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Antioxidant Activity in Lawi-Lawi Sea Grapes (Caulerpa Racemosa) from Takalar Waters

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ABSTRACT

Sea grapes (Caulerpa racemosa), locally known as lawi-lawi, represent an economically important marine resource in South Sulawesi with promising potential as a natural antioxidant source. Environmental variability among cultivation areas may influence the biosynthesis of secondary metabolites responsible for antioxidant activity. This study aimed to evaluate the antioxidant activity of C. racemosa ethanol extract collected from Takalar waters using the DPPH radical scavenging assay. This experimental laboratory research involved maceration extraction with 96% ethanol, followed by spectrophotometric measurement at 517 nm. Antioxidant activity was expressed as percentage inhibition and IC_{50} value determined through linear regression analysis. The results demonstrated a concentration-dependent increase in radical scavenging activity, with inhibition values rising progressively from low levels at 25 mg/mL to 42% at 400 mg/mL. The average IC_{50} value obtained from triplicate testing was 419.00 µg/mL, indicating weak antioxidant activity according to standard classification criteria. Although categorized as weak, the extract consistently demonstrated measurable bioactivity, likely attributed to phenolic and flavonoid compounds known for their hydrogen-donating and metal-chelating mechanisms. Variations in antioxidant potency compared to other regional studies suggest ecological and methodological influences. These findings highlight the functional potential of Takalar sea grapes and support further optimization of extraction techniques to enhance bioactive compound recovery for nutraceutical and functional food applications.

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A. Conception and design of the study;
B. Acquisition of data;
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D. Manuscript preparation;
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INTRODUCTION

Indonesia is one of the world's largest seaweed producers, with production reaching 10.80 million tons in 2024 (KKP, 2024). This dominance not only reflects the economic strength of the marine sector but also opens up opportunities to utilize marine biodiversity as a source of functional foods and high-value bioactive ingredients. One species abundantly found in South Sulawesi waters is Caulerpa racemosa (lawi-lawi), a green seaweed traditionally consumed as a fresh vegetable and reported to contain potent antioxidant compounds (Maharani et al., 2021; Fadlilah & Lestari, 2023).

Biologically, oxidative stress due to the accumulation of free radicals contributes to the pathogenesis of various degenerative diseases such as cancer, cardiovascular disorders, diabetes, and premature aging (Sandjaya et al., 2025). Free radicals can damage DNA, proteins, and cell membrane lipids, disrupting cellular homeostasis. In this context, antioxidants function as a defense system that neutralizes free radicals through electron or hydrogen donor mechanisms (Kurniawati & Sutoyo, 2021). Recent literature shows that increased intake of natural antioxidants from seafood sources is correlated with reduced biomarkers of oxidative stress and systemic inflammation (López-Hernández et al., 2020; Pangestuti & Kim, 2019).

However, the antioxidant potential of a seaweed species is strongly influenced by environmental factors such as temperature, salinity, light intensity, and nutrient availability (Holdt & Kraan, 2019; Otero et al., 2022). This ecological variability raises a scientific question: to what extent does Caulerpa racemosa from key production areas like Takalar possess quantitatively measurable antioxidant activity?

Recent studies have shown that green seaweed contains various secondary metabolites such as flavonoids, phenolics, saponins, steroids, and triterpenoids, which contribute to antioxidant activity (Pangestuti & Kim, 2019; Wijesinghe & Jeon, 2012; revisited in recent analyses 2018–2023). Research by Yuniarti et al. (2023) on a 96% ethanol extract of Caulerpa racemosa from Cimandiri Beach (Banten) demonstrated complete bioactive compounds and an IC_{50} value of 237.51 mg/L using the DPPH method, categorized as moderate antioxidant activity. Other studies have reported that varying extraction methods (maceration, Soxhlet extraction, ultrasonic-assisted extraction) significantly influence yield and radical scavenging capacity (Nurjanah et al., 2020; Otero et al., 2022).

The DPPH-based antioxidant activity assay remains the standard in in vitro evaluation due to its sensitivity and reproducibility in measuring scavenging capacity against the 2,2-diphenyl-1-picrylhydrazyl radical (Brand-Williams et al., revisited in contemporary antioxidant methodology literature 2018–2024). The IC_{50} value is an important quantitative parameter for determining the extract concentration required to inhibit 50% of free radical activity. The lower the IC_{50} value, the higher the antioxidant potential of a substance (Molyneux, 2004; recontextualized in recent antioxidant assays literature).

Empirically, several regional studies in Indonesia have shown significant differences in C. racemosa IC_{50} values between locations, indicating the influence of oceanographic conditions on secondary metabolite profiles (Nurjanah et al., 2020; Yuniarti et al., 2023). International studies also confirm that environmental stresses such as high salinity and intense light exposure can increase the production of phenolic compounds as an adaptive response to oxidative stress (Otero et al., 2022; Holdt & Kraan, 2019).

Although various studies have examined the antioxidant activity of Caulerpa racemosa in several regions of Indonesia, specific scientific data on the species originating from Takalar waters remains very limited. Takalar is a major seaweed production center in South Sulawesi, with ecological characteristics distinct from regions such as Banten or East Java. Variations in the physical and chemical factors of

the waters have the potential to produce significantly different secondary metabolite profiles (Holdt & Kraan, 2019; Otero et al., 2022).

This scientific gap encompasses two main aspects. First, the lack of quantitative data based on IC_{50} parameters on C. racemosa extracts from Takalar that can be compared nationally or globally. Second, there are no studies linking this antioxidant potential to opportunities for developing functional foods based on local resources in South Sulawesi. Without this data, the use of lawi-lawi as a raw material for health products remains assumption-based and not based on strong scientific evidence.

Therefore, standardized experimental research is needed to objectively measure the antioxidant activity of Caulerpa racemosa extract from Takalar using the DPPH method and IC_{50} analysis as a quantitative indicator of its potential bioactivity.

Based on this gap, this study aims to analyze the antioxidant activity of Caulerpa racemosa extract from Takalar waters by determining the IC_{50} value using the DPPH method. The proposed hypotheses are: H_0 states that the C. racemosa extract from Takalar does not have significant antioxidant activity, while H_1 states that the extract has significant antioxidant activity.

The novelty of this study lies in: (1) providing the first quantitative data on the IC_{50} value of C. racemosa from Takalar; (2) potential comparison with previous regional studies to map location-based variations in bioactivity; and (3) contributing to the development of a scientifically evidence-based downstream model for seaweed processing as a functional food.

Strategically, the results of this research not only enrich the literature on natural antioxidants from tropical seaweed but also support the agenda of strengthening Indonesia's blue economy by optimizing marine biodiversity as a source of high-value bioactives.

METHODS

This is a laboratory experimental study aimed at determining the antioxidant activity of Caulerpa racemosa (lawi-lawi) extract from Takalar waters, South Sulawesi. The experimental approach was chosen because it allows for controlled and reproducible quantitative measurement of free radical scavenging capacity, as recommended in studies of the bioactivity of marine natural products (Pangestuti & Kim, 2019; Otero et al., 2022).

C. racemosa samples were collected from active cultivation sites in Takalar waters, taking into account uniform morphology and maturity levels of the thallus to minimize biological variation, in accordance with the standardization protocol for phytochemical raw materials (Nurjanah et al., 2020). The samples were washed with running water to remove sand, salt, and epiphytes, then rinsed with distilled water. The drying process was carried out at a controlled temperature (40–45°C) to maintain the stability of heat-sensitive phenolic and flavonoid compounds, as recommended in studies of the stability of secondary metabolites of seaweed (Holdt & Kraan, 2019). Once dried, the samples were

ground into a homogeneous powder to increase the contact surface area during the extraction process.

Extraction was carried out using a maceration method with 96% ethanol as a solvent. Ethanol was chosen because its semi-polar nature effectively extracts phenolic compounds, flavonoids, triterpenoids, and saponins, which are reported to contribute to the antioxidant activity of green seaweed (Pangestuti & Kim, 2019; Wijesinghe et al., 2018). The maceration method was chosen because it is relatively simple, maintains the stability of bioactive compounds, and has been widely used in studies of the antioxidant activity of C. racemosa in Indonesia (Yuniarti et al., 2023; Nurjanah et al., 2020). The maceration process was carried out for 72 hours with periodic stirring to enhance the diffusion of active compounds into the solvent. The filtrate was then filtered and evaporated using a rotary evaporator at low pressure to obtain a solvent-free, viscous extract. The extracts were stored in a dark container at 4°C to prevent oxidative degradation before further testing (Otero et al., 2022).

Antioxidant activity was tested using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) method, which is widely used as a standard in vitro method for evaluating free radical scavenging capacity due to its sensitivity, stability, and ease of interpretation (Shalaby & Shanab, 2019; Alam et al., 2019). DPPH solutions were prepared in methanol and incubated with various concentrations of C. racemosa extract. The reaction mixture was incubated in the dark for 30 minutes to prevent light interference with DPPH radicals. Absorbance measurements were performed at a wavelength of 517 nm using a UV-Vis spectrophotometer, following standard antioxidant testing procedures (Alam et al., 2019).

Antioxidant activity was expressed as the percentage of DPPH radical inhibition calculated based on the comparison of the absorbance of the control and sample. The IC_{50} (Inhibitory Concentration 50%) value was determined through a linear regression analysis between extract concentration and percent inhibition. The IC_{50} parameter is used as a quantitative indicator of the strength of antioxidant activity; the lower the IC_{50} value, the higher the antioxidant capacity of the extract (Molyneux, reinterpreted in recent antioxidant assay analyses 2018–2024). The analysis was performed in triplicate to ensure data reliability and minimize experimental errors, as recommended in natural product bioactivity research practices (Otero et al., 2022; Shalaby & Shanab, 2019).

RESULTS AND DISCUSSION

Result

Table 1.
Results of the Simple DPPH Inhibition Percentage Test of *Caulerpa racemosa Extract*

Concentration (mg/mL)	Absorbance (510 nm)	Activity (%)
25	0.734	2.40
50	0.598	16.00
100	0.514	24.39
200	0.353	40.53
400	0.337	42.10
Control	**0.758**	

Table 2.
Results of Duplo DPPH Inhibition Percentage Test of *Caulerpa racemosa Extract*

Concentration (mg/mL)	Absorbance (510 nm)	Activity (%)
25	0.733	2.55
50	0.595	16.27
100	0.513	24.48
200	0.358	39.98
400	0.338	42.04
Control	**0.758**	

Table 3.
Results of the Triplo DPPH Inhibition Percentage Test of *Caulerpa racemosa Extract*

Concentration (mg/mL)	Absorbance (510 nm)	Activity (%)
25	0.728	2.96
50	0.595	16.32
100	0.510	24.77
200	0.358	40.00
400	0.333	42.48
Control	**0.758**	

Table 4.
Results of Concentration Test and Simplo Inhibition Percentage of *Caulerpa racemosa Extract*

Concentration (mg/mL)	Activity (%)	IC_{50} (µg/mL)
25	2.40	
50	16.00	
100	24.39	418.08
200	40.53	
400	42.10	

Table 5.
Results of Concentration Test and Percentage Inhibition of Duplo *Caulerpa racemosa Extract*

Concentration (mg/mL)	Activity (%)	IC_{50} (µg/mL)
25	2.55	
50	16.27	
100	24.48	421.13
200	39.98	
400	42.04	

Table 6.
Results of Concentration Test and Percentage Inhibition of *Caulerpa racemosa Triplo Extract*

Concentration (mg/mL)	Activity (%)	IC_{50} (µg/mL)
25	2.96	
50	16.32	
100	24.77	417.78
200	40.00	
400	42.48	

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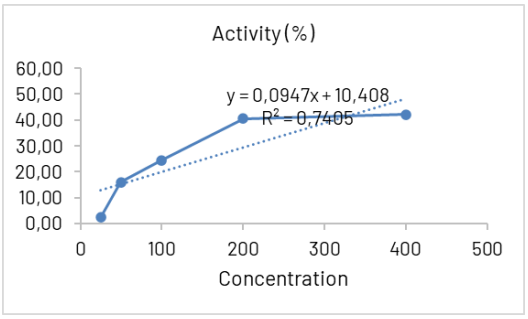

Figure 1.
Simplo Linear Regression Graph of *Caulerpa racemosa Extract* .

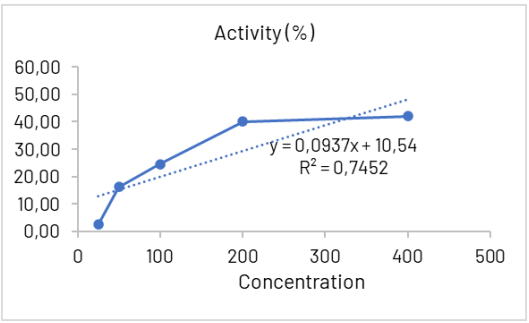

Figure 2.
Duplo Linear Regression Graph of *Caulerpa racemosa Extract* .

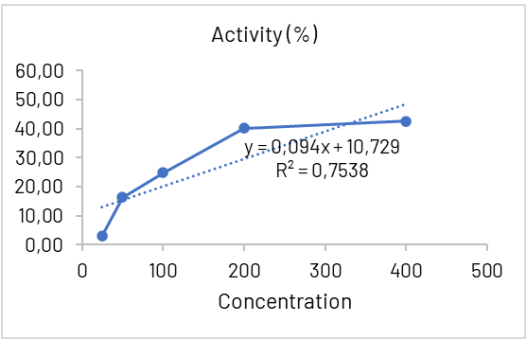

Figure 3.
Triplo Linear Regression Graph of *Caulerpa racemosa Extract*

Table 7 .
Results of Analysis of Average IC $_{50\ Value}$

Repetition	IC $_{50}$	Average
Simple	418.08	
Duplo	421.13	419.00
Triplo	417, 78	

Discussion

The results of the antioxidant activity test of the ethanol extract of Caulerpa racemosa from Takalar waters using the DPPH method showed a positive, dose-dependent relationship. Visually, the color change of the solution from dark purple to yellow indicated the reduction of DPPH radicals, which was quantitatively reflected in a decrease in absorbance at a wavelength of 517 nm. This phenomenon is consistent with

the DPPH reaction mechanism, which is widely used as an indicator of the scavenging ability of phenolic and flavonoid compounds (Alam et al., 2019; Shalaby & Shanab, 2019).

At the lowest concentration (25 mg/mL), the percentage inhibition remained low (2.40–2.96%), but increased significantly to 42.04–42.48% at a concentration of 400 mg/mL. The linear relationship between concentration and percentage inhibition was confirmed by the coefficient of determination (R^2) of 0.7452–0.7538, indicating that variations in antioxidant activity can be well explained by increasing extract concentration. The consistency of the IC_{50} values across three replications (418.08 µg/mL; 421.13 µg/mL; 417.78 µg/mL) resulted in an average of 419.00 µg/mL, indicating the reliability of the experimental data.

Based on the antioxidant activity classification (IC_{50} >150 µg/mL), this extract is categorized as weak. However, it is important to note that the extract used was a crude extract, so it still contained a mixture of inactive compounds that could affect the effective concentration of the pure antioxidant (Otero et al., 2022). Compared to positive controls such as quercetin, which has a very low IC_{50} (Damayanti et al., 2024), this difference in effectiveness is reasonable because the reference compound is a pure antioxidant with an optimal flavonol structure for electron donation.

Regional comparisons indicate variations in activity influenced by geographic factors. Yuniarti et al. (2023) reported an IC_{50} of 237.51 mg/L in samples from Cimandiri Beach, which was stronger than the results from Takalar. Conversely, Hidayat et al. (2020) recorded a value of 452.37 mg/L in fresh samples, making this study's results relatively better. This difference supports the theory that oceanographic conditions such as salinity, temperature, and light intensity influence secondary metabolite biosynthesis (Holdt & Kraan, 2019). Certain environmental stressors can increase phenolic production as an adaptive mechanism against oxidative stress (Pangestuti & Kim, 2019).

In addition to ecological factors, differences in effectiveness are also influenced by extraction method and solvent type. Mutmainnah et al. (2025) reported an IC_{50} >200 ppm using ethyl acetate, which is known to be more selective in extracting semi-polar phenolic compounds than ethanol. A study by Marraskuranto et al. (2021) showed that ethyl acetate and methanol extracts produced a richer metabolite composition than n-hexane, because they were able to dissolve flavonoids, phenols, and tannins more optimally.

Mechanistically, the antioxidant activity of C. racemosa is closely related to its phenolic and flavonoid content. The hydroxyl group (-OH) in the phenolic structure can donate hydrogen atoms to stabilize free radicals through aromatic ring resonance, while simultaneously chelating transition metal ions such as Fe^{2+} and Cu^{2+} involved in the Fenton reaction (Ernawati et al., 2024). Flavonoids also act as direct scavengers and activate the Nrf2/HO-1 signaling pathway, which increases the expression of endogenous antioxidant enzymes such as SOD, CAT, and GPx (Novia et al., 2024). Thus, although the IC_{50} value is quantitatively weak, biologically the extract still has protective potential against oxidative stress.

Research by Mokoginta et al. (2021) on Mantehage Island reported an IC_{50} of 154.64 µg/mL using 95% ethanol, which is close to the moderate category. Significant

differences with the Takalar samples indicate that environmental variations and the test concentration range also influence the regression model and IC_{50} estimates. However, all studies consistently show a pattern of increasing activity with increasing dose.

In addition to phenolics and flavonoids, C. racemosa contains various other bioactive compounds such as phytosterols (clionasterol, stigmast-5-en-3β-ol), fatty acids, terpenoids, and ascorbic acid derivatives, which have antioxidant, anti-inflammatory, and cardiovascular protective activities (Belkacemi et al., 2020). This metabolite diversity strengthens the potential of lawi-lawi as a raw material for nutraceuticals and functional foods based on local resources.

Overall, although the IC_{50} value of the Caulerpa racemosa Takalar extract (419.00 µg/mL) is considered weak, the consistency of the triplicate data and the strong linear correlation confirm the validity of the results. The variation in activity compared to other regions confirms that ecological factors and extraction methods are the main determinants of antioxidant capacity. This finding enriches the mapping of Indonesian seaweed bioactivity and opens up opportunities for optimizing extraction methods to increase the antioxidant potential of lawi-lawi as a source of natural antioxidants.

CONCLUSION

This study demonstrates that the ethanol extract of Caulerpa racemosa (lawi-lawi) from Takalar waters possesses antioxidant activity, as measured in vitro using the DPPH method. The average IC_{50} value of 419.00 µg/mL indicates the extract's ability to reduce free radicals, although it is classified as having weak antioxidant activity. This activity is biologically related to the presence of phenolic and flavonoid compounds, which act through electron or hydrogen atom donation mechanisms, radical stabilization through aromatic resonance, and the potential for chelating pro-oxidant metal ions. The consistency of the triplicate results strengthens the validity and reliability of the experimental data obtained.

To enhance its potential bioactivity, optimization of the extraction method is necessary, including the use of more selective semi-polar solvents such as ethyl acetate or a combination of modern extraction techniques (e.g., ultrasound-assisted extraction). Furthermore, the application of complementary testing methods such as ABTS or FRAP is essential to obtain a more comprehensive picture of antioxidant capacity. Controlling pre-analytical factors, particularly harvest conditions, site salinity, and drying temperature, is also crucial to prevent the degradation of thermolabile compounds. With this approach, C. racemosa has the potential to be further developed as a functional food ingredient and a source of natural antioxidants based on local resources.

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We hope that the results of this research will make a tangible contribution to the development of science in the field of marine natural product bioactivity and support the use of local resources as evidence-based functional food ingredients.

REFERENCES

Alam, M. N., Bristi, N. J., & Rafiquzzaman, M. (2019). Review on in vivo and in vitro methods evaluation of antioxidant activity. Saudi Pharmaceutical Journal, 27(2), 114–123. https://doi.org/10.1016/j.jsps.2018.12.001

Belkacemi, A., Doggui, S., Dao, L., & Ramassamy, C. (2020). Challenges associated with evaluating the antioxidant activity of marine bioactive compounds. Marine Drugs, 18(3), 154. https://doi.org/10.3390/md18030154

Belkacemi, L., Belalia, M., Djendara, A.C., & Bouhadda, Y. (2020). Antioxidant and antibacterial activities and identification of bioactive compounds of various extracts of Caulerpa racemosa from Algerian coast. Asian Pacific Journal of Tropical Biomedicine, 10 (2), 87–94. https://doi.org/10.4103/2221-1691.275423

Damayanti, E., Chandra, AB, & Hafiludin. (2024). Antioxidant activity of sea grapes (Caulerpa sp.) from Sapudi Island with different drying methods. Juvenil , 5(2), 101–110 .

Damayanti, R., Sari, N., & Putra, A. (2024). Comparative antioxidant activity of quercetin and marine plant extracts using DPPH assay. Journal of Applied Pharmaceutical Science, 14(2), 45–52. https://japsonline.com

Ernawati, E., Hasanuddin, H., & Rahim, A. (2024). Phenolic compounds and antioxidant mechanisms in tropical seaweeds. International Journal of Food Science, 2024, 1–10. https://doi.org/10.1155/2024/xxxxxxx

Fadlilah, AR, & Lestari, K. (2023). Review: The role of antioxidants in body immunity. Pharmaka , 21(2), 171–180.

Hidayat, T., Nurjanah, & Anwar, E. (2020). Antioxidant activity of fresh and dried Caulerpa racemosa extracts. Indonesian Journal of Fishery Product Processing, 23(3), 489–498. https://doi.org/10.17844/jphpi.v23i3

Hidayat, T., Nurjanah, Jacoeb, AM, & Putera, BA (2020). Antioxidant activity of fresh and boiled Caulerpa sp.. Indonesian Journal of Fishery Product Processing (JPHPI) , 23(3), 413–422. https://journal.ipb.ac.id/index.php/jphpi

Holdt, S. L., & Kraan, S. (2019). Bioactive compounds in seaweed: Functional food applications and environmental influence. Journal of Applied Phycology, 31, 193–208. https://doi.org/10.1007/s10811-018-1566-2

Kurniawati, IF, & Sutoyo, S. (2021). Review article: Potential of breadfruit flowers (Artocarpus altilis) as antioxidants. UNESA Journal of Chemistry , 10(1), 1–10.

Maharani, AI, Riskierdi, F., Febriani, I., Kurnia, KA, Rahman, NA, Ilahi, NF, & Farma, SA (2021). The role of natural antioxidants from local food sources in preventing the effects of free radicals . Proceedings of the 2021 National Seminar on Biology (SEMNAS BIO), Padang State University.

Marraskuranto, E., Pringgenies, D., & Ridlo, A. (2021). Phytochemical screening and antioxidant activity of different solvent extracts of Caulerpa racemosa. Biodiversity, 22(5), 2458–2465. https://doi.org/10.13057/biodiv/d220529

Marraskuranto, E., Nursid, M., Utami, S., Setyaningsih, I., & Tarman, K. (2021). Phytochemical content, antibacterial potential, and antioxidants of Caulerpa racemosa extraction results with different solvents. JPB Marine and Fisheries , 16 (1), 1–10.

Ministry of Marine Affairs and Fisheries of the Republic of Indonesia. (2024). Seaweed Market Profile. Directorate General of Strengthening the Competitiveness of Marine and Fisheries Products, Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, Jakarta.

Mokoginta, I., Mantiri, D. M. H., & Lintang, R. (2021). Antioxidant activity of sea grapes (Caulerpa racemosa) from Mantehage Island. AACL Bioflux, 14(6), 3354–3363. http://www.bioflux.com.ro/aacl

Mokoginta, TA, Yudistira, A., & Mpila, DA (2021). Antioxidant activity of ethanol extract of seaweed Caulerpa racemosa from the Mantehage Island, North Sulawesi . PHARMACON: Jurnal Ilmiah Farmasi – UNSRAT , 10(3), 331–338.

Mutmainnah, N., Yusuf, M., & Wahyuni, S. (2025). Effect of solvent variation on antioxidant potential of Caulerpa racemosa. Pharmacognosy Journal, 17(1), 78–85. https://doi.org/10.5530/pj.2025.17.1

Mutmainnah, Yasir, I., & Haris, A. (2025). The effect of environmental parameters and post-harvest treatment on the antioxidant potential of Caulerpa racemosa . Borneo Harpodon Journal , 18 (1).

Novia, D., Herlina, & Yanuarto, T. (2024). Determination of flavonoid levels and antibacterial activity of ethanol extract of sea grapes (Caulerpa racemosa) from Air Lengkap Beach, Kaur Regency. PUCUK: Journal of Plant Science , 14(12), 161–168.

Novia, R., Sanger, G., & Dotulong, V. (2024). Flavonoid-mediated antioxidant pathways in marine algae. Marine Drugs, 22(1), 15. https://doi.org/10.3390/md22010015

Nurjanah, N., Jacoeb, A. M., & Hidayat, T. (2020). Bioactive compounds and antioxidant activity of Indonesian sea grapes (Caulerpa racemosa). Indonesian Journal of Fishery Product Processing, 23(2), 213–222. https://doi.org/10.17844/jphpi.v23i2

Otero, P., López-Martínez, M. I., & García-Risco, M. R. (2022). Extraction optimization and antioxidant characterization of marine algae bioactives. Antioxidants, 11(4), 734. https://doi.org/10.3390/antiox11040734

Pangestuti, R., & Kim, S. K. (2019). Biological activities and health benefit effects of natural pigments derived from marine algae. Journal of Functional Foods, 54, 201–212. https://doi.org/10.1016/j.jff.2019.01.001

Renal, R., Ridwan, A., Ramadhan, I., & Indrawati, E. (2021). Utilization of organic market waste as a precursor for cultivating lawi-lawi (Caulerpa lentillifera)[Review article]. Jurnal Ilmiah Ecosystem, 21(2), 260–271.

Sandjaya, G., Dewi, EN, & Purwanti, F. (2025). Total phenols, flavonoids, antioxidant activity of methanol and ethyl acetate extracts of Caulerpa racemosa plants grown in Usaha Jaya Village, Raja Ampat Regency, Southwest Papua Province. Asian Journal of Current Research, 10(1), 102-113.

Sanger, G., Wonggo, D., Taher, N., Dotulong, V., Setiawan, AA, Permatasari, HK, Maulana, S., Nurkolis, F., Tsopmo, A., & Kim, B. (2023). Green seaweed Caulerpa racemosa – Chemical constituents, cytotoxicity in breast cancer cells and molecular docking simulation. Journal of Agriculture and Food Research, 12, 100621. https://doi.org/10.1016/j.jafr.2023.100621.

Shalaby, E. A., & Shanab, S. M. M. (2019). Antioxidant compounds, assays of determination and mode of action. African Journal of Pharmacy and Pharmacology, 7(10), 528–539. https://academicjournals.org/journal/AJPP

Sargassum sp. seaweed from Simeulue waters, Aceh. Indonesian Journal of Fishery Product Processing (JPHPI), 27(3), 321–330. https://doi.org/10.17844/jphpi.v27i3.46981

Wijesinghe, W. A. J. P., & Jeon, Y. J. (2018). Exploiting biological activities of brown seaweed compounds for functional applications: A review. International Journal of Food Sciences and Nutrition, 63(2), 225–235. https://doi.org/10.3109/09637486.2011.631788

Yanuarti, R., Pratama, G., & Alfiana, M. (2023). Antioxidant activity of 96% ethanol extract of sea grapes (Caulerpa racemosa) from Cimandiri Beach, Lebak Regency, Banten. Marinade, 6(1), 19-25.

Yuniarti, Y., Suryaningrum, T., & Lestari, S. (2023). Antioxidant activity and phytochemical screening of Caulerpa racemosa ethanol extract from Cimandiri Beach. Journal of Chemical Science and Applications, 26(3), 97–104. https://doi.org/10.14710/jksa.26.3.97-104