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Innovation *caulerpa* spp Cultivation in Controlled Tank Supporting the Blue Economy Program

Inovasi Budidaya Caulerpa spp *dalam Tangki Terkendali Mendukung Program Ekonomi Biru*

Dasep Hasbullah [1,] Gagan Garnawansah [1,] Endah Soetanti [1,]
Rahmat [1,] Dzikri Wahyudi [2] Agus Dwi Saputro [3] , Dadan Kurnia Wibawa [4]
[1.] Engineer at the National Research and Innovation Agency
[2.] Lecturer at POLYTECHNIC AUP Karawang
[3.] Dwi Amanah Nurah Sanggar *Caulerpa of the* Bahrul 'Ulum Education Foundation
[4.] Fisheries Supervisor of the Karawang Aquaculture Production Business Service Center
Email : hasbullahnurbayanti7@gmail.com, Dase003@brin.go.id, Gaga005@brin.go.id

ABSTRACT

One type of seaweed that has economic potential with very large market opportunities and tends to increase is Caulerpa spp. This type of macroalgae has many benefits and benefits besides being able to be consumed directly, processed as a side dish or snack and as a raw material for medicines, cosmetics and biostimulants so that in its development it has high economic value. Caulerpa cultivation technology in ponds has been popularized since 2011 by the Takalar Brackish Water Aquaculture Fisheries Center, but there are still many obstacles that affect the success of it. Including the limitations of the pond land environment, climate and water quality, so that aquaculture technology innovation is needed to be found in overcoming these problems. Cultivation in controlled tubs (indoor). The system is controlled for climate and environmental problems that affect production can be overcome and the availability of stock can be controlled. From the study of cultivation in controlled tubs, it resulted in an average daily specific growth of 15.57+1.79% with a multiple of production to the average planting weight of 4.19+0.82. The technical data shows that the cultivation of Caulerpa spp seaweed in controlled tubs can maintain the sustainability of cultivation and is profitable so that it is developed even more to support the government's program in succeeding the marine and fisheries Blue Economy concept.
Keywords: Blue Economy, Caulerpa spp, Controlled Tank, Innovation and Seaweed.

ABSTRAK

Salah satu jenis rumput laut yang memiliki potensi ekonomi dengan peluang pasar yang sangat besar dan cenderung meningkat adalah *Caulerpa* spp. Jenis makroalga ini memiliki banyak manfaat dan keuntungan selain dapat dikonsumsi langsung, diolah sebagai lauk pauk atau makanan ringan dan sebagai bahan baku obat-obatan, kosmetik dan biostimulan sehingga dalam pengembangannya memiliki nilai ekonomi yang tinggi. Teknologi budidaya *Caulerpa* di tambak telah dipopulerkan sejak tahun 2011 oleh Balai Besar Perikanan Budidaya Air Payau Takalar, namun masih banyak kendala yang mempengaruhi keberhasilannya. Diantaranya keterbatasan lingkungan lahan tambak, iklim dan kualitas air, sehingga perlu ditemukan inovasi teknologi akuakultur dalam mengatasi permasalahan tersebut. Budidaya dalam bak terkendali (indoor). Sistem tersebut dikendalikan agar permasalahan iklim dan lingkungan yang mempengaruhi produksi dapat diatasi dan ketersediaan stok dapat dikendalikan. Dari kajian budidaya pada bak terkendali diperoleh rata-rata pertumbuhan spesifik harian sebesar 15,57+1,79% dengan kelipatan produksi terhadap rata-rata bobot tanam sebesar 4,19+0,82. Data teknis menunjukkan bahwa budidaya rumput laut *Caulerpa* spp pada bak terkendali dapat menjaga keberlanjutan budidaya dan menguntungkan sehingga semakin dikembangkan untuk mendukung program pemerintah dalam menyukseskan konsep Ekonomi Biru kelautan dan perikanan.
Kata Kunci: Ekonomi Biru, *Caulerpa* spp, Bak Terkendali, Inovasi dan Rumput Laut.

I. Introduction

1.1. Background

Sea grape (Caulerpa spp.) is one of the seaweed species of the *class Chlorophyceae* is a biological resource. Sea grape (*Caulerpa* spp.) as one of the macroalgae found on the coastline and generally on rocky beaches is categorized into the classes *Chlorophyceae*, *Phaeophyceae* and *Rhodophyceae*. *Caulerpa*, known as lawi-lawi (Sulawesi) or latoh (Java), is widely known by coastal communities because several types of seaweed are used directly or indirectly as a natural food source, such as in Indonesia, and several countries such as Malaysia, Japan, Vietnam, the Philippines, China, and Korea.

Sea grapes (*Caulerpa* spp) are often found in coastal areas that have coral reefs (Pong Cook, *et* al., 2007). Grows in dead substrates, dead coral fragments, sand mud and mud mud and *C. serulata* grows in sand substrates. Most of these species are not drought tolerant and grow at the depth of the water at the lowest tide and are still waterlogged (Kadi and Atmaja, 1988). According to Riechert R and Dawe CJ. (1986), the distribution of *caulerpa* is widespread in tropical to subtropical coastal areas with the greatest diversity in the tropics. Sea grapes need a substrate as a function of the roots that are held to absorb nutrients from the soil. The development of caulerpa cultivation because it must be in the substrate, so pond land that is abandoned but adjacent directly to the coast can be used).

Sea grape / lawi-lawi (*Caulerpa*) was first developed by the Takalar Brackish Water Cultivation Center (Nana Putra. 2012), used directly as a food ingredient in fresh conditions (Hasbullah *et* al. 2016). At first, the law was obtained directly from the sea. Currently, it has been cultivated in ponds because it is very profitable and always sells out in the local market. In its development, sea grapes (*Caulerpa*) are not only used as food but have also been used for medical purposes because they contain antioxidants (Pencawan Y, 2013). The prospects for lawi-lawi cultivation are very promising because the cultivation techniques are easy, fast and profitable compared to other types of seaweed cultivation such as cotonii and high local market absorption to increase the motivation of pond farmers in South Sulawesi (Hasbullah *et* al. 2016).

1.2. Classification

According to Verlaque, *et* al (2003), that the classification of Caulerpa is as follows: Division: *Chlorophyta,* Class: *Chlorophyceae,* T Ribes: *Caulerpales,* Genus : *Caulerpa*, Species: *Caulerpa racemosa / caulerpa lentillifera, C sertulariodes.*

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Figure 1. Sea grape (*caulerpa* spp)

1.3. Morphology

General characteristics of Caulerpa are the main thallus grows creeping, the segmented stem resembles an overgrown root fiber and the branching form is diverse because the shape of the leaf resembles a single round leaf like a grape, such as fern, palm leaf and cassava leaf. Sea grapes (*caulerpa*) that have special characteristics, namely: Plants that can reach a height of 8.5 cm and standing branches are shaped like grape leaves, are one of the genera of algae that can be identified from their growth form and morphology. All species and sub-species *of caulerpa* live in the sea, but some can also live in lagoons (Silva 2003). Reports of the number of *caulerpa* species vary between 70 to 100 species. Carruthers *et* al. (1993) explained that among a number of caulerpa species, there are two types of caulerpa that can be directly consumed: *caulerpa lentilivera* and *caulerpa racemossa.*

1.4.Habitat and Distribution

According to Dawson (1966), stating that reef coral beaches are good for many seaweed species and some can live on sandy beaches. While the most common living substrate where seaweed grows is limestone or other forms of calcium carbonate which this material has a high fertility rate, a color that is easily eroded and clear so that sunlight reflects.

Mubarak and Wahyuni (1981) said that the best type of substrate for seaweed growth is a mixture of sand and coral pieces or coral debris, because the waters of the substrate are usually passed by streams suitable for seaweed growth. According to Sunaryo, (2015) this plant lives in the bottom substrate of waters such as: coral fragments, sand and mud. *Caulerpa* is mostly found in protected places with clear water, the water flow is not too strong and the bottom is smooth due to sedimentation. *Caulerpa diversity* is highest in the tropics, namely in the *zonaculitoral* and decreases in the inner zone. In the *sublittoral*

zone, Caulerpa grows attached to corals or creeps under the coral canopy (Prod'homme Van Reine and Trono, 2011) in (Saptasari, 2010).

The genus *Caulerpa* is often found in coastal areas that have coral reefs. Grows on dead substrates, dead coral fractions, sand mud and sludge. Most of these species are not drought resistant, grow at the depth of the water at the lowest tide and are still waterlogged (Kadi and Atmaja, 1988). *The caulerpa* is widespread in tropical waters and has shallow temperate climates. In 1926 a new form of algae was reported from Tunisia, possibly an immigrant from the Red Sea, and then spread to much of the east. *Caulerpa* has promising prospects for reproduction. Fijians have consumed a lot of seaweed in their diet, including of the type: *Caulerpa* var. *occidentalis*, *Codium bulbopilum*, *Hypnea pannosa*, *Gracilaria sp., Solieria robusta,* and *Acanthaphora spicifera*. And as the main dishes are *Caulerpa* and *Hypnea*.

Sea grapes (*Caulerpa* spp.) have great benefits and potential in meeting the increasing needs so that an increase in production is highly expected, but currently its availability still relies on nature and cultivation products in ponds are limited and depend on the season. The demand for quality and continuous supply of sea wine is a challenge that has not been met yet. Responding to these problems, to further optimize the use of sea grape resources, it is necessary to carry out a model/cultivation system business that can support sustainable production. According to Hadie, *et al* (2011) stated that the quality of seaweed that meets the standards is highly determined by the cultivation process. Thus, information is needed about the right cultivation method, which produces the best quantity and quality of production. So one of the concrete steps in responding to the above problems, in this applied study activity, tests were carried out on the cultivation of sea grapes in controlled tubs.

II. Material and Methods

2.1. Time and Place

Applied study of the economic study of sea grape cultivation in controlled tubs using *spot collector* was held at the DD Amanah caulerpa studio, Bahrul 'Ulum Education Foundation located in Sukamulya Hamlet, North Pusakajaya Village, Cilebar District, Karawang Regency, West Java Province. from August to November 2023.

2.2.Materials and tools

Sea grape seeds (*Caulerpa* spp.), seawater, organic fertilizers and medicinal drugs. Plastic baskets for *spot collectors*, *Styrofoam*, 10 liter volume plastic buckets, dippers,

Handrefractometers, Aerators, *Thermometers*, pH meters, scissors, spoons, harvest bags, hava, waring, digital scales, hanging scales, rulers and Stationery.

2.3. Working procedure

2.3.1. Maintenance container/medium

The main containers used as cultivation facilities are a concrete tub measuring 2x4x1 m^2 in a *semi-indoor hatchery* adjacent to the coast and seawater sources and not far from the location of the maintenance pond. Plastic baskets as *spotcollectors* with different dimensions/specifications, as stated in the table below

Table 1. Specification of the container (*spotcollector*) used in the test

Type of Container/ Spot Collector	CONTAINER DIMENSIONS	
	Empty weight	Size (cm)
A : Square basket 1	170	30 x 40 x 11
B : Square basket 2	80	19 x 26 x 7
C : Budar Basket	45	Φ 21 x 11
D : Koja 1	50	Φ 20 x 30
E : Koja 2	20	Φ 10 x 30

2.3.2. Seeds used

The sea grape seeds used in this activity are Bulaeng cultivars (C. *Lentilifera*) brought in from the Takalar Brackish Water Aquaculture Fisheries Center (BPBAP).

Figure 2. Bulaeng cultivar caulerpa (C. *Lentilifera*)

2.3.3. Seedling planting weight in testing

The seeds tested in the test on each *spot collector* consisted of six treatments and four replicates with the weights of each treatment as follows: A: 300 g/Sc, B: 200 g/Sc, C: 100 g/Sc, D: 200 g/Sc, E: 100 g/Sc ‘ Sc : *spot collector*

2.3.4. Measurement

To observe the rate of sea grape production, the productivity measurement of sea grapes is carried out periodically every week by calculating the absolute growth rate, specific growth and production multiple.

2.3.5. Water quality observation

As supporting data, water quality measurements such as salinity, temperature, pH and dissolved oxygen are carried out weekly.

III. Results and Discussion

During the trial activities to measure the feasibility of the maintenance medium and the productivity of cultivated sea grapes, periodic observations are made on the growth of test biota both in quality and quantity and at the end of the test the total biomass and growth rate are measured.

3.1. Productivity

Periodic observation of the treatment in controlled tubs is routinely carried out once a week by observing the growth and performance of cultivated sea grapes. At the end of the 40-day test, the following results were obtained; Treatment A of 300 g/sc clump dense performed better than other treatments by producing an average absolute growth of 1,318 g/sc, a specific growth of 17.93 and a yield multiple to planting weight of 5.39 times. Meanwhile, from the data obtained as a whole, the average treatment resulted in absolute growth of 625$\pm$439 g/sc, specific growth of 15.57$\pm$1.79% and multiple of production to planting weight of 4.19$\pm$0.82 times.

Table 2. Final results of measurements on the trial of sea grape cultivation in *spot collector*

Treatment	Biomass		Growth Total (g)	SGR (%)	Production in plants (x)
	Plant	Harvest			
A. Cage 1	300	1.618	1.318	17,93	5,39
B. Cage 2	200	923	723	16,45	4,61
C. Cage Round	100	334	234	13,62	3,34
D. Koja 1	200	780	580	15,90	3,90
E. Koja 2	100	368	268	13,96	3,68
Sub	900		3.123		
Med	180	805	625	15,57	4,19
SteDev	84	521	439	1,79	0,82

The difference in absolute growth and daily growth in each treatment is not only influenced by the initial weight of stocking, but also influenced by the area/volume of *the spot collector* that is the planting medium. The same information was also found in a study conducted by Iskandar SN *et al*, (2015). Based on the results of his research, it was

found that the specific growth weight is influenced by the planting weight where the smaller the number of planting densities, the greater the growth opportunity.

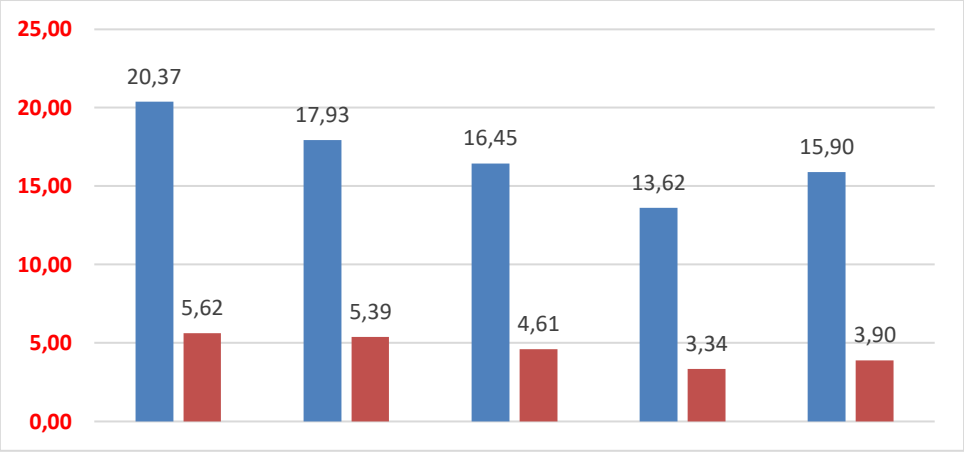

Figure 3. Specific Growth Diagram and Production Multiples at Each Treatment

In another study (Ortiz, *et al*. 2006), it was also suggested that several factors that affect the growth of *Caulerpa* sp. in cultivation are environmental conditions. Furthermore, Thilahgavani and Vairappan, (2013) revealed that the optimal environmental carrying capacity for seaweed growth is greatly influenced by the location and time of seaweed planting, this is related to the availability of nutrients.

Figure 4. Observations on the performance of sea grapes tested

3.2. Water Quality

Water quality measurements during the maintenance of test biota at the test site showed that dissolved oxygen data was in the range of 4.15-5.41 ppm, temperature 27.50-32.00 ^{0C,} Salinity 30.00-32.00 ppt and pH in the range of 7.45-7.81. The condition of water quality is qualified and feasible for sea grape cultivation activities (*Caulerpa* spp.). The growth of seaweed is completely dependent on the availability of nutrients and environmental conditions during cultivation including water depth and seedling spacing. The depth of water is one of the factors that affect the growth of seaweed. Because depth affects the level of intensity of light entering the waters (Serdiati and Widiastuti, 2010)

Table 3. Measurement data on several water quality parameters on the maintenance medium

Observed Water Quality Parameters	Range of Water Quality at Sampling Point								
	Inlet Tank			Maintenance Tank			Purification Tank		
Ph	7.33	-	7.74	7.45	-	7.81	7.83	-	8.17
Salinity (ppt)	30.00	-	32.00	30.00	-	32.00	30.00	-	32.00
Temperature (^{0C})	28.00	-	32.00	27.50	-	32.00	28.00	-	32.00
Measurement (ppm)	4.11	-	4.83	4.15	-	5.41	4.54	-	5.71
NO2	0.00	-	0.11	0.00	-	0.12	0.00	-	9.00
NO3	24.70	-	27.70	25.63	-	27.83	24.10	-	26.32
NH4	0.09	-	0.11	0.00	-	0.10	0.00	-	0.09
NH3	0.00	-	0.10	0.00	-	0.08	0.00	-	0.08
PO4	0.54	-	2.10	0.42	-	1.93	0.25	-	1.44
PB	0.00	-	0.01	0.00	-	0.01	0.00	-	0.01
CD	0.00	-	0.01	0.00	-	0.01	0.00	-	0.01
CU	0.00	-	0.01	0.00	-	0.01	0.00	-	0.01
ZN	16.20	-	18.30	12.42	-	14.22	11.95	-	12.22

3.3. Business Analysis

To measure the level of business feasibility in the cultivation of sea grapes in controlled tubs using *spot collectors*, at the end of the test, a business feasibility measurement was carried out. From the results of simple calculations, it can be concluded that the sea grape cultivation business in the tank is prospectively controlled, economically profitable and can be developed in large-scale businesses (*Industrialization and commercialization*), supporting the movement to utilize seaweed resources as a source of income to improve the welfare of cultivators and State Foreign Exchange (*Green Gold*).

Table 4. Analysis of a simple business of sea grape cultivation (*Caulerpa* spp.) in controlled tubs (*semi-indoors*)

Description	Total	Unit	Price (Rp)	Cost (Rp)
A. Infestation				
Tank	3	Unit	1.000.000	3.000.000
Facilities	1	Package	1.000.000	1.000.000
Harvest Cage	1	Unit	800.000	800.000
Scales	1	Unit	300.000	300.000
Total Infestation				**5.100.000**
B. Cost Production				
Seed Seaweed	25	Kg	40.000	1.000.000
Organic Fertilizer	5	liter	35.000	175.000
Depreciation Costs (15% from Infest)	1	once	765.000	765.000
Total Cost Production				**1.940.000**
C. Income				
Harvest	246	Kg	25.000	6.150.000
Profit				**4.210.000**

IV. CONCLUSIONS

Based on the results obtained at the end of the test, from the technical point of view of the applied study, the following conclusions were made different spot collector dimensions and seedling planting weights have different effects on specific growth and production multiples (weight gain). The highest daily specific growth rate of treatment A (planting weight 300 g) was 17.93+5.39, but all treatments showed a positive trend where the average daily specific growth rate was 13.84+1.59 and the average production multiple was 4.19+0.82 times. *Caulerpa* spp. can be cultivated and grown well in a maintenance medium (*spot collector*) that is maintained in a controlled tub and prospective for development, becoming a solution to the problem of cultivation in ponds / the creation of cultivation technology that is environmentally friendly, sustainable and sustainable.

Ideal cultivation technology is needed for mass production of Caulerpa. Thus, Caulerpa cultivation technology using *spot collectors* in controlled tubs is not only a solution to the problem of cultivation in ponds, but also one of the powerful weapons to overcome these problems while answering the expectations *of fisheries stakeholders*, namely the creation of environmentally friendly, sustainable and sustainable cultivation technology. Furthermore, to answer the challenges of the times, *the Caulerpa* cultivation model in *this spot collector* can be developed on an even larger scale. For further research, it is necessary to test the effect of planting different weights on the same *spot collector* dimensions and growth testing on different *spot collector* colors .

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Attachment:

Activity Documentation

Attachment Picture 1. The process of selecting and sorting sea grapes before packaging

Attachment 2. Seawine packaging ready for market