Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(5): 1 – 9 (2024)
www.ejabf.journals.ekb.eg

Seaweed Variety Growth Different (*Halyemenia durviela* and *Caulerpa racemosa*) with the Off- Bottom Method

Riyadi Subur , Muhammad Irfan*, Fatma Muchdar, Rovina Andriani, Juharni
Aquacultur Departement, Faculty of Fisheries and Marine Science, Khairun University, Jl. Jusuf Abdurrahman, Gambesi, Ternate 97719 Ternate, North Maluku, Indonesia
***Corresponding Author: ifan_fanox@yahoo.co.id**

ARTICLE INFO
Article History:
Received: Oct. 26, 2023
Accepted: March 26, 2024
Online: Sep. 1st, 2024

Keywords:
Varieties,
Seaweed,
Off-bottom methods,
Growth

ABSTRACT

Seaweed varieties, *Halymenia durviela* and *Caulerpa racemosa*, hold a significant economic value since they can be used as raw materials in food, medicine, and cosmetics. Therefore, proper cultivation methods are essential to enhance the productivity of these seaweeds. This study aimed to assess the growth effects on *C. racemosa* and *H. durviela* and identify which variety exhibits the best growth performance. Two different seed variety treatments were tested, each with three replications. The treatments were as follows: Treatment A involved *C. racemosa* seeds, and Treatment B involved *H. durviela* seeds. The data analyzed included absolute weight growth and relative growth rates. The results indicated that the off-bottom method influenced the growth of both seaweed varieties, with *Halymenia durviela* showing the best results in terms of absolute weight growth and relative growth rates.

INTRODUCTION

Seaweed is a marine algae, it is growing from natural shock or pond culture. Seaweeds have no true roots and leaves. They are attached to substrates such as sand, mud, rocks and shells or ranging from tide level to considerable depths in the ocean and seas. Currently, seaweeds are used in food, chemical, textile, agriculture industries including pharmaceuticals and medicine **(Keyimu & Abuduli, 2019)**.

Seaweed is one of the potential natural resources of Indonesian marine waters. Moreover, they are widely used as raw materials for carrageenan and gelatin. Ecologically, seaweed can provide many benefits to the surrounding environment **(Rukmi *et al*., 2012)**.

Cultivation technology for seaweeds *H. durviela* and *C. racemosa* has not been widely developed, thus research needs to be carried out to obtain information on the components of cultivation technology through the application of appropriate cultivation methods. The application of the off-base method is expected to increase the production of cultivated seaweed varieties optimally **(Muslimin & Sari, 2017)**.

H.durviela and *C. racemosa* are varieties of seaweed that have important economic value, as they can be used as raw materials for food, medicine and cosmetics **(Irfan & Muchdar, 2022)**. Therefore, this grass variety needs to be utilized and developed through proper cultivation with the right method to increase business productivity.

One of the internal factors that influences the growth of seaweed is variety or type. Each type of seaweed has different growth. Based on the aforementioned data, research is needed to study the growth of seaweed with different varieties using the off-base method in order to obtain information about which varieties provide the best growth **(Mamang, 2018)**.

MATERIALS AND METHODS

This research was carried out in Kastela waters, Ternate Island sub-district, Ternate City, over a 45-day period from April to May 2023.

The equipment used to measure water quality is a refractometer (ATC) for water salinity, a mercury thermometer for water temperature, a digital pH meter (ATC) for water pH, a current meter for measuring current speed, and a DO meter for measuring dissolved oxygen. Additionally, the materials used in this research were seaweed *H. durville* and *C. racemose* seeds taken from the waters around the research location. The cultivation containers were made using a 4mm diameter polyethylene (PE) rope for the long line and raffia rope to tie the seed clumps.

The initial weights of the *C. racemosa* and *H. durviela* clumps used refer to the initial weight of the *K. alvarezii* family, which is around 50g/ clump. The stretched rope used is a polyethylene (PE) rope with a diameter of 4mm and a length of 15m, while maintaining a distance of 1m between each stretch rope. Maintenance was carried out using the off-bottom monoline method. The placement of the tested seaweed in the cultivation containers was carried out randomly, with 30 clumps per experimental unit. In this research, 2 different seed variety treatments were tried, each with 3 replications. The treatments tried were as follows:

Treatment A: *C. racemosa* seaweed seed variety

Treatment B: *H. durviela* seaweed seed variety

Weight growth observations were carried out once a week on the test seaweed. Monitoring seaweed for biological disturbances was also carried out during maintenance. As supporting data, *in situ* water quality measurements (temperature, salinity, pH, current velocity and dissolved oxygen) were also carried out once a week.

Data analysis was used to determine the growth of seaweed cultivated, *C. racemose* and *H. durviela*. The data analyzed were the absolute weight growth data, obtained from the difference between the average weight at the end of rearing and the initial weight recorded upon stocking/planting, as well as the relative growth rate.

To calculate absolute weight growth, the following formula was used according to **Arjuni *et al*. (2018)**:

$$W = Wt - Wo$$

Where :

W = Growth (Absolute weight growth) (grams)

Wt = Final weight (grams)

Wo = Initial weight (grams)

To calculate the growth rate (relative growth rate) the formula described in the study of **Dharmawaty *et al*. (2016)** was used:

$$LPN = Ln \left(\frac{Wt - Wo}{t}\right) x\ 100\%$$

Where :

LPN = Growth rate (%)

Wo = Wet weight at the start of the study (grams)

Wt = Wet weight at the end of the study (grams)

t = Maintenance time (45 days)

The design used in this research was a completely randomized design (CRD). For data analysis, the analysis of variance **(Steel & Torrie, 1993)** was used.

RESULTS AND DISCUSSION

1. Absolute weight growth

The average absolute weight growth in each treatment is shown in Table (1).

Table 1. Average absolute weight growth (grams) in each treatment

Test	Treatment		
	A	**B**	**Amount**
1	32	35	67
2	30	37	67
3	30	39	69
Total	92	111	203
Average	30,66	37	

Table (1) shows that the absolute weight growth is different in each treatment or type of seaweed, where treatment A (*Caulerpa racemosa*) has an average absolute weight growth of 30.66 grams, and treatment B *(Halymenia durviela*) is 37 grams. The differences in the effect of each treatment on absolute weight growth is shown in Table (2).

Table 2. Results of analysis of absolute weight growth varieties

Source of diversity	Degree of freedom	Squared sum	Middle square	F count	F table	
					0,05	0,01
Treatment	1	60,167	60,167	22,568**	7,71 21,20	
Error	4	10,667	2,666			
Total	5					

Informatioan: ** = very different indeed

Table (2) shows that the calculated F value (22.568) is greater than the F table value at both 0.05 and 0.01 significance levels, indicating a highly significant difference in the effect on the absolute weight growth of seaweed. The specific differences between treatments were determined through the LSD test, with results presented in Table (3).

Table 3. LSD test results showing effect of each treatment on absolute weight growth

Treatment	Average	Difference		LSD	
				0,05	0,01
A	30,66	-		3,261	4,941
B	37	-6,34	6,34**		
		-			

Informatioan: very different indeed

In Table (3), it can be seen that treatment A to B has an effect that is not significantly different, while treatment B to A is very significantly different. The results of the LSD test also show that treatment B provides the best results for absolute weight growth. From the difference in average values with the LSD test, it is deduced that treatment B has a higher difference in average values than treatment A.

Absolute weight growth is a measurement of the weight of seaweed at the end of the study minus the weight of the seaweed at the start of the study **(Ikhsan *et al*., 2022)**. Based on the absolute weight growth analysis, it was noticed that seaweed the *Halymenia durviela* type has a higher average absolute weight growth value of around 37 grams compared to the seaweed *Caulerpa racemosa* type which is only around 30.66 grams. The seaweed *H. durviela* type has a higher absolute weight growth since this type of seaweed has strong branches and few thallus so it can grow firmly even in fast-flowing waters, compared to *Caulerpa racemosa* which generally has dense thallus but soft branches. The morphological condition of these two types of seaweed is shown to be one of the factors influencing its growth. This fact is clearly visible, where the branches of *Caulerpa racemosa* are often detached, whereas in *H. durviela*, the branches remain sturdy and are not easily separated from the thallus, resulting in the difference in weight between these two types influencing their growth. According to **Yudhasmara (2014)**, *Caulerpa racemosa* is a type of seaweed with dense thallus and lives attached to the substrate of coral fragments, sand and mud, but has branches that are easily detached.

While, **Langoy (2011)** stated that *H. durviela* is one of the marine macro algae which lives on coral substrates and coral fragments with strong thallus conditions.

Another factor influencing growth is the smaller and less dense thallus of the seaweed, which allows for greater absorption of nutrients and sunlight, leading to faster development **(Ikhsan *et al.*, 2022)**. The low thallus condition of *H. durviela* likely enables this seaweed to obtain better nutrients, thereby enhancing its growth. Additionally, *Halymenia durviela* utilizes optimal sunlight more effectively than *Caulerpa racemosa* for photosynthesis, which increases its ability to acquire essential nutrients. The growth of seaweed is also affected by water currents, which help transport and trap nutrients within each seaweed thallus, optimizing the growth process **(Guiry & Guiry, 2018)**.

2. Relative growth

The results of the relative growth analysis can be seen in Table (4).

Table 4. Relative growth (%) in each treatment

Test	Treatment		
	A	B	Amount
1	1,099	1,179	2,278
2	1,044	1,230	2,274
3	1,044	1,281	2,325
Total	3,187	3,69	6,877
Average	1,062	1,23	

Table (4) shows that the relative growth value in treatment B (seaweed type *H. durviela*), with an average relative growth value of 1.23% compared to treatment A (seaweed type *Caulerpa racemosa*), which recorded a value of 1.062%. To detect the differences in the effect of each treatment, an analysis of variance was carried out which is shown in Table (5).

Table 5. Results of analysis of relative growth variations

Source of diversity	Degree of freedom	Squared sum	Middle square	F count	F table	
					0,05	0,01
Treatment	1	0,042	0,042	24**	7,71 21,20	
Error	4	0,007	0,00175			
Total	5					

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Table (5) shows F calculated (24) > F table (0.05 or 0.01), thus giving a very significantly different influence on the relative growth of seaweed. The LSD test was used to determine the differences in the effect of each treatment, the results of which are displayed in Table (6).

Table 6. BNT test results with the effect of each treatment on relative growth

Treatment	Average	Differences		LSD 0,05	LSD 0,01
A	1,062	-		0,080	0,122
B	1,23	-0,168	0,168**		

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Table (6) shows that treatment A to treatment B is not significantly different, and treatment B to A is very significantly different, so that treatment B gives the best results regarding relative growth. The highest relative growth was in treatment B (*H. durviela* seaweed type) compared to treatment A (*Caulerpa racemosa* seaweed type). The highest relative growth in treatment B had an average value of 1.23%, which means that the relative growth recorded a daily increase of 1.23%.

The highest average relative growth rate of seaweed *H. durviela* was 1.23%/day and for *Caulerpa racemosa*, it was 1.062%. This shows that seaweed cultivation carried out using the off-base method is not yet profitable. **Desy *et al*. (2016)** stated that a seaweed cultivation activity is said to be profitable if it has an additional relative growth rate of at least 3% per day.

3. Water quality

Water quality parameters measured during the research can be seen in Table (7).

Table 7. Research water quality

Parameter	Range
Temperature (°C)	28 – 30
Current velocity (cm/det)	25-35
pH	7,5 – 8,2
Salinity (‰)	26-34

4. Temperature

Water temperature has an impact on seaweed growth. **Musadat and Afandi (2018)** explained that the water temperature suitable for seaweed's living needs is around 28 – 32^{0}C. A high temperature increase will cause the seaweed thallus to become pale yellowish and unhealthy.

The temperature of a body of water is influenced by solar radiation, position of the sun, geographical location, season, cloud conditions, as well as the interaction process between water and air, evaporation and wind gusts **(Nirmala *et al*., 2014)**. Furthermore, it is said that changes in temperature affect the physical, chemical and biological processes of water bodies. Water temperature plays an important role in the photosynthesis process, where the higher the intensity of the sun and the more optimal the temperature conditions, the more systematic the results of photosynthesis will be. Water temperature also affects several physiological functions of seaweed such as photosynthesis, respiration, metabolism, growth and reproduction **(Irfan *et al.*, 2021)**.

The average temperature value at the research location ranges from 28 – 30^{o}C. The temperature range values obtained are still considered suitable for seaweed cultivation. The best temperature for cultivating *Halymenia* sp. is around 27-32^{o}C **(Siti Fadila & Pratiwi, 2020)**, while the optimal temperature range to support the growth of *Caulerpa racemosa* is between 25-31°C **(Irfan *et al*., 2021)**. From the temperature obtained, it still supports the growth of cultivated seaweed.

5. Current velocity

The current velocity plays a crucial role in delivering nutrients to seaweed, with the appropriate speed being essential for an optimal growth. According to **Musadat and Afandi (2018)**, favorable water currents facilitate the transport of nutrients necessary for seaweed growth and help remove dirt and sediment adhering to the plants. Additionally, proper current velocity allows seaweed to absorb nutrients efficiently and ensures that the photosynthesis process is not disrupted. However, excessively strong currents can hinder nutrient absorption, making it difficult for seaweed to grow. A current velocity of approximately 20-40cm/ sec is ideal for seaweed growth, while velocities exceeding 40 cm/sec can damage cultivation containers and break seaweed branches **(Irfan *et al*., 2021)**. Moreover, **Hartanto and Gunarso (2021)** noted that sufficient water movement enhances oxygen and nutrient levels, cleaning the thallus surface. A clean thallus allows for better nutrient absorption and sunlight exposure, promoting an effective photosynthesis. The measured current speed during this study ranged from 25-35cm/ sec, making it suitable for the growth and development of the cultivated seaweed.

6. pH

pH is a limiting factor in the life and existence of a plant. Even though seawater has a relatively stable pH value, it can be influenced by photosynthetic activity, temperature, and industrial waste. The optimal water pH for seaweed cultivation is generally 7.3 – 8.2 **(Pongmasak & Sarira, 2018)**.

Seaweed needs pH to grow; the pH of the water during the research was around 7.5 – 8.2, hence it is still suitable for seaweed growth. *Caulerpa racemosa* needs a pH of 7-7.8 **(Irfan *et al*., 2021)**. According to **Siti Fadilah and Pratiwi (2020)**, a good pH for the growth of *Halymenia* sp. is in the range of 7.7-8.4.

7. Salinity

Salinity is important for the survival of organisms; almost all marine organisms can live in waters that have a certain salinity range **(Hutabarat & Evans, 2001)**. Salinity is one of the water quality parameters possessing an influence on organisms and plants living in marine waters. The ideal water salinity to be used for the seaweed cultivation land is that in the range of 32 – 34ppt. However, if fluctuations are outside the ideal range, it will cause low growth and rapid aging of the seaweed thalus. To obtain salinity in this range, cultivation locations should not be close to river estuaries or other fresh water sources **(Pongmasak & Sarira, 2018)**.

The results of salinity measurements during the research obtained a range of 28 – 30‰. According to **Siti Fadila and Pratiwi (2020)**, the *Halymenia* sp. were cultivated in locations with the saliity range of 32-34ppt. Meanwhile, the salinity range for the cultivation of *Caulerpa racemosa* fluctuated from 26-31ppm **(Irfan *et al*., 2021)**. Remarkably, the salinity obtained is still suitable for the growth of the cultivated seaweed.

CONCLUSION

There is an influence on the growth of seaweed (*C. racemosa* and *H. durviela*) using the off-bottom method. Seaweed *Halymenia durviela* gives the best results for an absolute weight growth and a relative growth using the off-bottom method.

REFERENCES

Arjuni, A.; Cokrowati, A. and Rusman, A.R. (2018). Pertumbuhan Rumput Laut *Kappahycus alvarezii* Hasil Kultur Jaringan. J. Biologi Tropis; 18 (2): 216-223.

Darmawati, D.; Rahmi, B. and Jayadi, A.E. (2016). Optimasi Pertumbuhan *Caulerpa* sp Yang Dibudidayakan dengan Kedalaman Yang Berbeda di Perairan Laguruda Kabupaten Takalar. J. Octopus; 5 (1): 435-442.

Desy, S.A.; Izzati, M. and Prihastanti, E. (2016). Pengaruh Jarak Tanam Pada Metode Longline Terhadap Pertumbuhan dan Rendemen Agar *Gracillaria verrucosa* (Hudson) PAPENFUSS. J. Biologi; 5 (2): 11-12.

Guiry, M.D.; Guiry, G.M. (2018). Algaebase. World-Wide Electronic Publication, National University of Ireland, Galway (Taxonomic Information Republished From Algaebase With Permission Of M.D. Guiry). *Turbinaria* J.V. Lamouroux, 1825.

Hartanto, S.; and Gunarso, H. (2021). Kandungan Nutrisi Rumput Laut (Eucheuma cottonii) dengan Metode Rakit Gantung pada Kedalaman Berbeda. J. Aquamarina; 8 (1): 27-33.

Hutabarat, S.; and Evan, S. (2001). Pengantar Oseanografi. PT. Gramedia.Jakarta.

Irfan, M.; and Muchdar, F. (2022). Komoditas Budidaya Makro Alga Laut Komersial, Lepkhair Press. Ternate.

Irfan, M.; Samadan, G.; Subur, R. and Malan, S. (2021). Uji Coba Budidaya Rumput Laut *Caulerpa racemosa* dengan Metode Lepas Dasar di Perairan Kastela Kecamatan Pulau Ternate Kota Ternate. J.Agrikan; 14 (1):80-83.

Ikhsan, F.; Irawan, H.M.; and Rika, W. (2022). Laju Pertumbuhan Rumput Laut *Kappaphycus alvarezii* Varietas Hijau dan Coklat Pada Metode Budidaya yang Berbeda. J. Intek Akuakultur; 6 (1): 82-91.

Keyimu, X.G.; Abuduli.; M. (2019). Seaweed Composition and Potential Uses. International J. of ChemTech Research; 12 (1): 105-111.

Langoy, M.; Saroyo, J.; Dapas, F.; Katili, D. and Hamsir, S.A. (2011). Deskripsi Alga Makro di Taman Wisata Alam Batuputih, Kota Bitung-Manado. J. Ilmiah Sains; 2011: 56-59.

Mamang, N.; (2018). Laju Pertumbuhan Bibit Rumput Laut *Kappahycus alvarezi* Dengan Perlakuan Asal Thallus Terhadap Bobot Bibit di Perairan Lakeba Kota Bau-Bau Sulawesi Tenggara. Skripsi. Program Studi Ilmu dan Teknologi Kelautan. Institut Pertanian Bogor. 121 hal.

Musadat, F.; and Afandi, A. (2018). Analisis Tingkat Kesesuaian Lokasi Budidaya Rumput Laut di Perairan Desa Kamelanta dan Pulau panjang dengan Menggunakan Sistem Informasi Geografis (SIG). J. Akuakultur; 2 (1): 2579-4752.

Muslimin and Sari, P. K. W. (2017). Petunjuk Teknis Teknologi Budidaya Rumput Laut *Sargassum* sp Dengan Metode Lepas Dasar. Lokas Riset Budidaya Rumput Laut. Boalemo. Gorontalo. 13 hal.

Nirmala K.; Ratnasari A.; and Budiman, S. (2014). Penentuan kesesuaian lokasi budidaya rumput laut di perairan Teluk Gerupuk - Nusa Tenggara Barat menggunakan penginderaan jauh dan SIG. J. Akuakultur Indonesia; 13 (1) : 73–82.

Pongmasak, R.P., and Sarira. (2018). Analisis Kesesuaian Lahan Untuk Pengembangan Budidaya Rumput Laut di Gusung Batua Pulau Badi Kabupaten Pangkep. J. Ris. Aquakultur; 5 (2) : 299-316.

Rukmi, R. A., Sunaryo, and Djunaedi, A. (2021). Sistem Budidaya Rumput Laut *Gracilaria verrucosa* di Pertambakan dengan Perbedaan Waktu Perendaman di Dalam Larutan NPK. J. Marine Research; 1 (1): 90-94.

Siti Fadilah.; and Pratiwi, A.D. (2020). Peningkatan Pertumbuhan Rumput Laut *Halymeni*a sp. melalui Penentuan Jarak Tanam Rumpun. J. Perikanan.Universitas Gadjah Mada; 22 (1): 37-42.

Steel and Torrie.; (1993). Prinsip dan Prosedur Statistika. PT. Gramedia. Jakarta.

Yudhasmara, A.G.; (2014). Budidaya Anggur Laut (*Caulerpa racemosa*) Melalui Media Tanam Rigid Quadrant Nets Berbahan Bambu. J. Sains dan Teknologi; 3 (2): 468-473.