Productivity of several *Caulerpa* species grown in fishponds

[1]Hasni Y. Azis, [2]Muhammad Y. Karim, [2]Khairul Amri, [3]Dasep Hasbullah

[1] Center of Excellence on Seaweed Science and Technology, Hasanuddin University, Indonesia; [2] Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Sulawesi Selatan, Indonesia; [3] Center for Brackishwater Aquaculture Development, Takalar, Indonesia. Corresponding author: H. Y. Azis, hasni_yulianti@yahoo.com

Abstract. *Caulerpa* is an aquatic resource that has high nutritional value. It can be consumed directly or made various kinds of processed products so that it has a potency to be developed through its cultivation. This research was carried out at the Mandalle Farm Aquaculture Unit, Pangkep Regency, South Sulawesi aimed at analyzing the growth rate and production of several *Caulerpa* species grown in fishponds. The seeds used were *Caulerpa* from pond farmers in Laikang Village, Takalar Regency which were growth for 40 days. The study was designed using a completely randomized design consisting of 3 treatments with 5 replications each. The three treatments are differences in *Caulerpa* types, namely: *C. racemosa, C. lentillifera* and *C. sertularioides*. The results of the analysis of variance showed that the differences in species had a very significant effect ($p<0.1$) on the growth rate and production of *Caulerpa*. The highest growth rates and production were produced by *C. sertularioides* and *C. racemosa* (i.e. 4.46 and 4.40%/days for growth rates and 247.80 and 240.60 g) while the lowest for *C. lentillifera* (3.43%/day and 147.6 g).

Key Words: *Caulerpa racemosa*, *Caulerpa entillifera*, *Caulerpa sertularioides*, growth rate, production.

Introduction. Seaweed is one of the outstanding commodities for coastal communities. This asset may provide positive contribution to job availability and income multiplication. Seaweed species that frequently found in rocky or coralline shores are mainly from Classes *Chlorophyceae*, *Phaeophyceae*, and *Rhodophyceae*. *Caulerpa* or locally named as lawi-lawi (Sulawesi) and latoh (Jawa) is a genus of *Chlorophyceae*. *Caulerp*a has been exploited by local communities for its high nutritional values. Beside direct consumption, this seaweed may also be transformed into various products. Therefore, *Caulerpa* is potential to be developed through culture activity.

In general, *Caulerpa* grows in shallow waters with calm flow. Prud'homme van Reine & Trono (2001) stated that *Caulerpa* consisted of several genera that are extensively distributed in the coastal areas both in tropical and subtropical latitudes with the highest diversity being found in tropical areas. Species *C. racemosa* is largely found in coastal areas particularly around the fringing reefs protected from strong waves action and currents (Trono 1997). *Caulerpa* grows at dead substrate, dead coral rubble, muddy sand and mud. Similarly, *C. sertularioides* is distributed within tropical and subtropical waters and is mostly found in benthic sandy habitat at seagrass area to a depth of 10 m (Trono 1997; Fernandez-Garcia et al 2011).

Initially, *Caulerpa* was collected by local fishermen directly from the coasts. However, at this moment, *Caulerpa* has been cultivated along the shores in spite of it has not massively developed yet as milkfish, shrimp and other fishery commodities. Currently, global market demand on *Caulerpa* has increased particularly to Japanese market. Therefore, in order to establish intense *Caulerpa* culture, a comprehensive study to elaborate diverse crucial factors related to the seaweed *Caulerpa* culture was performed. It is expected that in the future, *Caulerpa* become a priority export commodity.

The objective of this study was to determine the species of *Caulerpa* that performed the best growth and production within fishponds.

Material and Method. This present study was conducted at Local Fishpond Units, located in Mandalle District, Pangkep Regency of South Sulawesi. *Caulerpa* was grown in fishpond with muddy silt substrate. Water quality was analyzed at Water Quality Laboratory of the State Polytechnique in Pangkep.

Container used in this study was green plastic baskets (28 x 21 x 7 cm^3 LxWxH) placed in the depth of 40 cm from the water surface. Seedlings of three *Caulerpa* species were planted in the fishpond in Laikang village, Takalar Regency, South Sulawesi. These seedlings were spread when initial biomass was 50 g/container and they have been grown for 40 days. This research was designed using completely randomized design consisting of three treatments with five replicates each. Therefore, this experiment consisted of 15 experimental units. These three treatments implied different *Caulerpa* species (i.e. A. *Caulerpa racemosa*, B. *C. lentillifera* and C. *C. sertularioides*).

The parameter observed were growth rate, production, and nutritional content of *Caulerpa.* Growth rate of *Caulerpa* was measured by formula as suggested by Dawes et al (1994) in Munoz et al (2004):

$$LPN = \frac{\ln(W_t - W_o)}{t} \times 100$$

Where:
LPN= Growth rate (%/day);
W_o= Wet weight of *Caulerpa* at initial study (g);
W_t= Wet weight of *Caulerpa* at the end of this study (g);
t= study length (days).

Production of *Caulerpa* was determined by the following formula:

$$W = W_t - W_o$$

Where:
W= Production of *Caulerpa* (g/container);
W_t = Biomass of *Caulerpa* at the end of this study (g);
W_o= Biomass of *Caulerpa* at the beginning of this study (g).

As supporting data, several water quality parameters (i.e. salinity, temperature, pH, nitrate, and orthophosphate) were measured. Salinity, temperature, pH was measured by portable instruments (refractometer, thermometer, pH meter), whereas, nitrate and orthophosphate were measured by spectrophotometer. Temperature, salinity and pH were measured twice a day (i.e. 6 am and 5 pm). Nitrate and phosphate concentration was measured once at the beginning, in the middle and at the end of the study.

Water quality. Range of water quality values at culture media of *Caulerpa* is presented in Table 1.

Table 1

Values of water quality parameter in *Caulerpa* culture during the study

Parameter	*Range of values*	*Suitability (References)*
Temperature (°C)	25–30	25-30 (Ukabi et al 2013; Guo et al 2014)
Salinity (ppt)	27–29	25- 30 ppt (Putra et al 2012)
Orthophosphate (ppm)	7.85–7.89	7.70-8.30 (Ilustrisimo et al 2013)
pH	0.98–1.27	0.10-3.50 (Guo et al 2015)
Nitrate (ppm)	0.022–0.026	0.02-1.00 ppm (Guo et al 2014)

These values indicates that temperature of seaweed culture environment ranged between 25-30°C, salinity 27-29 ppt, pH 7.85-7.89, nitrate 0.98-1.27 ppm, and orthophosphate 0.022-0.026 ppm. These value ranges are suitable to support growth of *Caulerpa* sp.

According to Ilustrisimo et al (2013), Ukabi et al (2013), and Guo et al (2014, 2015) the optimal ambient factors values for *Caulerpa* growth are: temperature 25-30^{o}C, salinity 25-30 ppt, pH 7.70-8.50; nitrate 0.10-3.50 ppm, and orthophosphate 0.02-1.00 ppm.

Results and Discussion. Average growth rates and production of several species of *Caulerpa* that were grown within fishpond are presented at Table 2.

Table 2

Productivity of several *Caulerpa* species grown within fishponds

Species	*Growth rate (%/day)*	*Production (g/container)*
Caulerpa racemosa	4.40±0.02^{a}	240.60±1.82^{a}
Caulerpa lentillifera	3.43±0.09^{b}	147.60±6.80^{b}
Caulerpa sertularioides	4.46±0.04^{a}	247.80±5.10^{a}

Different letters at the same column indicate significant difference among treatments at confidence level of 5% (P<0.05).

Analysis of variance test demonstrates that species of *Caulerpa* have strong significant influences (P<0.01) to the growth rate and production of seaweeds grown within fishponds. Furthermore, advanced W-Tukey test shows that growth rate and production of C*. lentillifera* is significantly different (P<0.05) to *C. racemosa* and *C. sertularioides,* whereas, the growth rate and production of *C. racemosa* did not differ (P>0.05) to *C. sertularioides*.

Table 2 shows that the highest growth rate and production are performed by *C. sertularioides* (4.46 %/day and 247.80 g), and *C. racemosa* (4.40 %/day and 240.60 g), whereas, *C. lentillifera* performed the lowest growth rate and production as much as 3.43 %/day and 147.60 g, respectively.

High growth rate and production of *C. sertularioides* and *C. racemosa* that obtained during this study indicated that both *Caulerpa* species are suitable to be grown in fishpond with muddy silt substrate. This condition is in agreement to the statement of Littler et al (2008) that mostly *C. sertularioides* are found in the coastal and estuaries environments grow in sandy areas, in seagrass or in roots of mangroves. Living environments in surrounding coastal areas and estuaries which are commonly used as fishponds are muddy clay. The smaller of the sediment size, the higher N and P availability within sediments. This will support *Caulerpa* in utilizing nutrients as its main diet for its growth. *C. racemosa* is often found to grow well at various substrates with extensive distribution. This algae is largely found at lower mid intertidal calcareous rock, water stream and tide pool (Jha et al 2009).

Lower growth rate and production of *C. lentillifera* in this study indicates that this species is not suitable to be grown within fishpond with muddy clay. According to Rabia (2016), this seaweed is able to adapt to various environments that naturally inhabit several substrate types such as coral rubbles to the depth of over 50 meter, sandy substrate at coral beds and shallow lagoon.

Basically, *Caulerpa* is suitable to grow at various substratum types, however, the growth rate resulted is different. Pong Masak et al (2007) in Hasbullah et al (2014) stated that *Caulerpa* requires particular substratum as root's function to absorb nutrient from the soil, dead coral rubble, muddy sand, mud and sand.

Conclusions. The species of *Caulerpa* have strong significant influences to the growth rate and production of seaweeds grown within fishponds. Lower growth rate and production of *C. lentillifera* in this study indicates that this species is not suitable to be grown within fishpond with muddy clay substrate.

References

Fernandez-Garcia C., Cortes J., Alvarado J. J., Nivia-Ruiz J., 2011 Physical factors contributing to the benthic dominance of the algae *Caulerpa sertularioides*

(Caulerpa, Chlorophyta) in the upwelling Bahia Culebra, North Pacific of Costa Rica. Revista de Biologia Tropical 60(suppl. 2):93-107.
Guo H., Yao J., Sun Z., Duan D., 2014 Effects of salinity and nutrient on the growth and chlorophill fluorescence of *Caulerpa lentillifera*. Chinese Journal of Oceanology and Limnology 33(2):410-418.
Guo H., Yao J., Sun Z., 2015 Effect of temperature, irradiance on the growth of green algae *Caulerpa lentillifera* (Bryopsidophyceae, Chlorophyta). Chinese Journal of Applied Phycology 27(2):879-885.
Hasbullah D., Akmal, Bahri S., Agung I. G. P., Suaib M., Ilham, 2014 [Implementation of several bottom substrates as culture media of *Caulerpa*]. Octopus 3(1):244-251. [In Indonesian].
Ilustrisimo C., Palmitos I. C., Senagan R. D., 2013 Growth performance of *Caulerpa lentillifera* (Lato) in lowered seawater pH. Research Paper, Science and Technology in Partial Fulfillment of the Requirement, Philippines, 33 p.
Jha B., Reddy C. R. K., Thakur M. C., Rao M. U., 2009 Seaweeds of India. Springer Science, Gujarat, India.
Littler D. S., Littler M. M., Hanisak M. D., 2008 Submersed plants of the Indian River lagoon. Offshore Graphics, Inc. Washington, D.C. USA.
Munoz J., Pelegrin Y. F., Robiedo D., 2004 Mariculture of *Kappphucus alvarezii* (Rhodophyta, Solleriaceae) color strains in tropical waters of Yucatan. Cinvestaf-lpn Yucatan, Mexico.
Pong Masak P., Mansyur A., Rachmansyah, 2007 *Caulerpa* seaweed and its culture opportunity in South Sulawesi. Media Akuakultur 2(2):80-85.
Prud'homme van Reine W. F., Trono G. C. (eds), 2001 Plant resources of South-East Asia. No. 15 Cryptogams: Algae. Backhuys Publishiers, Leiden, The Netherlands, 318 p.
Putra U. N. S., Jumriadi, Rimmer M., Rahardjo S., 2012 Caulerpa culture within fishpond as a diversification effort of Indonesian Aquaculture. Indonesian Aquaculture and Innovation Forum on Aquaculture Technology. Center for Brachkiswater Aquaculture Development, Takalar.
Rabia M. D. S., 2016 Cultivation of *Caulerpa lentillifera* using tray and sowing methods in brackishwater pond. Environmental Sciences 4(1):23-29.
Trono G. C. Jr., 1997 Field guide and atlas of the seaweed resources of the Philippines. Bookmark, Inc. Manila.
Ukabi S., Dubinsky S., Steinberger Y., Israel A., 2013 Temperature and irradiance effects on growth and photosynthesis of *Caulerpa* (Chlorophyta) species from the Eastrern Mediterranean. Aquatic Botany 104(1):106-110.

Received: 11 December 2018. Accepted: 12 February 2019. Published online: 18 February 2019.
Authors:
Hasni Yulianti Azis, Hasanuddin University, Center of Excellence on Seaweed Science and Technology, Indonesia, South Sulawesi, Makassar, Jl. Perintis Kemerdekaan Km-10 Tamalanrea, Research Center 5th Floor, e-mail: hasni_yulianti@yahoo.com
Muhammad Yusri Karim, Hasanuddin University, Faculty of Marine Science and Fisheries, Fisheries Department, Indonesia, South Sulawesi, Makassar, Jl. Perintis Kemerdekaan KM-10 Tamalanrea, e-mail: yusri_karim@yahoo.com
Khairul Amri, Hasanuddin University, Faculty of Marine Science and Fisheries, Marine Science Department, Indonesia, South Sulawesi, Jl. Perintis Kemerdekaan KM-10 Tamalanrea, Makassar, e-mail: kamri.ikl@gmail.com
Dasep Hasbullah, Center for Brackishwater Aquaculture Development, Indonesia, South Sulawesi, Jl. Perikanan, Desa Mappakalompo, Kecamatan Galesong, Kabupaten Takalar, e-mail: dash.agrifisheries@gmail.com

How to cite this article:
Azis H. Y., Karim M. Y., Amri K., Hasbullah D., 2019 Productivity of several *Caulerpa* species grown in fishponds. AAB Bioflux 11(1):21-24.