Growth and Carotenoid Content of The Green Seaweed *Codium fragile* on Different Depth

Sunaryo[1], Rajuddin Syamsuddin[2], Hasni Yulianti Azis[2], Muh. Nur[3]

[1]Masters Program, Graduate School of Hasanuddin University
[2]Faculty of Marine and Fisheries Sciences, Hasanuddin University
[3]Research Center for Brackish Water Cultivation and Fisheries Extension Maros

Correspondence Author Email: sunaryoyayo4@gmail.com

DOI: 10.29322/IJSRP.12.06.2022.p12627
http://dx.doi.org/10.29322/IJSRP.12.06.2022.p12627

Paper Received Date: 22nd May 2022
Paper Acceptance Date: 6th June 2022
Paper Publication Date: 14th June 2022

Abstract-Seaweed as one of the export commodities and potential to be developed is *C.fragile* because it has a fairly high nutritional content as a source of vegetable protein, minerals, and vitamins, and has a high Fe content. A very important factor in supporting the success of seaweed cultivation is the depth of planting and the proper maintenance container when the seaweed is cultivated. This study aimed to analyze the effect of different cultivation depths on the growth of *C. fragile*. This research used a container in the form of a bag made of bamboo and nets. Then analyzed the growth and content of carotenoids. This study was designed using a Randomized Block Design (RAK) which consisted of 3 treatments with 3 replications each. As treatment is the use of depths of 40 cm, 80 cm, and 120 cm. The results showed that different depths had a significant effect ($P<0.05$) on the growth of *C. fragile* seaweed. The best cultivation depth for the growth of *C. fragile* seaweed is 40 cm.

Keywords: *C. fragile*, Growth, Caratenoid Content, Depth

I. Introduction

Seaweed as one of the export commodities is a source of foreign exchange for the country. The need for world seaweed has increased, and the volume of world seaweed exports throughout the period (2010-2014) increased by 8.15% per year (ITC, 2015). The world's need for seaweed is projected to continue to increase every year, this is due to the many industries abroad that have a high demand for seaweed raw materials such as the cosmetic, food, and pharmaceutical industries (Hikmah, 2015).

One of the seaweeds that have the potential to be developed is *C. fragile* because it has a fairly high nutritional content as a source of vegetable protein, minerals, and vitamins. This type of seaweed contains 15.6% protein, 7.1% fat, and 1.4% total fiber (Ghazali et al. 2018).

One of the most important factors in supporting the success of seaweed cultivation is the right planting depth. The depth of planting seaweed needs to be considered because the depth will affect the growth of seaweed. The depth of planting seaweed needs to be considered because the depth will affect the growth of seaweed. The depth of planting is related to the amount of penetration of sunlight which plays a very important role in the photosynthesis process. *C. fragile* cultivation in the area is still not managed so seaweed production is still low. In this regard, to increase seaweed production, it is necessary to apply new technology with the use of bags in seaweed maintenance. Marine algae bags can improve the quality of marine algae and are a solution for farmers to increase the selling value of marine algae.

Cultivation of *C. fragile* seaweed has not been cultivated because its thallus is easily broken by the influence of currents, so it is necessary to conduct a cultivation trial using the bag method. Based on the description above, it is necessary to research the effect of different water depths on the cultivation of *C. fragile* seaweed on the growth and quality of *C. fragile* with the bag method.

II. METHOD

This research was conducted in September-October 2021, Punaga Village, Mangarabombang District, Takalar Regency, South Sulawesi as the location for *C. fragile*. Analysis of the carotenoid content of *C. fragile* was analyzed at the Laboratory of the Faculty of Animal Husbandry, Hasanuddin University, Makassar. The map for the location of *C. fragile* is shown in Figure 1 below.

This publication is licensed under Creative Commons Attribution CC BY.

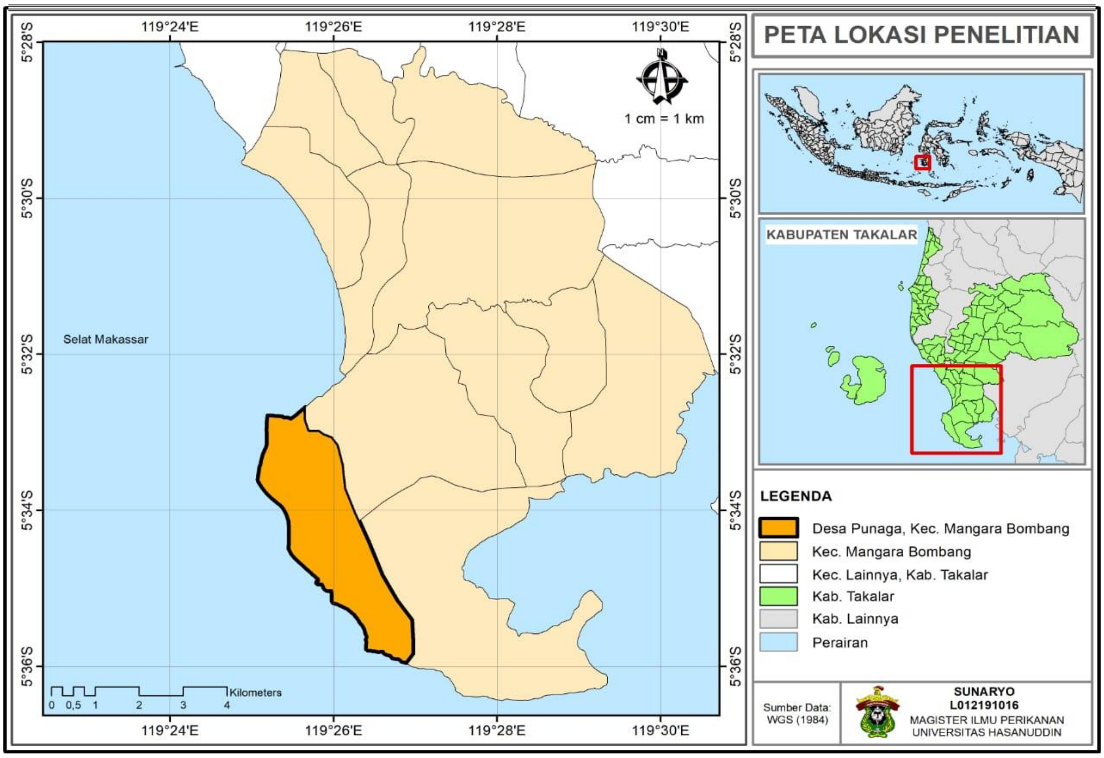
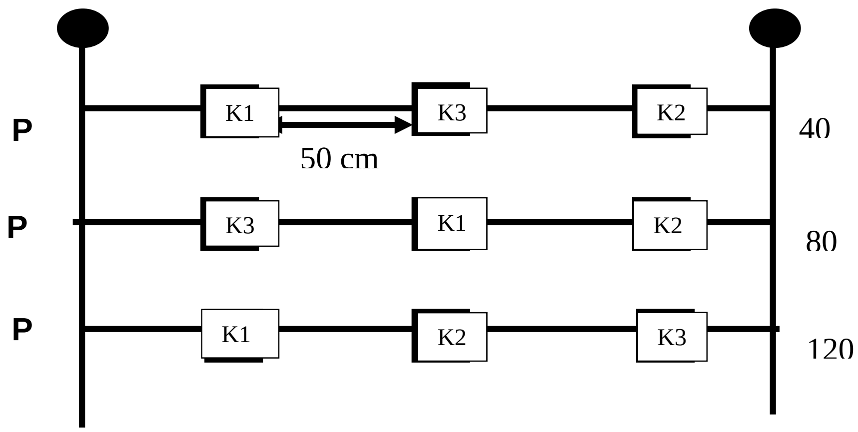


Figure 1. *C. fragile* Location Map

The *C. fragile* seaweed seeds used in this study came from Takalar Regency, South Sulawesi. *C. fragile* seaweed seeds were selected which were still fresh with green characteristics, and not mushy. After sorting, the seaweed seeds are then weighed. The following container used in this study is a bag made of bamboo and net with a bag height of 10 cm and a width of 8 cm, mesh size of 0.5 cm (Figure 2).

Figure 2. Research container

Seaweed was reared for 45 days. The initial weight of seaweed was the same in each treatment, namely 50 g/container each, with a distance between bags of 50 cm. Harvesting is done when the seaweed is 45 days old after planting. The arrangement and layout of the treatment containers are random and can be seen in Figure 3 below.



This publication is licensed under Creative Commons Attribution CC BY.

Figure 3. Research Scheme of *C. fragile* Seaweed Cultivation

The experimental design used in this study was a Randomized Block Design (RAK). This study consisted of 3 treatments and each treatment had 3 replications, thus there were 9 experimental units. The treatment being tested is the depth of cultivation treatment, namely:

1. Treatment A = depth 40 cm
2. Treatment B = depth 80 cm
3. Treatment C = depth 120 cm

Daily Growth Rate. Measurement of the growth rate of seaweed by lifting it from the container and then washing it with clean water to remove mud or dirt attached to the seaweed and placed on a tissue for 3-5 minutes to obtain the actual weight, then the seeds were weighed using an electric scale. Measurements were made by weighing the seaweed every week. The daily growth rate measurement was calculated using the following formula (Fortes, 1981):

$$\mathbf{LPH = Ln\ (Wt/Wo)\ t \times 100}$$

Information :
LPH : Daily weight growth rate/day (% day)
Wo : Initial seedling weight (0 days)
Wt : plant weight after t days
T : Longplanting (days)

Carotenoid content. The number of carotenoids is estimated to be present in the thallus using the Kirk method Shahidi *et al.* (1997) The carotenoid content is calculated by the following formula:

$$C = \frac{\Delta 480 \times \mathrm{V}}{\mathrm{E1\%\ 1\ cm} \times \mathrm{B}}$$

Information:
C : total caratemoid pigment concentration (ppm)
V : extract volume (ml)
E : absorbance coefficient of 1% standart in aseon and in 1 cm cuvette tube
B : weight of the extracted sample (g wet weight)

Water quality. Water quality parameters measured during the study included temperature. which is measured by a thermometer, pH or degree of acidity is measured by using a pH meter, Salinity is measured by a hand refractometer, Light is measured by a lux meter, and current is measured by a kite current. Each water quality parameter is measured twice a week, in the morning and evening at 08.00 and 15.00 WITA.

To determine the effect of cultivation depth on the daily growth rate and carotenoid content of *C. fragile*, an analysis of variance was carried out. If the treatment gives a significant effect on these parameters, then proceed with further test W-Tuckey as a tool for statistical analysis using SPSS version 16.00. The water quality parameters were analyzed descriptively based on the viability of *C. fragile*.

III. RESULTS

Daily growth rate

The results of the analysis of daily growth variance at each depth treatment can be seen in Table 1.

Table 1. Average daily growth rate of *C. fragile* seaweed at different depths by bag method

Depth	Daily Growth Rate (%) ± Stdv
40 cm	1.31±0.01^{a}
80 cm	1.26±0.05^{b}
120cm	1.22±0.03^{b}

Information: Different letters in the same column indicate a significant difference between treatments at the 5% level ($p < 0.05$).

Based on the results of the analysis of variance showed that the depth treatment had a significant effect ($p>0.05$) on the daily growth rate of *C. fragile*. W-Tuckey's further test results showed that *C. Fragile* at a depth of 40 cm was significantly different from the treatment at a depth of 80 cm and 120 cm, while the depth of 80 cm was not significantly different at a depth of 120 cm. The highest results were obtained in treatment A by 1.31% and the lowest in treatment C by 1.22%.

This publication is licensed under Creative Commons Attribution CC BY.

Carotenoid Content

The results of the analysis of the variance of carotenoid content at each treatment depth can be seen in Table 3.

Table 3. Average carotenoid content C. fragile seaweed at different depths

Depth	Carotenoids (%) ± Stdv
40 cm	6.05±1.01[a]
80 cm	4.28±0.63[a]
120cm	5.59±0.98[a]

Note: Different letters in the same column indicate a significant difference between treatments at the 5% level ($p < 0.05$).

Based on the results of the analysis of variance, it showed that each depth treatment had no significant effect ($p>0.05$) on carotenoids

Water Quality Parameters

The average results of water quality measurements during the study can be seen in Table 3 below.

Table 3. Water quality parameters of *C. fragile* at different depths using the bag method

Parameter	Range
Light	370 – 1014 x 100 Cd 345 – 945 x 10 Cd
Salinity	27 – 30 ppt
Temperature	28 – 33 C
pH	6 – 7
Current	0.18 – 0.28 m/s

IV. RESULT

The results of the analysis of variance showed that the depth of cultivation had a significant effect ($p<0.05$) on the daily weight growth rate of *C. fragile* seaweed. The highest daily growth rate of *C. fragile* was obtained at a depth of 40 cm (Table 1). Sunlight is an important factor for seaweed growth. The difference in light intensity received by seaweed at different depths causes different growth rates. The daily growth rate at a depth of 40 cm was the best weight growth during the study. This is because, at that depth, *C. fragile* seaweed is closer to the surface of the water so that the sunlight received is better and has a better effect on growth (Sugiarto et al. 1978)

In addition, environmental factors, namely temperatures of 28–33^{o}C (Table 3) affect the growth of seaweed. Indriani and Sumiarsih (2003), suggested that the growth of seaweed is influenced by environmental factors for its growth in the form of nutrients obtained from the surrounding water by diffusion through the wall of the thallus. Another factor that can affect the growth of *C. fragile* seaweed is the current 0.18–0.28 cm/s (Table 3) which is relatively stronger at a depth of 40 cm. This is following the opinion of Amin et al. (2005) that currents play an important role in seaweed growth because currents carry nutrients needed by seaweed. The greater the movement of water, the faster the growth of seaweed, the current range of 20-40 cm/s is a suitable range for seaweed growth (Sulistijio, 2002). The greater the movement of water, the greater the diffusion of nutrients so that the metabolic process is accelerated, thereby increasing growth. The movement of water that empties water near plants causes the process of entering nutrients into plant cells and releasing metabolic products smoothly (Sulistijio, 2002).

The high content of carotenoids (Table 3) can be influenced by the intensity of light received by seaweed which is greater at a depth of 40 cm so the carotenoid content in seaweed is also high at that depth (Tabri, 2019). The development of the carotenoid content of *K. alvarezii* seaweed along with the development of the content of chlorophyll a. This is caused by carotenoids which are accessory pigments that can protect against damage to chlorophyll a. Chlorophyll cannot accumulate when the synthesis of carotenoids is inhibited, such as beta carotene (Gantt and Cunningham, 2001).

Water quality is one of the factors that influence the success of seaweed cultivation. Seaweed growth and quality are influenced by environmental factors such as light, salinity, temperature, acidity (pH), and currents. The results of light measurements in the study of *C. fragile* in the range of 370-1014 showed indications of growth every day. The difference in light intensity affects the growth rate. This shows that light has a role in the growth of C. fragile because the light is a provider of energy for the continuity of photosynthesis (Widodo and Suadi 2006). Light intensity is a limiting factor in the photosynthesis process, the greater the light intensity, the photosynthesis process can run well (Susilowati et al 2012).

Salinity is one of the important factors that can affect the survival and growth of organisms. The range of salinity obtained during the study was relatively high, ranging from33-54 ppt. The salinity range obtained during the study was 27-30 ppt. according to the Directorate General of Cultivation (2015), seaweed cultivation has a feasible range of cultivation ranging from 28-35 ppt. Guo (2014) stated that the optimal salinity range for the growth of *C. lentilifera* was 25-33 ppt and Burhanuddin (2014) suggested that Caulerpa racemosa seaweed could grow well at salinities ranging from 25-35 ppt. According to Seob et al. (2010)

This publication is licensed under Creative Commons Attribution CC BY.

algae can experience slow growth if the salinity is too low (less than 15 ppt) or too high (more than 35 ppt) from the salinity range that is suitable for their habitat for a certain time. Differences in salinity will affect physiological and biochemical mechanisms because the process of changing osmotic pressure is closely related to the role of cell membranes in the nutrient transport process.

Based on the data obtained, the temperature of the seawater during the study ranged from 28-33^{0}C, this range is still considered feasible to support seaweed life. Syamsuddin (2014) states that in seaweed cultivation, the proper temperature is around 26 – 33°C. While Novianti et al. (2015) the growth of seaweed C. lentilifera was good at temperatures ranging from 27-32 ^{0}C. High-temperature environmental conditions can cause the rapid growth of seaweed because it can accelerate photosynthetic activity. But it can also cause damage to enzymes and the destruction of seaweed thallus if the temperature is too high while the temperature is too low, the biochemical activity in the thallus can stop.

The range of degrees of acidity (pH) during the study ranged from 6-7, this range value is still suitable for the growth of *Codium* sp., this is following what Supit (1989) stated that most grasses like the pH range of 6.8-9.6 so that the pH is not a problem for growth. While according to Yuliyana et al. (2015) argues that the pH range in the growth of C. lentilifera seaweed is 7.7-8.3. Anggadireja (2006) stated that the ideal pH in seaweed cultivation has a range of 6-9. Whereas Ruslaini (2016) that the best pH value for the growth of Gracilaria verrucosa seaweed ranged from 6–9.

The results of current velocity measurements that have been carried out in the *C. fragile* seaweed cultivation area obtained values ranging from 0.18 to 0.28 m/s. Differences in current speed can be caused by tidal currents or wind and waves. Currents have an important role in the growth of seaweed. If the current is too slow it will interfere with the absorption of nutrients in the waters, besides that a slow current will have an impact on the epiphytes that grow attached to the seaweed so that they can become competitors in getting nutrients (Arisandi, 2012). Parenrengi et al. (2012), stated that a good current velocity for seaweed cultivation is 0.2-0.4 m/s. In a nutrient-rich location, a slow current velocity of about 10 cm/sec can support good seaweed growth.

V. CONCLUSIONS

The growth and carotenoid content of C. fragile at different depths showed that the best cultivation depth for growth was 40 cm with a value of 1.31 ± 0.01^a and a carotenoid content of 6.05 ± 1.01^a. So *C. fragile* has the potential to be cultivated at a depth of 40 cm.

REFERENCES

Amin, M.T.P. Rumayar, N.F. Femmi, D. Kemur dan I.K. Suwitra. *Kajian Budidaya Rumput Laut (Eucheuma cotonii) dengan Sistem dan Musim Tanam yang Berbeda di Kabupaten Bangkep Sulawesi Tengah*. Jurnal Pengkajian dan Pengembangan Teknologi Pertanian, 2005. 8 (2): 282-291.

Anggadireja. *Rumput Laut, Pembudidayaan, Pengelolaan dan Pemasaran Komoditas Perikanan Potensial. Seri Agribisnis.* Penebar Swadaya. Jakarta. 2006

Arisandi, P. *Pengukuran Kualitas Air Hulu Daerah Aliran Sungai Kali Brantas Berdasarkan Keragaman Taksa Ephemeroptera, Plecoptera, Dan Tricoptera.* Surabaya. 2012

Burhanuddin. *Respon Warna Cahaya Terhadap Pertumbuhan Dan Kandungan Karatenoid Anggur Laut (Caulerpa racemosa) Pada Wadah Terkontrol*. Jurnal Balik Diwa, 2014. 5 (1): 8-13.

Ditjen Budidaya. *Profil Rumput Laut Indonesia. Direktorat Jederal Perikanan Budidaya. Departemen Perikanan dan Kelautan.* Jakarta. 2015.

Fortes, T.G. *Introduction to The Seaweed Their Characteristics and Economic Importance. Report in Training Course of Glacillaria Algae.* Up-South China Sea Project. Manila Philippines. 1981.

Gantt, E., and F.X. *Cunningham. Algal Pigments*. Encyclopedia of live sciences. John Wiley & Sons. Ltd. 2001.

Gazali, M., N. Nurjanah, dan N.P. Zamani. *Eksplorasi senyawa bioaktif alga cokelat Sargassum sp. Agardh sebagai antioksidan dari Pesisir Barat Aceh. J. Pengolahan Hasil Perikanan Indonesia,* 2018. 21(1): 167.

Guo, H., J. Yao, Z. Sun dan D. Duan. *Effect of Temperature, Irradiance on the Growth of the Green Alga Caulerpa lentillifera (Bryopsidophyceae, Chlorophyta).* Journal of Applied Phycology, 2014. 27 (2): 879-885.

Hikmah. *Strategi Pengembangan Industry Pengelolaan Komoditas Rumput Laut E.Cottoni Untuk Peningkatan nilai tambah di sentra kawasan industrilisasi.* Jurnal kebijakan sosek KP. 2015. 5(1): pp. 27-36.

Indriani, H dan E. Suminarsih. *Budidaya, Pengelohaan dan pemasaran Rumput Laut*. Penebar Swadaya. Jakarta. 2003.

International Trade Center (ITC). *Data ekspor impor rumput laut dunia* HS 121220, HS 121221, HS 121229, HS 130231, HS 130239 Periode 2010-2014. 2015.

Novianti, Sri Rejeki and Titik Susilowati. *Pengaruh Bobot Awal yang Berbeda Terhadap Pertumbuhan Rumput Laut Latoh (Caulerpa lentillifera) yang Dibudidaya Di Dasar Tambak, Jepara*. Journal of Aquaculture Management and Technology, 4(4). (2015).

Parenrengi dan Sulaeman. *Mengenal Rumput Laut Kappaphycus alvarezii,* Media Akuakultur, 2(1). (2012)

Ruslaini. *Kajian Kualitas Air Terhadap Pertumbuhan Rumput Laut (Gracilaria verrucosa) di Tambak Dangan Menggunakan Metode Vertikultur.* Octupus Jurnal Ilmu Perikanan, 5 (2). 2016.

Seob, C., E. Kang, K. Ju-Hyoung, dan K. Kwang. *Effect of Salinity on Growth and Nutrient Uptake of Ulfa Pertusa (Chlorophyta) From and Eelgrass Bed. Korea*: Departement of Oceanography, Chonnam National University, Gwangju. 2010.

This publication is licensed under Creative Commons Attribution CC BY.

ISSN 2250-3153
Shahidin, F., Metusalach, & J.A. Brown. *Caratenoid Pigmens in Seafood and Aquakulture*. Cnt: Rev. Journal of Food Sci. Nutr. 1997. 38:1-67.

Soegiarto, A. Sulistijo. W, S, Atmaja dan H, Mubarak. *Rumput Laut, Manfaat, Potensi, dan Usaha Budidayanya*. LON-LIPI. Jakarta. 1978. 49 Hlm

Sulistijo. *Penelitian Budidaya Rumput laut (Alga makro/Seaweeds) di Indonesia. Pidato Pengukuhan Ahli Peneliti Utama Bidang Akuakultur.* Pusat Penelitian Oseanografi Lembaga Ilmu Pengetahuan Indonesia, Jakarta. (2002).

Supit. *Karakteristik Pertumbuhan dan kandungan Caragenan Rumput Laut (Eucheuma cattonii) yang berwarna Abu-abu Cokelat dan Hijau yang ditanam di Goba lambungan Pasir Pulau Pari*. Karya Ilmiah. Bogor: Fakultas Perikanan, Institut Pertanian Bogor. (1989).

Susilowati, T., S. Rejeki, E. N. Dewi, dan Zulfitriani. *Pengaruh Kedalaman Terhadap Pertumbuhan Rumput Laut (Eucheuma cottonii) yang Dibudidayakan dengan Metode Longline di Pantai Mlonggo*, *Kabupaten Jepara*. Jurnal Saintek Perikanan, 8 (1). 2012.

Syamsuddin, R. *Pengelolaan Kualitas Air Teori dan Aplikasi di Sektor Perikanan*. Cetakan Pertama. Pijar Press. Katalog Dalam Terbitan. 2014. 340 hlm

Tabri, R. *Pertumbuhan dan Kualitas Coulerpa recemose yang Dibudidayakan dengan Bobot Awal Berbeda Di Dalam Media Air Limbah Budidaya Udang Supra Intensif*. Skripsi. Program Studi Budidaya Perairan. Departemen Perikanan. Fakultas Ilmu Kelautan dan Perikanan. Universitas Hasanuddin, Makassar. 2019..

Widodo J dan Suadi, *Pengelolaan Sumber Daya Perikanan Laut,* Gadjah Mada University Press, Yogyakarta. 2006,

Yuliyana, Sri Rejeki, dan Lestari Lakhsmi Widowati. *Pengaruh Salinitas yang Berbeda Terhadap Pertumbuhan Rumput Laut Latoh (Caulerpa lentillifera) di Laboratorium Pengembangan Wilayah Pantai (Lpwp) Jepara*. Journal of Aquaculture Management and Technology, 4(4). 2015

AUTHORS

First Author – Sunaryo, Program Magister, Sekolah Pascasarjana Universitas Hasanuddin dan sunaryoyayo4@gmail.com
Second Author – Rajuddin Syamsuddin, Fakultas Ilmu Kelautan dan Perikanan, Universitas Hasanuddin dan rajuddin.syamsuddin09@gmail.com
Third Author – Hasni Yulianti Azis, Fakultas Ilmu Kelautan dan Perikanan, Universitas Hasanuddin dan hasniasiz375@gmail.com
Fourt Author – Muh. Nur, Balai Riset Budidaya Air Payau dan Penyuluhan Perikanan Maros,
dan muhammad.nursp89@gmail.com

Correspondence Author – Sunaryo, sunaryoyayo4@gmail.com, 081254567438

This publication is licensed under Creative Commons Attribution CC BY.