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CULTIVATION OF SEAWEED *Caulerpa racemosa* USING DIFFERENT SUBSTRATES ON A LABORATORY SCALE

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ABSTRACT

Caulepa racemosa is a type of sea grape from the group of green algae (Chlorophyceae) that can be found in Indonesian waters. Coastal communities use this species as a source of daily food. Besides being a food ingredient, *C. racemosa* can be used for medical purposes because it contains antioxidants. The distribution of *C. racemosa* and its density in waters depends on the type of substrate and season. The substrate in the cultivation container is an essential factor in cultivating *C. racemosa*. Various substrates have different characteristics and influence the growth of *C. racemosa.* This research aims to analyze the best substrate for the survival of seaweed on a laboratory scale. This research used an experimental method using a Completely Randomized Design (CRD) consisting of 4 treatments, namely different substrates of sand, coral, volcanic rock, and coral sand. The results of this research are that different types of substrates have a real influence on the survival rate of *C. racemosa* cultivated on a laboratory scale. Sand substrate gave the best results: a survival rate of 112.83%, a final weight of 22.56 g, and the highest antioxidant content on volcanic rock substrate of 83.19%. This research concludes that differences in substrate directly influence the survival rate and final weight of *C.racemosa*. The substrate that provided the best survival rate of 112.83% was sand substrate.

Keywords: *Caulerpa racemosa*, Substrate, Survival Rate, Antioxidant.

1. INTRODUCTION

Indonesia is a maritime country with diverse natural resource potential, including seaweed. Seaweed has become a source of income for coastal communities; apart from being easy to cultivate, it also has good nutritional content and high economic value, so it can increase people's revenue. The type of seaweed has potential but has not been widely developed in *C. racemosa* or sea grape[1].

Caulepa racemosa is a type of sea grape from the group of green algae (Chlorophyceae) that can be found in Indonesian waters. Coastal communities use this species as a source of food. Besides as a food ingredient, *C. racemosa* can be used for medical purposes because it contains antioxidants[2]. The availability of *C.racemosa* seaweed is still limited because it is seasonal, depends on nature, and is not widely cultivated. *C.racemosa* cannot grow in the rainy season, allegedly due to a lack of nutrients from the substrate, which can result in the absence of continuity in the production of *C. racemosa* in sufficient quantities at any time and significantly endanger the sustainability of the grape population sea in nature.

According to Muliani[1], in cultivating *C. racemosa*, several problems need to be considered, including the selection of waters and good oceanographic factors for cultivation locations because this plant is difficult to grow if the water conditions are not suitable. *C. racemosa* is a phytobenthos where algae, such as dead coral, coral fragments, sand, and mud, live on seabed substrates. The distribution of the marine algae *C.racemosa* and its density in waters

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depends on the type of substrate and season. An important factor in cultivating *C. racemosa* is determining the substrate. Various substrate types have different characteristics and influence the growth of *C. racemose.*

The substrate used is mud, sand, and rock. Dahlia *in* Windarto et al.[3] also studied the substrate of *C. racemosa*, with the substrate being sandy mud and dead coral fragments. Information about the ideal substrate for research on cultivating *C.racemosa* is rarely carried out. The differences in substrates used are thought to influence the growth and protein content of *C. racemosa*. This research aims to study the type of substrate most suitable for optimal growth of *C. racemose.*

2. RESEARCH METHOD

Time and Place

This research was conducted at the Fish Production and Reproduction Laboratory, Aquaculture Study Program, Faculty of Agriculture, University of Mataram on June 18 – July 17, 2023.

Method

The research used was an experimental method with a completely randomized design (CRD), which consisted of 4 treatments as follows:

T1: Beach sand substrate
T2: Coral substrate
T3: Volcanic rock substrate
T4: Beach sand and coral substrate

Parameters

Survival rate

The survival rate of seaweed, according to Yustiani et al. *in* Yudiastuti et al.[4], is calculated using the following formula:

$$\mathbf{SR} = \frac{\mathbf{Nt}}{\mathbf{N0}}\mathbf{x100\%}$$

Note:
SR = Survival rate (%)
Nt = Weight-t (g)
No = Weight-0 (g)

Weight and Length Growth

Final weight growth is calculated at harvest age by draining and weighing the water using an analytical balance. The absolute growth length was calculated by observing the growth in the *C. racemosa* seaweed stolon length using a ruler.

Antioxidant Analysis

The antioxidant activity of sea grapes was tested using a UV-Vis spectrophotometer.

Thallus Tissue

Thallus tissue slices were carried out by observing sections of the talus from *C.racemosa* with a slice length of 1 cm, then observed under a microscope. Observations were carried out using a microscope by placing slices of the thallus on a covered glass to be observed under a microscope**.**

3. RESULT AND DISCUSSION

Survival Rate

The difference in substrates gave the highest survival rate in treatment P1, 112.83%. The volcanic rock treatment obtained the lowest survival rate, 46.13%. The results of measuring the survival rate are presented in the following Figure 1.

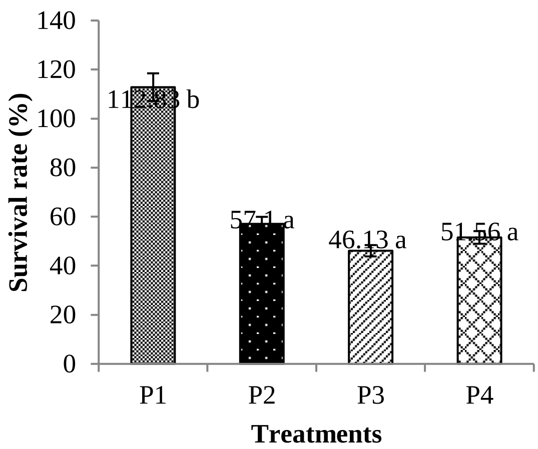


Figure 1. Survival rate *C. racemose*

The results of the ANOVA test showed that cultivating *C. racemosa* seaweed on different substrates had a significantly different effect on the survival rate of *C. racemosa*. The factor that supports the growth of *C.racemosa* is substrate availability. The substrate is a place for roots to attach and absorb nutrients. *C.racemosa* has adapted to the substrate and environment, characterized by the emergence of roots and the roots clinging to the substrate so that *C.racemosa* can survive and grow.

According to Masak *et al. in* Hasbullah[5], *C.racemosa* needs a substrate as a function of its roots to absorb nutrients. The high survival value of the sand substrate is thought to be because the characteristics of the sand substrate make it easier for *C.racemosa* roots to attach and enter the sediment, thereby facilitating the adaptation process. The lowest survival was obtained on volcanic rock substrates; this is thought to be because volcanic rock has a slippery surface, so the roots of *C.racemosa* cannot attach perfectly, which causes the growth of *C.racemosa* not to run optimally.

Weight Growth

The highest final weight was in treatment P1 with a sand substrate, which produced an average value of 22.56 g. Then, in treatments P2, P3, and P4, it decreased.

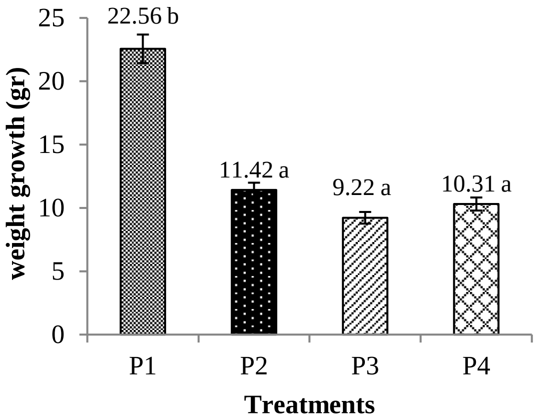


Figure 2. Weight of *C. racemosa*

The results of the ANOVA test showed that cultivating *C. racemosa* on different substrates had a significantly different effect on the growth of the final weight of *C. racemosa*. The highest final weight growth parameter is based on the results of further test analysis (Duncan Test); treatment P1 significantly differed from treatments P2, P3, and P4.

Dahlia[6], *C.racemosa* is generally found on rocky beaches and lives on various substrates such as sand, rocks, mud bottoms, seagrass, protected bays, and artificial substrates. This shows that the substrate used during the research is suitable for the substrate or habitat of *C.racemosa* in nature. Windarto et al.[3] cultivated *C.racemosa* in Jepara using round tarpaulin ponds with different substrate treatments, namely bamboo, coral, sandy mud, and nets, where the highest value was obtained on the sandy mud substrate, namely 22. 6 g. The availability of nutrients in the substrate is related to particle size and sediment thickness. The smaller the size of the sediment, the greater the nutrients in the. Dahlia[6] states that algae have a high ability to absorb nutrients from sediment through roots. In contrast to treatments P2, P3, and P4, the values obtained were lower; this is thought to be because the absorption of nutrients in the substrate was less than optimal. Masak et al. *in* Hasbullah[5] stated that *C.racemosa* requires a substrate as a function of its roots to absorb nutrients from the soil, a fraction of dead coral, mud sand, and mud and sand.

Final Length

The highest final length was in treatments P1 and P3, with an average value of 9.16 cm. The final length growth measurement results are presented in the following Figure 3.

The use of different substrates in laboratory-scale cultivation of *C. racemosa* does not affect the final length of *C.racemosa* seaweed. Sitorus et al. (2020) state that light intensity is essential in growth metabolism and photosynthesis processes. The light intensity obtained during the research was 625 lux. This is still considered optimal for the growth of *C.racemosa*. According to Burhanuddin *in* Ginting et al.[7], *C.racemosa* can still grow at a relatively low light intensity, namely 70 – 74 lux.

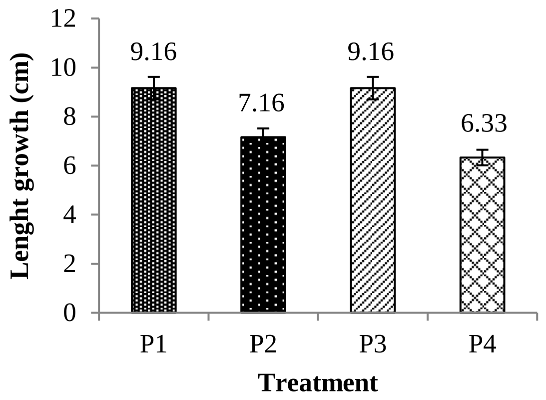


Figure 3. Length of stolon *C. racemosa*

Based on observations during the research, stolons or ramuli grew towards the light source. According to a study by Sitorus et al.[8], light affects photosynthesis because light can stimulate cell division activity, resulting in the widening and elongation of the body or thallus, ultimately resulting in seaweed growth.

Antioxidant

The highest antioxidant content was obtained in the P3 treatment with a stone substrate valued at 83.19%, as shown in Figure 4.

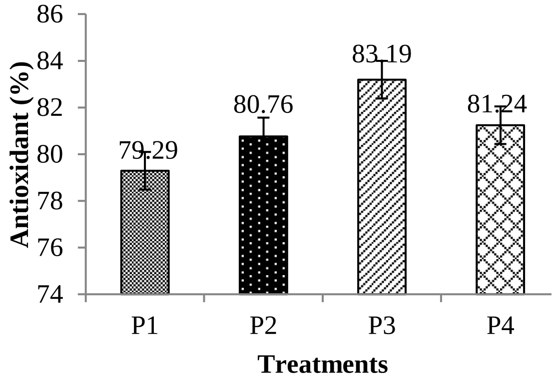


Figure 4. Antioxidant *C. racemose*

Jumsurizal et al.[9] state that *C.racemosa* can produce antioxidant activity. Zuhdi et al.[10], antioxidants can inhibit oxidation reactions by binding free radicals. Aryudhani *in* Mokoginta et al.[11], *C.racemosa* produces primary and secondary metabolites; one type of secondary metabolite is antioxidants. *C.racemosa* contains phenolic compounds as non-nutritional components, which are thought to function as antioxidants.

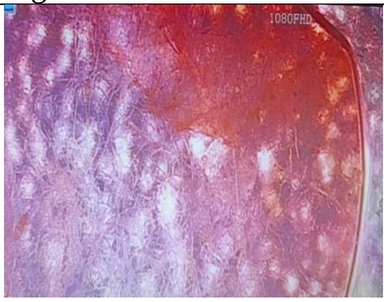
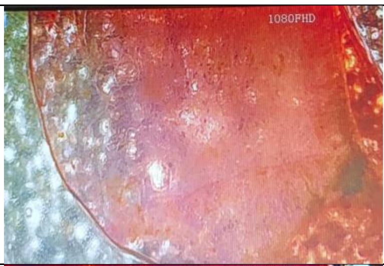
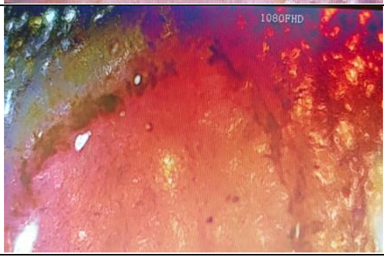
Based on the results of the antioxidant analysis obtained, the highest antioxidant content was produced by P3 treatment with a stone substrate, namely 83.19%. The high antioxidant content obtained in each treatment is thought to be due to the high level of secondary metabolites produced by *C.racemose*. Firda et al.[12] show that differences in concentrations of secondary metabolites in plants can have different levels of antioxidants. The more secondary metabolites produced, the stronger the antioxidant activity. Secondary metabolites are formed due to the response of seaweed to the surrounding environment. The more seaweed feels threatened or stressed, the higher the secondary metabolites produced. According to the opinion of Setyorini et al. *in* Firda et al.[12], secondary metabolite compounds are produced in excessive amounts if plants are threatened with maintaining life. Secondary metabolite compounds in plants protect themselves from environmental stress, protect against pest/disease attacks, and protect against ultraviolet rays as a growth regulator and competing with other plants.

Based on research that has been carried out, *C. racemosa* is thought to experience stress because it still needs time to adapt to the environment and the substrate used to attach its roots. This is because the substrate used does not have the same characteristics, where sand is the best treatment, allegedly because the small particle size makes it easier for the roots to attach and absorb nutrients. In contrast, the coral, volcanic rock, and sandy coral substrates are thought to be because the substrate was not taken from its natural habitat; it was taken from another place, which causes *C. racemosa* not to adapt as quickly as in nature.

Thallus Tissue

The shape of *C. racemosa* tissue resembles irregular threads, and there are empty spaces filled with fluid, and the epidermis, outer cortex, inner cortex, and cell walls are not visible (Table 1). This is different compared to the form of *Kappaphycus alvarezzi* tissue. Darmawati[13] stated that *K.alvarezzi* cells are oval-shaped on the outside/after the thallus wall, will get more significant in the middle of the thallus, and are arranged irregularly. The network of cell components is visible between the epidermis, outer cortex, inner cortex, and intact cell walls.

Table1. Tissue of *C.racemosa*

Treatment / Day	Figure
Day-0	
P1/day-30	
P3/day-30	
P4/day-30	

The shape of the tissue slices in the initial/control treatment clearly shows cell walls and tissues that resemble irregular threads. Observations of tissue slices were carried out again at the end of the study; it was found that the results of the slices in the treatment with sand substrate (P1) and volcanic rock substrate (P2) were relatively the same as the initial tissue slices with the cell walls and tissue shape still clear, then in the treatment with sandy coral substrate (P4), it can be seen that the condition of the cell walls is not intact. The shape of the tissue is not very clear. Environmental conditions influence differences in the shape of the thallus tissue in the seaweed *C.racemosa*. Hayashi et al. *in* Darmawati[13] stated that different ecological conditions of seaweed significantly affect the speed of seaweed in meeting nutrient needs for thallus growth, which involves changes in the state of several cells to form organs with a structure and different functions.

4. CONCLUSION

Based on the research results, it can be concluded that differences in substrates in laboratory-scale cultivation of C.racemosa have a real influence on the survival and final weight of *C. racemosa*. The best treatment was obtained on a sand substrate with a survival value of 112,83%.

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