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MEASUREMENT OF THE HEAVY METAL CONTENT OF ZINC (Zn) AND COPPER (Cu) FROM THE GREEN SEAWEED *Caulerpa taxifolia* AND *Caulerpa racemosa*

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ABSTRACT

Aceh has a great potential in coastal areas because Aceh has a large source of marine biota, especially seaweed. The coast that has great potential for seaweed growth is Ulee lheue Beach. Ulee lheue Beach is a tourist area and port, so it tends to be exposed to heavy metals. Seaweed can absorb heavy metals easily and is used as a bioindicator of environmental pollution. The aim of this research was to measure the heavy metal content of Cu and Zn from the green seaweeds *Caulerpa taxifolia* and *Caulerpa racemosa*. The research method was carried out using a hydrothermal analysis digestion process using a hydrothermal-microwave analysis tool for 30 minutes. Metal content was analyzed using an Atomic Absorption Spectrophotometer (AAS). The results showed that the levels of heavy metals of Zn and Cu in *Caulerpa taxifolia* seaweed were 11.05 and 3.65 ppm. Furthermore, the levels of heavy metals Zn and Cu in the seaweed *Caulerpa racemosa* were 18.46 and 12.26 ppm. It can be concluded that *Caulerpa taxifolia* and *Caulerpa racemosa* can absorb heavy metals.

Keywords: Seaweed, Heavy Metals, Atomic Absorption Spectrophotometer (AAS)

ABSTRAK

Aceh memiliki potensi besar di kawasan pesisir disebabkan memiliki sumber biota laut yang besar, terutama rumput laut. Pesisir pantai yang memiliki potensi besar terhadap pertumbuhan rumput laut adalah pantai Ulee lheue. Pantai Ulee lheue merupakan daerah wisata dan pelabuhan sehingga memiliki kecendrungan terpapar akan logam berat. Rumput laut dapat menyerap logam berat dengan mudah dan dijadikan sebagai bioindikator pencemaran lingkungan. Tujuan penelitian ini untuk mengukur kandungan logam berat Cu dan Zn dari rumput laut hijau Caulerpha taxofilia dan Caulerpha recemosa. Metode penelitian dilakukan dengan proses destruksi secara hidrotermal analisis menggunakan alat hidrotermal-mikrowafe analisis selama 30 menit. Kandungan logam dianalisis menggunakan Spektrofotometer Serapan Atom (SSA). Hasil menunjukan kadar logam berat Zn dan Cu pada rumput laut Caulerpha taxofilia adalah 11,05 dan 3,650 ppm. Kadar logam berat Zn dan Cu pada rumput laut Caulerpha recemosa adalah 18,46 dan 12,26 ppm. Dapat disimpulkan bahwa Caulerpha taxofilia dan Caulerpha recemosa dapat menyerap logam berat.

Kata kunci : *Rumput Laut, Logam Berat,* Atomic Absorption Spectrophotometer (AAS).

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Introduction

Indonesia is an archipelago country surrounded by spacious sea (Radiarta et al., 2018). Indonesian sea is rich in marine biota such as fish, coral reefs and seaweed. Seaweed is marine biota that is very abundant in Indonesian waters (Erniati et al., 2022). Seaweed can be applied in the food, medicine and cosmetics industries (Mayasri, 2021). In addition, several studies state that seaweed can adsorb metal ions, especially heavy metals (Yayu & Yani, 2015). Seaweed in Indonesian waters can absorb heavy metals very easily and is used as a bioindicator for environmental pollution (Yayu & Yani, 2015).

Aceh has great potential in coastal areas because Aceh has a large source of marine biota, especially seaweed (Kusumawati et al., 2018). Seaweed production is around 2.15 million tons per year (Setiawan, 2020). One beach that has the potential for seaweed growth is Ulee lheue Beach. Ulee lheue Beach is located in Meuraxa District which is very busy with tourists. Ulee lheue Beach has a sandy and rocky beach so it is suitable as a seaweed habitat (Nufus, 2019). Apart from that, Ulee lheue Beach is a port area used for crossing to Sabang Island (Nufus, 2019), so that Ulee Lheue Beach has a tendency to be exposed to heavy metal pollution.

Heavy metals are the biggest cause of environmental pollution in waters. Heavy metals are dangerous and toxic when present in large quantities, affecting various aspects of life in waters, both biologically and ecologically. The metal levels contained in the waters depend on the condition of the waters, if there is more human activity, the more metal levels will be contained in the waters (Saputri, 2019). Heavy metals that are generally found in waters include Cu, Zn, Cd and Cr (Saputri, 2019). Cu and Zn metals are essential heavy metals that are present in living things in small amounts. Excessive amounts of Cu and Zn metals in the body pose a risk of death (Saputri, 2019). Likewise, the heavy metal Cu comes from industrial waste around waters and paint dyes that coat boats (Mufidah, 2021). Zn metal comes from household waste where the disposal process is not taken into account (Mufidah, 2021).

Generally, marine biota such as seaweed are able to absorb heavy metals (Farizky et al., 2022). Heavy metals absorbed by seaweed are persistent and stored intra- and extra-cellularly. If seaweed is exposed to heavy metals and consumed by humans, these metals accumulate in the human body and pose a risk to health (Mufidah, 2021). Based on the description above, a process of measuring the heavy metals Cu and Zn were carried out at Ulee lheue Beach, Banda Aceh City, contained in the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* in order to provide information on heavy metal pollution in seaweed.

Methods

Material and tools

The tools used in the research include analytical scales, ovens, a set of glassware, hydrothermal reactors. The ingredients used include green seaweed *Caulerpa racemosa* and *Caulerpa taxifolia* was taken from Ulee lheue Beach, Banda Aceh, Nitric Acid (HNO_3), Hydrogen peroxide (H_2O_2), and Aquades.

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Research procedures

The seaweed sampling process was taken from Ulee lheue Beach, Banda Aceh City. The seaweed sampling process was carried out using the quadrant transect method. Measurements were carried out at one location (Figure 1), a sample with distance of 50 meters and 1 meter from the sea edge towards the sea. Sampling was carried out at a distance of 10 meters from the starting point at 5 collection points. 2 Kg wet weight of seaweed was taken, put into the sampling box and continued with analysis in the laboratory. Measurements of aquatic environmental conditions were carried out in situ, that is direct measurements on the spot using portable equipment. Measurements of environmental conditions were made in the form of temperature, salinity and pH.

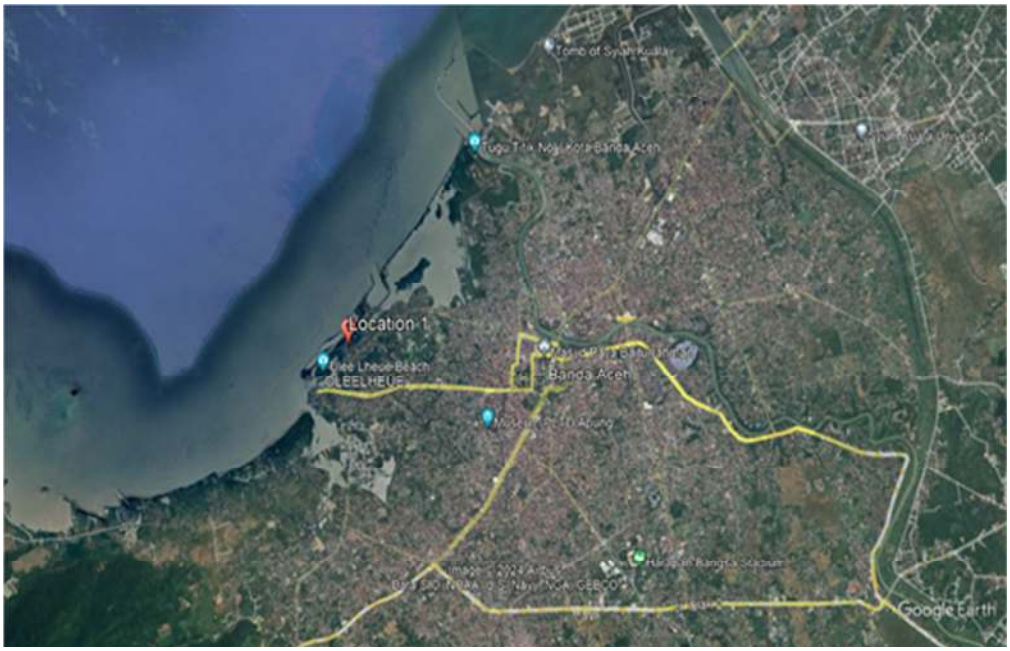

Figure 1. Sampling location for green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* (5°33'26.28"N - 95°18'47.23"E)

The seaweed was air-dried for 8 × 2 days, then grounded. Weigh 0.5 grams of seaweed sample, and add 10 mL of HNO3 p.a., then let stand for 20 minutes. After that, add back 4 mL of HNO3 p.a., and 30% H2O2, do the destruction using a hydrothermal-microwave analysis tool for 30 minutes. The stages in the hydrothermal analysis process are the hydrothermal process for 10 minutes at a temperature of 130 ° C, continued for 5 minutes at a temperature of 150 ° C, another 5 minutes at a temperature of 180 ° C and finally 10 minutes for 200 ° C. After completion, let the tool stand until the temperature is 70 ° C or can be opened (stated on the tool). The solution is transferred to a measuring flask and diluted to the limit mark. The seaweed sample solution can be analyzed for heavy metal content of Cu and Zn using AAS.

Results and Discussion

Heavy metals are one of the causes of environmental pollution. If they pollute the environment, especially water areas, it will be one of the factors causing disease

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in humans (Nasprianto et al, 2019). Green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* were taken from Ulee lheue Beach, Banda Aceh, which is located at 5 ° 33'26.28 "N - 95 ° 18'47.23" E. The collection of green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* was carried out first by measuring environmental conditions in the form of temperature, salinity and pH in situ, that is direct measurements using portable equipment (Table). The collection of green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* was carried out in the dry season between 14.00 and 16.30.

Table 1 Measurement of environmental conditions of Ulee lheue Beach

Sampling location	Coordinate	Environmental conditions		
		Temp (°C)	pH	Salinity(ppt)
Ulee lheue	5°33'37" N 95°17'09" E	28	8.2	32

Temperature is a physical parameter that affects the physiological processes of seaweed, such as respiration, photosynthesis and seaweed metabolism (Ruslaini, 2016). The temperature on Ulee lheue Beach is 28 °C. This temperature is quite high, this is because sampling was carried out during the dry season with little rainfall. Sampling was carried out between 14.00 when the sun had a high intensity of rays causing the absorption of sunlight intensity by the water to also increase (Nikhlani & Kusumaningrum, 2021). Temperature measurements on several beaches that have been carried out include the waters of Teluk Cina, Lemukutan Island, Bengkayang Regency where the temperature was between 28.1 and 28.4 °C (Maulana et al., 2023).

pH is an important parameter for the survival of seaweed. pH in the range of acid or 8-14 base will disrupt the growth and metabolic system of seaweed and can even reduce the rate of seaweed reproduction (Ardiansyah et al., 2020). Good pH value for seaweed growth ranges from 6–9, because the normal pH range can support life and growth (Risnawati et al., 2018). This study obtained a pH value of 8.2. Which is still considered good for seaweed growth. Each macroalgae has a different pH tolerance value, such as *Kappaphycus alvarezii* has a pH value of 6 (Risnawati et al., 2018), and pH 7.5-8.6 (Nikhlani & Kusumaningrum, 2021), *Gracilaria verrucosa* has pH 7.75-8.15 (Ruslaini, 2016), *Eucheuma cottonii* has pH 8.17 - 8.27 (Maulana et al., 2023), and *Caulerpa sp.* has a pH of 6 - 8.5 (Ardiansyah et al., 2020).

Salinity is directly related to the osmotic pressure of seawater. The salinity obtained from the research results is 32 ppt. The results are still considered as good salinity conditions for seaweed growth which is between 15 - 35 ppt (Consequence et al., 2016). This is because the research process was carried out in the dry season, where the rainfall intensity was relatively low. If the rainfall is high, it will result in a decrease in salinity values and can even reach below the optimum limit, causing macroalgae to break easily, be less elastic, and have a slow growth rate (Gultom et al., 2016). Salinity on the Coast of Lakeba ranges for 32-36 ppt (Risnawati et al., 2018), and the salinity value of Geger Coastal waters ranges from 33-35 ppt (Gultom et al., 2016).

The metal content of the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* analyzed was Cu and Zn. The results of the analysis of the heavy metal content of Cu and Zn in the green seaweed *Caulerpa taxifolia* and *Caulerpa*

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racemosa are shown in Table 2. The measurement of the metal content of the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* was first made a standard which aims to determine the concentration of unknown heavy metals by comparing them with heavy metals whose concentrations are known (Figure 2). It can be interpreted that the calibration curve is a straight line equation that connects concentration with absorption. (Ashar et al, 2023). The results show that the heavy metal content in the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* is quite large (Table 2).

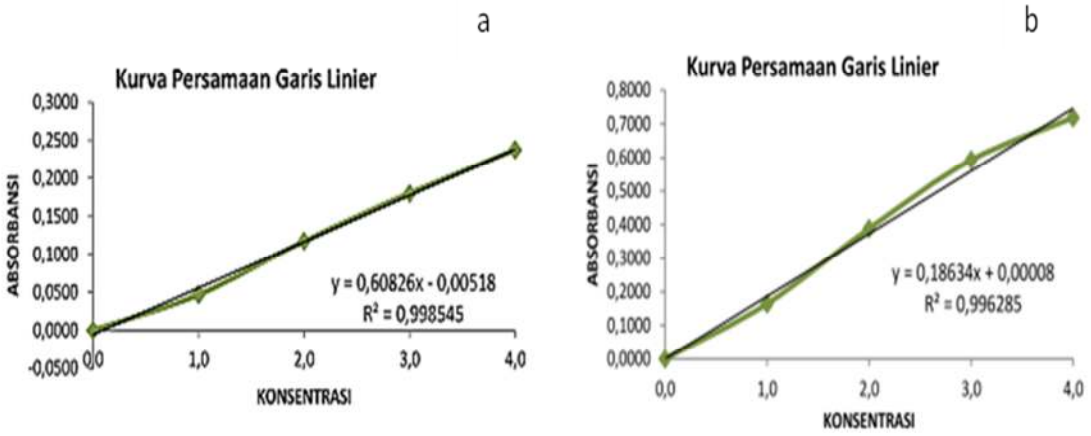

Figure 2 Standard regression curves of solutions, a) Zn and b) Cu

The heavy metal content of Zn from the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* that live on the Ulee lheue coast is 11.05 and 18.46 ppm. And the heavy metal content of Cu from the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* that live in the waters of Ulee lheue is 3,650 and 12.26 ppm. The presence of heavy metal content in seaweed is caused by the absorption process of heavy metals Zn and Cu by the green seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* which have functional groups and act as ligands for metal ions (Nasprianto et al, 2019). The seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* also contain phenol, steroid, alkaloid and triterpenoid compounds that act as heavy metal biofertilizers (Fitri et al., 2021). The measurement results show that the metal content on Ulee lheue Beach exceeds the SNI 7387: 2009 quality standard. The heavy metal content of Zn in the seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* is greater than the metal Cu.

Table 2 Cu and Zn metal content in seaweed

No	Seaweed	Heavy metal	
		Zn (ppm)	Cu (ppm)
1	*Caulerpa taxifolia*	11.05	3.650
2	*Caulerpa racemosa*	18.46	12.26

The cause of the Zn heavy metal content is greater than Cu because Ulee lheue Beach is a domestic area filled with tourists, resulting in heavy metal waste. However, the Cu content itself is because Ulee lheue Beach is also the center of the ship port that cross to Sabang Island. Cu metal usually comes from coloring paint of fishing boats (Naulfa, 2019).

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Conclusion

The conclusion obtained from this study is that seaweed *Caulerpa taxifolia* and *Caulerpa racemosa* can absorb heavy metals Zn and Cu. The results of the study showed that the content of Zn and Cu metals exceeded the standard quality of SNI 7387: 2009. The contents of heavy metals Zn and Cu in seaweed *Caulerpa taxifolia* were 11.05 and 3.650 ppm. The levels of heavy metals Zn and Cu in seaweed *Caulerpa racemosa* were 18.46 and 12.26 ppm.

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