Evaluation of land suitability of Kappaphycus alvarezii cultivation in the dry and rainy season

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Abstract. Kappaphycus alvarezii seaweed is one of the important economically valuable commodities. Kappaphycus alvarezii is one of the macro algae species that has many benefits. Kappaphycus alvarezii seaweed cultivation is the dominant mariculture activity on Panggang Island, DKI Jakarta. The condition of the quality of the aquatic environment greatly affects the production of Kappaphycus alvarezii seaweed. This study aims to analyze the suitability level of Kappaphycus alvarezii seaweed cultivation in the dry season and rainy season. This research was carried out in Panggang Island, DKI Jakarta during the dry and rainy seasons. The observed environmental quality parameters include the physical physics parameters, namely temperature, current speed, brightness, and depth observed in situ. Aquatic chemical parameters namely salinity, pH, dissolved oxygen observed in situ and nitrates and phosphate observed in ex-situ. In order to get a classification of the suitability level, the suitability of the marine matrix is made through scoring and weighting on the parameters limiting seaweed farming activities. Based on the results of the study it can be concluded that the suitability of the waters on Panggang Island, DKI Jakarta is very suitable (S1) for Kappaphycus alvarezii cultivation both during the planting period in the dry season or the rainy season.

1. Introduction

Kappaphycus alvarezii seaweed is one of the main commodities of aquaculture that is economically important and has been commercially cultivated [1, 2, 3]. Kappaphycus alvarezii cultivation has developed very rapidly since the demand for carrageenan for industries in many countries [4, 5].

The development of this commodity cultivation business is expected to play an important role in improving the welfare of the community. Some of the advantages of seaweed farming are: the production system does not require complicated technology, can be done manually and can be developed as a labor-intensive business. In addition, the production cycle is short so that it can generate income quickly, post-harvest handling is easy and inexpensive, does not require special facilities and can be stored for a long time [6].

Panggang Island is one of the islands surrounded by waters so that the area has the potential for the development of marine culture. Kappaphycus alvarezii seaweed cultivation is the dominant mariculture activity on Panggang Island, DKI Jakarta. The potential of the cultivation must of course
be studied properly in order to provide data and information that is useful for the development of marine culture, especially Kappaphycus alvarezi seaweed cultivation on Panggang Island.

The condition of the quality of the aquatic environment greatly influences the production of Kappaphycus alvarezi seaweed [7]. Description of the condition of seaweed waters is important to know because it really determines the development cycle of seaweed [8, 9]. This study aims to analyze the suitability level of Kappaphycus alvarezi cultivation during the dry season and rainy season. The results of this study are expected to provide an overview of the profile and suitability of land in Panggang Island, DKI Jakarta.

2. Material and methods
This research was carried out in Panggang Island, DKI Jakarta during the dry and rainy seasons. The geographical position of seaweed farming locations are: S 05° 44’ 30,7’’ and E 106° 36’ 04’’.

Environmental quality parameters observed include the physical physics parameters, namely temperature, current speed, brightness, and depth observed in situ. Aquatic chemical parameters namely salinity, pH, dissolved oxygen observed in situ and nitrates and phosphate were observed at the Environmental Laboratory of the Department of Aquaculture, Faculty of Fisheries and Marine Sciences, IPB.

In order to get a classification of the suitability level, the suitability of the marine matrix is made through scoring and weighting on the parameters limiting seaweed farming activities. In this study, each parameter is divided into three classes, namely very suitable (S1), quite suitable (S2) and not suitable (N).

| Parameter               | Range                      | Very suitable/S1 | Quite suitable/S2 | Not suitable/N | Weighting |
|-------------------------|----------------------------|------------------|-------------------|----------------|-----------|
| Depth (m)               | 3-10                       | 15-20            | <2 or >20         | 15             |
| Brightness (m)          | >3                         | 1-2              | <1                | 15             |
| Current rate (m/s)      | 0.2 - 0.3                  | 0.1- <0.2 or >0.3-≤0.4 | <0.1 or >0.4     | 15             |
| Temperature (°C)        | 27-30                      | 25-<27 or >30-35 | <25 or >35       | 15             |
| Salinity (ppt)          | 32-35                      | 25-<32           | <25 or >35       | 10             |
| Dissolved oxygen (mg/l) | 6-8                        | 4-<6             | <4                | 10             |
| pH                      | 7-8.2                      | >8,2-9           | <7 or >9         | 10             |
| Nitrate (mg/l)          | 0.1 – 3.5                  | 0.008-<0.1       | <0.008 or >3.5   | 5              |
| Phosphate (mg/l)        | 0.02-0.1                   | >0.1-2.0         | <0.02 or >2.0    | 5              |

Source: Modification Dawes [10]; Lobban and Morrison [11]; Atmadja et al. [12]; Sulistijo and Atmadja [13]; Lundsor [14]; Lourenco et al. [15]; Hayashi et al. [16]; Radiarta et al. [17]; Hasnawi, et al. [18].

Table 2. Classification of suitability of seaweed cultivation

| Score     | Suitability classification |
|-----------|---------------------------|
| 367-500   | Very suitable (S1)        |
| 234-365   | Quite suitable (S2)       |
| 100-233   | Not suitable (N)          |

3. Results and discussion
3.1. Cultivation profile of Kappaphycus alvarezi on Panggang Island
Kappaphycus alvarezi seaweed cultivation method which is applied in the waters of Panggang Island is a longline method. The cultivation site is 200 meters from the beach. Long line method is a method of cultivation using a long rope stretched. Seaweed cultivation techniques using a method of 50-100
meters long ropes at both ends are given anchors and large buoys, every 25 meters are given a main buoy made of plastic or Styrofoam drums. At each distance of 5 meters, buoys are given in the form of styrofoam / rubber sandals or 500 ml plastic bottles.

At the time of installation of the main rope must be considered the direction of the current in a parallel position or at a slight angle to avoid the occurrence of entanglement with one another. Seaweed thallus seeds as much as 50 - 100 grams are tied along the rope with a distance between points of about 25 cm. The distance between the ropes in a block of 0.5 meters and the distance between the blocks of 1 meter, in one block there are 4 ropes that function for control canoe lines.

This cultivation method is much in demand by the community because the tools and materials used are more durable, and are easy to obtain relatively easily in its construction, and predation by aquatic bottom biota can be minimized because seaweed is located on the surface and the absorbed lighting is much greater for photosynthesis.

3.2. Water quality parameter conditions

The results of observing water quality parameters can be seen in Table 3.

**Table 3. Parameters of aquatic quality of Kappaphycus alvarezii seaweed cultivation with the longline method in Panggang Island in the dry and rainy season**

| Parameter                  | Dry season | Rainy season |
|----------------------------|------------|--------------|
| Depth (m)                  | 5-8        | 5-8          |
| Brightness (m)             | 4,71-5,11  | 3,3-4        |
| Current rate (m/s)         | 0,054-0,072| 0,053-0,059  |
| Temperature (°C)           | 29,88-30,81| 28,31-28,48  |
| Salinity (ppt)             | 30,7-31,3  | 27,8-28,1    |
| Dissolved oxygen (mg/l)    | 6,4-6,8    | 5,6-6,4      |
| pH                         | 8,1-8,5    | 6,9-7,1      |
| Nitrate (mg/l)             | 0,22-0,56  | 0,07-0,21    |
| Phosphate (mg/l)           | 0,27-0,33  | 0,16-0,17    |

The depth of the water is affected by changes in tides and bottom contours of the water, and plays a role in determining the method of lau grass cultivation [18]. The results of observations of water depth range from 5-8 meters, very suitable for seaweed cultivation [17, 18]. Brightness that is formed at the location of cultivation in the dry season ranges from 4.71 m - 5.11 m, while in the rainy season around 3.3 m - 4 m Clear water conditions with transparency levels ranging from> 1.5 m are good enough for seaweed growth [10].

Current rate at the observation site in the dry season ranges from 0.054 to 0.072 m / sec, while in the rainy season it ranges from 0.053 to 0.059 m / sec. According to Atmadja et al. [12] good current velocity for the cultivation of Kappaphycus alvarezii is 0.2 - 0.3 m / sec. The temperature range at the observation site in the dry season ranges from 29.88 - 30.81 °C, while in the rainy season it ranges from 28.31 - 28.48 °C. Temperature range between 27 - 29 °C gives a growth rate of 5% [13]. Water temperature controls the growth of seaweed [19]. Salinity levels at the study site in the dry season ranged from 30.7 - 31.3 ppt, while in the rainy season around 27.8 - 28.1 ppt. According to Dawes [10] the range of good salinity for Eucheuma growth is 30-35 ppt.

The concentration of dissolved oxygen in seaweed cultivation locations in the dry season ranges from 6.4 to 6.8 mg/L, while in the rainy season it ranges from 5.6 to 6.4 mg/L. The value of the range of dissolved oxygen concentrations in the two different seasons is still in a range that is feasible for optimal growth of seaweed, from 4.8 to 6.2 mg/L [11]. The degree of acidity (pH) at the location of seaweed cultivation in the dry season ranges from 8.1 to 8.5, while in the rainy season it ranges from
6.9 to 7.1. According to Lundor [14] a good pH range for the growth of Kappaphycus seaweed is 7-9 with an optimum range of 7.3 - 8.2.

Nitrate concentrations in cultivation sites in the dry season ranged from 0.22 to 0.56 mg/L, while in the rainy season it ranged from 0.07 to 0.21 mg/L. The range of nitrate content in the Kappaphycus alvarezii seaweed cultivation location is still relatively low for the feasibility of seaweed growth habitats when compared with an ideal concentration of 1.0 - 3.2 mg/L [15]. Phosphate concentrations in the dry season ranged from 0.27 to 0.33 mg/L, while in the rainy season it ranged from 0.16 to 0.17 mg/L. The concentration of phosphate content in seaweed cultivation locations is very high above the ideal limit of seaweed cultivation locations ie 0.02 - 0.1 mg/L [16].

3.3. Land suitability of Kappaphycus alvarezii cultivation

Land suitability is one aspect that determines the success of Kappaphycus alvarezii cultivation activities. After data processing, weighting and scoring are based on the water suitability assessment system for Kappaphycus alvarezii cultivation. The results of the analysis of the suitability of waters in the dry season and rainy season are very suitable (S1).

| Season     | Suitability classification |
|------------|---------------------------|
| Dry season | Very suitable (S1)        |
| Rainy season | Very suitable (S1)       |

3.4. Attack of ice-ice disease

Ice-ice disease is a major disease that attacks seaweed cultivation [20, 21]. Ice-ice disease causes a decrease in seaweed farming production ranging from 70% - 100% which occurs in several seaweed producing countries such as in the Philippines, Vietnam, Tanzania, Malaysia, and Indonesia [8, 22, 23, 24, 25, 26]. Ice-ice disease in seaweed cultivation is caused by bacteria. The bacteria that cause ice-ice disease in Kappaphycus alvarezii are Vibrio, Aeromonas, Cytophaga, Flavobacterium, Pseudomonas and Bacillus [27, 28].

The results showed an ice-ice disease attack on the location of Kappaphycus alvarezii seaweed on Panggang Island. The clinical symptoms that arise are preceded by a change in the color of the thallus from bright to pale. Next arises white spots / spots on the surface of the tip of the thallus, eventually the entire thallus turns white, porous and broken.

The phenomenon of ice-ice disease has similarities reported by Ask et al. [29] that the occurrence of ice-ice disease in a seaweed cultivation region begins with changes in thallus that are experiencing stress, followed by bleaching and ultimately thallus damage (broken). Stress characterized by changes in the color of the thallus is an early symptom of seaweed that has a disruption of ice-ice disease, along with the time of maintenance the tip of the thallus turns white and finally porous [30].

Discoloration (depigmentation) and reduction in wet weight occur due to pathogenic bacterial infection that causes ice-ice disease in seaweed thallus. These changes are increasing with increasing time of bacterial activity in secreting virulence factors to the host (seaweed thallus). According to Lobban and Horrison [11], Largo et al. [27], that the increase in ice-ice disease attacks intensified with the time of pathogenic bacterial infection in the seaweed thallus resulting in failure of Kappaphycus alvarezii seaweed cultivation.

4. Conclusion

Based on the results of the study it can be concluded that the suitability of the waters on Panggang Island, DKI Jakarta is very good for Kappaphycus alvarezii cultivation both during the planting period in the dry season or the rainy season. Ice-ice disease can cause production failure in the Kappaphycus alvarezii seaweed farming system due to total death. This can be detrimental to seaweed farmers.
Therefore, management of seaweed culture in Panggang Island, DKI Jakarta is important to implement.

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