 33°C; St.2 is located in the waters of Malacca District. North Lombok with three points, namely 32°C and St.3 located in the waters of West Sekotong Regency. West Lombok, namely 32°C.

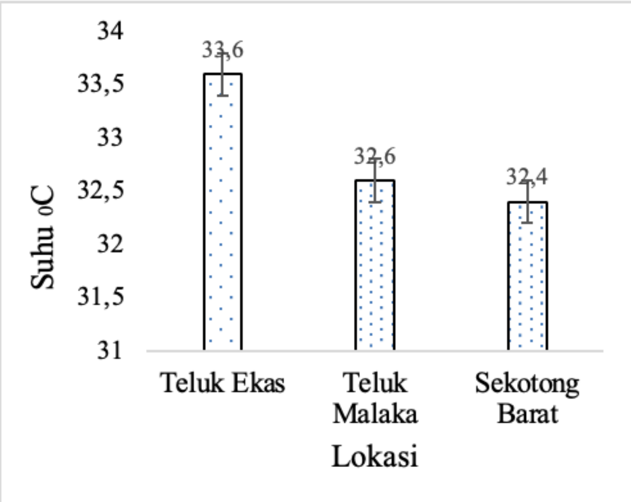

Figure 1. Temperature Parameter Graph

From the results of these measurements it shows the Station. 1, 2 and 3 that this location is not optimal for cultivating Gracilaria sp seaweed. because at each research point the temperature concentration is unstable and there is a decrease and increase in temperature at the station at each point. The water temperature observed at each station was relatively high, because observations were made during the day when the intensity of sunlight was high. Sunlight can increase the temperature of the water but does not cause the temperature to reach a temperature point that can kill organisms because of the presence of mangrove forests which can stabilize the temperature. Based on research, it was observed at the Ekas Bay location (first station) that gracilaria growth was relatively good because in these waters there is a mangrove ecosystem compared to other stations. A good water temperature for cultivating gracillaria seaweed is 25-30 ºC. Temperature greatly influences the ability of seaweed to carry out photosynthesis and indirectly influences the solubility of oxygen used for respiration by marine organisms. Although temperature is not deadly, it can inhibit the growth of seaweed. An increase in temperature can cause the seaweed thallus to become pale yellowish (Khasanah, 2013).

Depth

Seaweed requires sunlight for photosynthesis, therefore seaweed can only grow in waters with a certain depth where sunlight can reach the bottom of the water. The average depth of all stations is 2 – 7 meters, where this depth is still at a level that is favorable for the growth and development of Gracillaria sp seaweed cultivation. Because at this depth the intensity of sunlight reaching the seaweed is still very high so the photoynthesis process can still take place well. The average depth of the research location shows that St1 (Ekas Bay) is 7 m, St2 (Malacca Bay) 2 m and St3 (West Sekotong) 5 m. The depth measurement obtained is in the ideal range. This is confirmed by the results of the study by Aris and Muchdar (2020) in Madina (2022) which states that good depth conditions for seaweed growth range from 2-15 m.

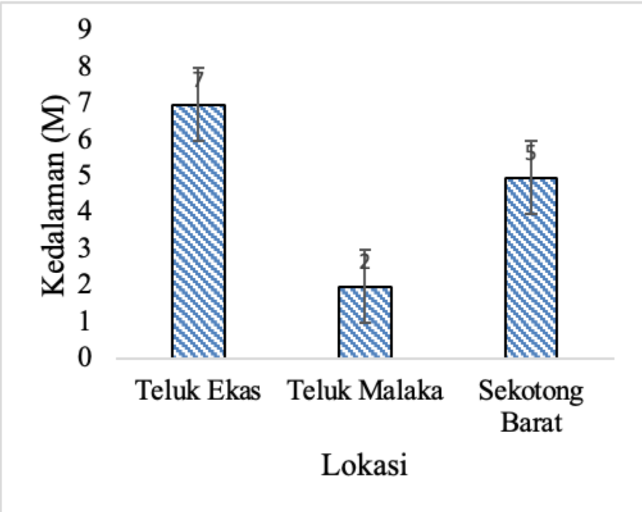

Figure 2. Graph of Depth Parameters

Seaweed can grow at various depths, but generally its growth is better in shallow places than deep ones, because this is related to the high intensity of sunlight. Even so, the depth should not be too shallow because it will cause the waters to become cloudy easily. The depth of the water should not be less than 2 feet (around 60 cm) at low tide and should not be more than 7 feet (around 210 cm) at high tide, because if this is not the case, the plants will dry out at low tide and if it is too deep it will makes it difficult both during planting, maintenance and harvesting. Depth also affects the penetrating power of sunlight which plays an important role for growth (especially in the photosynthesis process) (Bahri, 2012). These three stations have different depth values. Differences in water depth cause the intensity of sunlight to vary in each water zone, causing differences in tallus growth, which is a measure of seaweed growth. Increasing the photosynthesis process will stimulate the metabolic process, thereby stimulating seaweed to absorb more nutrients, absorbing more nutrients to support its growth. In addition, differences in sunlight intensity and nutrients cause differences in morphology, chlorophyll a and carotenoid content. This is because as the depth of the water increases, the intensity of sunlight entering the water decreases, thereby reducing the rate of photosynthesis in plants. Based on data on the potential area for seaweed cultivation, a distance of 5 km from the coastline is still considered suitable for seaweed cultivation activities. This is quite reasonable, especially in coastal areas which have many small islands around them, while for open waters it still needs to be considered carefully.

Brightness

Brightness is a parameter that is closely related to the amount of light penetration into waters. Sunlight energy is needed by seaweed thallus in the photosynthesis mechanism. At the pick-up location Depth (m) Station 1 (Ekas Bay), Station 2 (Malacca Bay) and Station 3 (West Sekotong).

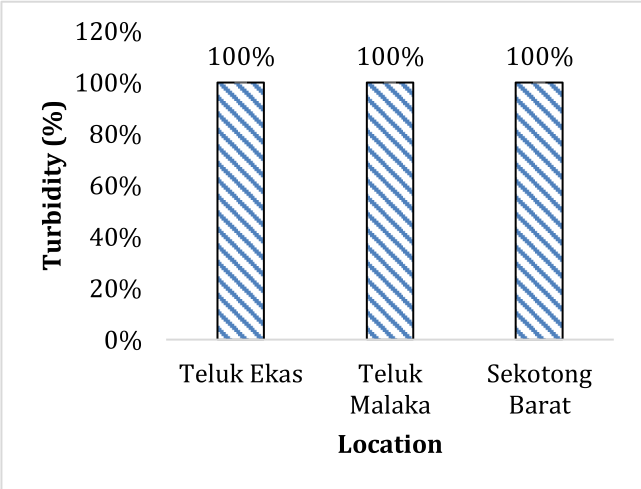

Figure 3. Brightness Parameter Graph

The average brightness data has a percentage level of 100%. The brightness values obtained at all points from each station are very good for seaweed growth. Brightness that penetrates to the bottom supports the photosynthesis process optimally. states that the value of water transparency that is good for the growth and survival of aquatic organisms is greater than 45 cm. Low water brightness values are generally caused by high turbidity due to the large amount of dissolved and suspended organic matter, floating objects and light intensity. The amount of sunlight that penetrates into the water really depends on the brightness of the water. The brighter the waters, the deeper the light will penetrate into the waters. Light penetration becomes low when the suspended particle content is high in waters near the coast, due to tidal activity and depth (Hutabarat & Evans, 2008).
Brightness is an expression of the optical properties of water caused by the presence of suspended solids in the form of clay particles, mud and other organic particles. Suspended solids will limit the intensity of sunlight entering the water surface, so that it can inhibit the photosynthesis process by phytoplankton (Hasim et al., 2015).

Photosynthesis will increase in line with increasing light intensity to a certain optimum value (light saturation). Light intensity is also directly related to the primary productivity of a body of water, the higher the light intensity, the higher the primary productivity at a certain limit (Susilowati et al., 2012). The brightness of the waters in a suitable location for seaweed cultivation is more than 2 m. The higher the brightness level, the more effective the photosynthesis process will be, to increase the number of cell masses that make up the seaweed thallus (Mustafa et al., 2010).

The brightness values obtained at all stations are quite suitable for seaweed growth. The brightness that penetrates the water layer supports the photosynthesis process optimally. A good water transparency value for the growth and survival of aquatic organisms is greater than 45 cm. Low water brightness values are generally caused by high turbidity due to the large amount of dissolved and suspended organic matter, floating objects and light intensity.

Salinity

In this study, various salinity ranges were obtained for each station. The average result obtained from each station point (St) is 34-35 ppt, where the value produced at St1 (Ekas Bay): 35 ppt, St2 (Malacca Bay): 34 ppt and St3 (West Sekotong): 35 ppt.

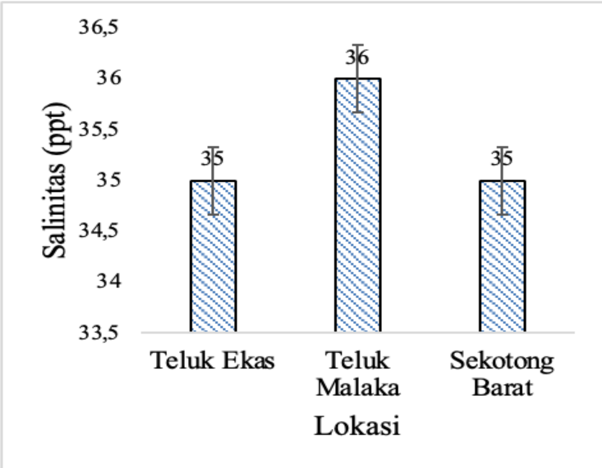

Figure 4. Graph of Salinity Parameters

These results show that the results from each station are optimal enough to support the growth and development of Gracillaria sp seaweed cultivation. in open waters (sea). The salinity values at the research locations Station 1 (Ekas Bay) and Station 3 (Sekotong Barat) obtained the same salinity values, while at Station 2 (Malacca Bay) the values obtained were low. This is due to differences in salinity thought to be due to water topography factors. Apart from that, differences in salinity are caused by differences in time when sampling affects the evaporation process. These results show that the salinity values obtained from each station are suitable for cultivating Gracilariasp seaweed. This type of seaweed has a fairly high level of tolerance to salinity. Gracilariasp. Can grow in a salinity range of 15–35 ppt (Widyorini, 2010).

According to Nybakken (1992), salinity is the dissolved salts in one kilogram of sea water and is expressed in units per thousand. Furthermore, it is stated that in sea water dissolved various salts, especially NaCl, apart from that there are also salts of magnesium, potassium and so on (Nontji, 1993). Most macroalgae or seaweed have low tolerance to changes in salinity (Prud'homme van Reine and Trono, 2001). Seaweed Gracilaria sp. is a type of seaweed that is stenohaline. This plant cannot tolerate high salinity fluctuations. Salinity can influence the osmoregulation process in seaweed plants (Aslan, 1991). High salinity can inhibit the growth of seaweed. Furthermore, Aslan (1991) recommends that the salinity suitable for cultivating this type of seaweed is between 30 – 37 ppm.

The level of salinity is influenced by several factors, namely temperature, evaporation, rainfall, the number of rivers that empty into the sea, the concentration of solutes and solvents. The higher the concentration of a solution, the higher the absorption capacity of the salt to absorb water. Salinity also affects the osmotic pressure of water. The higher the salinity in a body of water, the greater the osmotic pressure. Biota that live in salty waters must be able to adapt to the osmotic pressure of their environment

(Pambudiarto, 2010). From the results of observations and data processing (Graph 4) it shows that station 1 (Ekas Bay), station 2 (Malacca Bay), Station 3 (West Sekotong), fall within the appropriate criteria for the location of Gracilaria sp seaweed cultivation. According to Aslan (1991) the salinity suitable for cultivating this type of seaweed ranges from 30 – 37 ppm.

Chemical Parameters

pH

pH is an abbreviation for "Negative Puissance de H", namely the negative logarithm of the sensitivity of H ions released in a solution (liquid) which has a big influence on the life of aquatic plants and animals, so that the pH of a body of water is often used as an indication. to state whether a body of water is good or bad. The average pH results obtained from each point at the station (St), namely 9,0.

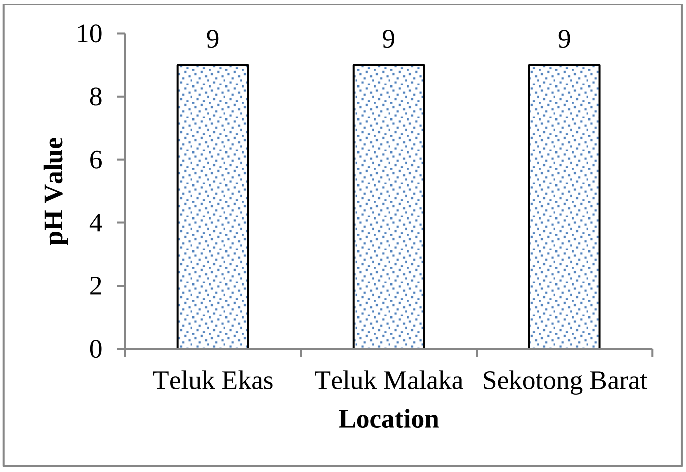

Figure 5. Graph of pH Parameters

From these results, the pH conditions at the research location show that the location is suitable for seaweed cultivation because Serdiati (2011) explains that the pH is optimal for the growth of Gracilariasp type seaweed. namely in the range of 6-9. Based on this, there are four points that indicate the optimum pH for grass growth. The value of the degree of acidity at the research location shows an even distribution or there is no significant difference at each sample point. According to (Damayanti, 2012), the pH of seawater is relatively constant due to the presence of a buffer resulting from a balance of carbon dioxide, carbonic acid and bicarbonate which is called a buffer. The pH range in natural waters is greatly influenced by the concentration of carbon dioxide, which is an acidic substance.

The degree of acidity is one of the environmental parameters that greatly influences organisms in waters. The pH concentration (degree of acidity) of the waters at the observation location was found to be around 9 (Graph 7). The degree of acidity (pH) of the waters at the observation location shows the same pH concentration at all stations. Based on Figure 8, it shows that the 3 observation stations in the research waters are slightly wet. According to Aslan (1991) in (Khasanah, 2013), the pH range suitable for seaweed cultivation is one that tends to be wet. Based on the results obtained, it shows that the degree of acidity (pH) of all observation stations at the research location falls within the suitability criteria, namely quite suitable.

Dissolved Oxygen

Dissolved oxygen is the total concentration of oxygen in a body of water. The average range of dissolved oxygen obtained from each point in the station is 6 – 9 mg/l, where the average result from point St1 is 8 mg/l, St2 (Teluk Melaka) 9 mg/l and St3 (West Sekotong) 6 mg /l. These results show that the higher the dissolved oxygen content, the better the water quality on cultivated land. This is in accordance with the statement (Nikmawati, 2008) that cells need oxygen to convert glucose into energy needed to carry out various tasks, such as physical activity, food absorption, building immunity, restoring body condition, and eliminating all dangerous metabolic waste. Oxygen is very important because it is needed by aquatic organisms and greatly influences the lives of organisms, both directly and indirectly. Dissolved oxygen in water is obtained directly from the air, namely by direct diffusion from the air and through regular water movement, it is also produced from photosynthesis of plants with chlorophyll ranging from > 4 ppm.

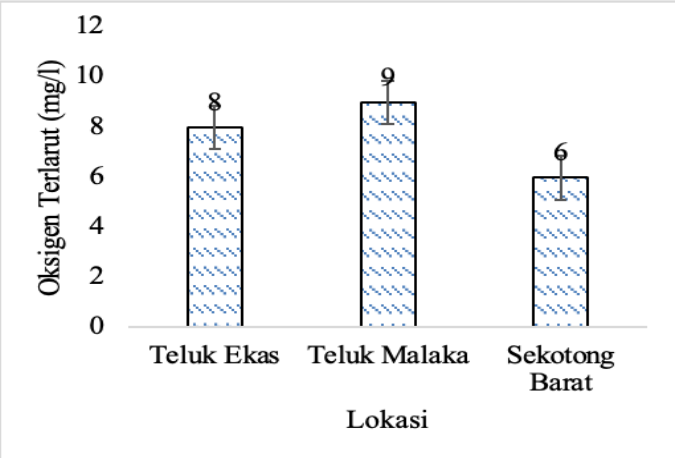

Figure 6. Graph of Dissolved Oxygen Parameters

Dissolved oxygen observations were carried out at 09.00 am. Dissolved oxygen at this time increases until 17.00. On the other hand, it decreased after 17.00 until the morning. It is suspected that the cause is the photosynthetic activity of phytoplankton and seaweed, Gracillaria, which is related to sunlight. Oxygen in waters comes from diffusion or is the result of the photosynthesis process of producing organisms (Goldman & Horne, 1983). This is also in line with the opinion (Boyd, 1990) that during the day, when photosynthesis occurs, the amount of dissolved oxygen is quite large. On the other hand, at night, when photosynthesis does not occur, the oxygen formed during the day will be used by fish and aquatic plants, resulting in a drastic decrease in oxygen concentration. Photosynthesis occurs during daylight hours but respiration by plants occurs during daily recycling. So if there are aquatic plants there will be an influx of oxygen through photosynthesis during the daytime hours, but the continuous use of oxygen is by respiration.

Oxygen levels in sea water will increase with lower temperature and decrease with higher salinity. In the surface layer, oxygen levels will be higher, due to the diffusion process between water and free air and the photosynthesis process. With increasing depth there will be a decrease in dissolved oxygen levels, because the process of photosynthesis decreases and the existing oxygen levels are mostly used for respiration and oxidation of organic and inorganic materials. An organism's need for oxygen varies relatively depending on the type, stage and activity. Dissolved oxygen levels that drop drastically in water indicate the decomposition of organic substances and produce foul-smelling gas that is harmful to organisms (Salmin, 2005).

Factors that reduce oxygen levels in sea water are an increase in water temperature, respiration (especially at night), the presence of a layer of oil above the sea surface and the entry of easily decomposed organic waste into the marine environment. For the growth of seaweed Gracilaria sp. It requires an amount of dissolved oxygen in the water of 2 – 4 ppm, but growth is better if the dissolved oxygen is above 4 ppm. (Brotowijoyo et al., 1995) said that in open water conditions, oxygen is in natural conditions so it is rarely found in open water conditions that are poor in oxygen.

Chlorophyll Content

From the results of observations and data processing (Graph 6) it shows that station 1 (Ekas Bay), station 2 (Melaka Bay), station 3 (Sekotong Barat), are included in the appropriate criteria for seaweed cultivation locations *Gracilaria* sp.

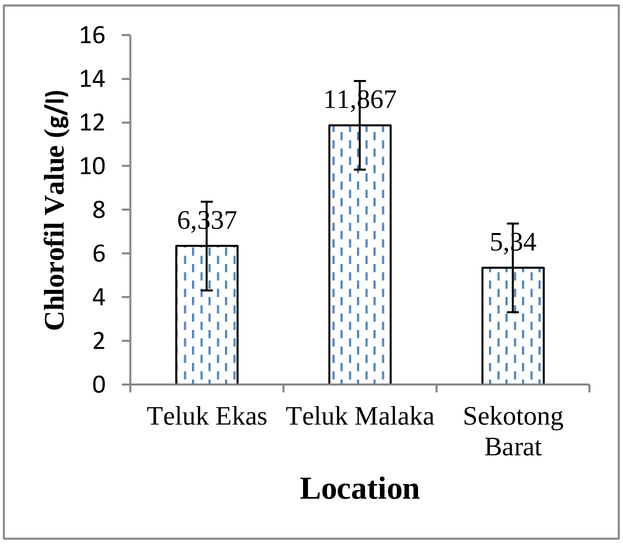

Figure 6. Chlorophyll Content Parameter Graph

Based on these results (Figure 6) it shows that the pigment in the first station (chlorophyll 6,337 g/l), the second station with a value (chlorophyll 11,867 g/l) and at the third station (chlorophyll 5,340 g/l). So the highest pigment content at each station is the chlorophyll of the second station (chlorophyll 11.867 g/l), the first station (chlorophyll 6.337 g/l) while the lowest pigment content at each station is the chlorophyll of the third station (chlorophyll 5.340 g/l). Referring to the results and analysis of this research, it was found that the comparison of chlorophyll values from each station was due to differences in the levels of nutrients found in the aquatic environment, the increase in nutrients was parallel to the pigment concentration (Nasir et al., 2015).

Seaweed is a lower plant that absorbs its food in the form of ions together with water by osmosis. Plants make their food through the process of photosynthesis. The process of plant photosynthesis requires CO2, sunlight, chlorophyll and minerals. The results of photosynthesis in the form of carbohydrates are used as an energy source for growth (metabolism) and individual reproduction.

The pigment content consists of chlorophyll and carotenoids found in Gracilariasp seaweed. Functions as a cell regeneration process to help close wound tissue where carotenoids are pigments that are red to orange in color, usually bound to chlorophyll in chloroplasts. Research conducted by seaweed found chlorophyll and carotenoids which contain pigments. Results of laboratory analysis of the chlorophyll content of seaweed Gracilaria sp. at each observation station, including St (Ekas Bay) 6,337 g/l, St2 (Melaka Bay) 11,867 g/l and St3 (West Sekotong) 5,340 g/l.

Phosphate Content

Phosphate is a form of phosphorus that can be utilized by plants. According to (Mustafa et al., 2010). Phosphate concentrations in natural waters range between 0.005 - 0.020 mg/L, while in groundwater it is usually around 0.02 mg/L. Furthermore, it is said that PO4 rarely exceeds 1 mg/L, even in eutrophic waters. (Simanjuntak, 2006) which states that waters are relatively fertile if the normal phosphate nutrient range is 0.10-1.68 ppm. Based on phosphate concentration, waters are classified into three, namely: waters with low fertility, which have phosphate concentrations ranging from 0-0.02 mg/L; waters with a medium fertility level, which have a phosphate concentration of 0.021-0.05 mg/L; and waters with a high level of fertility, which have a phosphate concentration of 0.051-0.10 mg/L (Mustafa *et al.*, 2010).

Stasiun	Jumlah hasil fosfat yang didapatakan dari setiap stasiun		
	Titik 1	Titik 2	Titik 3
Teluk Ekas	1 mg/l	1 mg/l	1 mg/l
Teluk Malaka	1 mg/l	1 mg/l	1 mg/l
Sekotong Barat	1 mg/l	1 mg/l	1 mg/l

Figure 7. Table of results for phosphate content

From the results of observations and measurements it was found that the three stations fell within the criteria of no conformity, namely not suitable. Indriani & Sumiarsih (1991) said the optimal phosphate range for seaweed growth is 0.051 ppm – 1.00 ppm.

Phosphate is a form of phosphorus that can be utilized by plants. According to (Mustafa et al., 2010). Phosphate concentrations in natural waters range between 0.005 - 0.020 mg/L, while in groundwater it is usually around 0.02 mg/L. Furthermore, it is said that PO4 rarely exceeds 1 mg/L, even in eutrophic waters. (Simanjuntak, 2006) which states that waters are relatively fertile if the normal phosphate nutrient range is 0.10-1.68 ppm. Based on phosphate concentration, waters are classified into three, namely: waters with low fertility, which have phosphate concentrations ranging from 0-0.02 mg/L; waters with a medium fertility level, which have a phosphate concentration of 0.021-0.05 mg/L; and waters with a high level of fertility, which have a phosphate concentration of 0.051-0.10 mg/L (Mustafa et al., 2010).

The phosphate content at all points at each station is 1 mg/l. These results indicate that the location of each station is relatively high for cultivating Gracilaria sp. This is because the research area is in open water. The high level of phosphate is caused by sea waves which are visible directly in areas where there is no seaweed cultivation which is large enough to cause the water mass to stir and raise the phosphate content at the bottom of the waters to the surface. This is in accordance with the opinion of (Simanjuntak, 2006) which states that high phosphate levels are caused by currents and stirring of the water mass which results in the lifting of high phosphate contents from the bottom to the surface layer. Phosphate levels measured during the research at the three locations of each station were still within a tolerable range so that they could support the growth of seaweed.

If the phosphate content in cultivation waters is at least 0.01 ppm, the growth rate of biota will not be hampered, but if the phosphate level falls below this critical level, the rate of cell growth will be disrupted. Phosphate is an essential element for aquatic plants and algae and greatly influences the level of aquatic productivity (Armita, 2011). Phosphate can be a limiting factor both temporally and spatially because there are few sources of phosphate in the waters. Phosphate is a key nutrient in aquatic primary productivity. This compound can describe whether a body of water is fertile or not (Wardoyo, 1982).

Nitrate Content

Nitrate is the main form of nitrogen in natural waters and is the main nutrient that is useful for plant and algae growth. Nitrates are very soluble in water and are stable. This compound is produced from the complete oxidation process of nitrogen compounds in waters. This process is important in the nitrogen cycle. The function of nitrogen is to build and repair body tissue and provide energy. Plants and animals need nitrogen for protein synthesis. Nitrate in waters comes from the breakdown of organic 15 and inorganic nitrogen in soil which comes from the decomposition of organic matter with the help of microbes (Makatita et al., 2014).

Stasiun	Jumlah hasil Nitrat yang didapatakan dari setiap stasiun		
	Titik 1	Titik 2	Titik 3
Teluk Ekas	10 mg/l	10 mg/l	10 mg/l
Teluk Malaka	10 mg/l	10 mg/l	10 mg/l
Sekotong Barat	10 mg/l	10 mg/l	10 mg/l

Figure 8. Table of Nitrate Content Results

From the observations above it can be seen that the three stations with high average nitrate levels of 10 mg/l have high nutrient content. The condition of nitrate concentration at each station is caused by environmental factors and the equipment used. According to Kanglan 2006, the appropriate nitrate range for organisms is 0.2-0.7 ppm. Nitrate concentration is thought to influence seaweed growth. If the nitrate concentration in a body of water does not match what has been determined, seaweed growth will not be optimal (Wahyuni et al., 2012).

Nitrate nutrients are one of the factors that play an important role in supporting metabolic processes, growth and survival of organisms. Nitrate levels are one of the criteria for suitability of waters for cultivation locations for seaweed species Grcilaria sp. because nitrate is one of the nutrients that seaweed really needs. If the nitrate content in the water is low, it can cause stunted growth, metabolism and reproduction. The average result of nitrate observations from all points at each station location is 10 mg/l. Based on these results, it can be seen that all three stations show the same results. This is because the research area is in open water (not controlled by the aquatic environment) and also the tool used for measurement uses a Nitrate kit so that the resulting nitrate values are slightly inaccurate. Apart from that, in the environment at each station's location there is no seaweed cultivation because the area at each station's environment is not limited by all kinds of ecosystems and different flow systems so that this location shows that it does not support seaweed cultivation. Nitrate is an important nutrient for plants, but excessive levels can cause significant water quality problems. Excessive nitrate will accelerate eutrophication and cause increased growth of aquatic plants, thereby affecting dissolved oxygen levels, temperature and other parameters (Patricia et al., 2018).

Hasil pengukuran kisaran kualitas air pada masing-masing stasiun

No	Parameter	Teluk Ekas				Teluk Malaka				Sekotong Barat			
		Nilai paramete	Skor	Bobot	N	Nilai	Skor	Bobot	N	Nilai	Skor	Bobot	N
1	Suhu °C	33.6	3	2	6	32.6	3	2	6	32.4	3	2	6
2	Kecerahan %	100%	4	3	12	100%	4	3	12	100 %	4	3	12
3	Kedalaman cm	7	1	2	2	2	1	2	3	5	1	2	2
4	PH	9.0	3	2	6	9.0	3	2	6	9.0	3	2	6
5	Salinitas ppt	35	1	2	2	36	1	2	3	35	1	2	2
6	Oksigen terlarut mg/l	8	4	3	12	9	4	3	12	6	4	3	12
7	Fosfat mg/l	1	4	3	12	1	4	3	12	1	4	3	12
8	Nitrat mg/l	10	4	3	12	10	4	3	12	10	4	3	12
9	Klorofil g/l	6.337	3	2	6	11.867	4	3	12	5.34	1	2	2
Jumlah nilai kesesuaian		70				78				66			

Seaweed Aquatic Suitability Analysis *Gracilaria* sp.

Analysis of the suitability of waters for the development of seaweed species *Gracilaria* sp. based on several requirements regarding physical and chemical parameters in the waters of Ekas Bay, Malaka and Sekotong, it can be a limiting factor in the growth of Gracilaria sp seaweed. the same water class with the same drilling as (Table 8).

The radiation score values for physical and chemical parameters for all stations are in the appropriate criteria range for *Gracilaria* sp cultivation locations. (Table 8) this is because several physical and chemical parameters are in the appropriate category, namely temperature, brightness, depth, salinity, pH, dissolved oxygen, phosphate, nitrate and pigment content are in the appropriate category for the cultivation location of seaweed species *Gracilaria* sp. Based on the explanation for the score value of the scoring evaluation results from the physical and chemical parameters above, the waters of Kas Bay, Malacca and West Sekotong are in accordance with the criteria.

Table 9. Results of Suitability Analysis of Seaweed Water Quality Parameters *Gracilaria* sp.

Stasiun	Value obtained	Criteria
(Ekas Bay)	70	Very suitable
(Melaka Bay)	78	Very suitable
(West Sekotong)	66	Very suitable

CONCLUSSION AND SUGGESTION

Conclussion

Based on the results of water analysis for the gracilaria seaweed cultivation location, it can be concluded that the score obtained is in the range of 66-78, which shows that the three research locations, Station 1 (Ekas Bay), Station 2 (Malacca Bay) and Station 3 (West Sekotong) are suitable.

Suggestion

It is necessary to conduct research at different times to complete information on different times or periods to complete information on the suitability of waters for seaweed *Gracilaria* sp cultivation locations.

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