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Seaweed Diversity at Muluk Beach, Sengkol Village, Pujut Sub-District, Central Lombok Regency, Nusa Tenggara Barat

Keanekaragaman Rumput Laut di Pantai Muluk, Desa Sengkol, Kecamatan Pujut, Kabupaten Lombok Tengah, Nusa Tenggara Barat

Nunik Cokrowati[*1], Nur Yatin[1], Jayusri[1], Nur Yatin[1], Muhammad Jum'at[1], Salnida Yuniarti Lumbessy[1], Wiyat Zahroh Sepia Utami[1]
[1]Department of Aquaculture, Faculty of Agriculture, University of Mataram, Mataram 83115 Indonesia
*Correspondent Author: nunikcokrowati@unram.ac.id

ABSTRACT

Seaweed can produce compounds that have diverse biological activities, including antioxidants. These compounds can be used in food, food sources, and medicines. This study aimed to analyze the types of seaweed that grow wild in the waters of Muluk Beach. The research was conducted at Muluk Beach, Sengkol Village, Pujut District, Central Lombok Regency. The research methods used in this study were survey methods and laboratory experiments. The results explained that the type of wild seaweed that grows in the waters of Muluk Beach is *Padina* sp, *Gracilaria coronopifolia, Sargassum cristaefolium, Gracilaria* sp, *Caulerpa taxifolia, C. taxifolia, Ulva intestinalis, Halimeda opuntia, Ulva* sp, *Codium, H.tuna, G.salicornia, G.verrucosa,* and *Acanthopora.* The type with the highest antioxidant content is *Padina* sp, which is 81,31% and has 14,39 mg/L chlorophyll-a levels. The species with the lowest antioxidant content was *H.opuntia* at 1,79% and chlorophyll at 8,83 mg/L.

Keywords: Seaweed, Antioxidant, Chlorophyll-a, *Sargassum* sp, Bioactive

ABSTRAK

Rumput laut dapat menghasilkan senyawa yang memiliki aktivitas biologis yang beragam termasuk antioksidan. Senyawa-senyawa tersebut dapat dimanfaatkan sebagai bahan pangan, sumber makanan dan obat-obatan. Tujuan dari penelitian ini adalah untuk menganalisis jenisrumput laut yang tumbuh liar di perairan pantai Muluk. Penelitian dilakukan di Pantai Muluk, Desa Sengkol, Kecamatan Pujut, Kabupaten Lombok Tengah. Metode penelitian yang digunakan dalam penelitian ini adalah metode survei dan eksperimen laboratorium. Hasil penelitian menjelaskan bahwa jenis rumput laut liar yang tumbuh di perairan Pantai Muluk adalah *Padina* sp., *Gracilaria coronopifolia*, *Sargassum cristaefolium*, *Gracilaria* sp, *Caulerpa taxifolia*, *CUlva intestinalis*, *Halimeda opuntia, Ulva* sp, *Codium, H. tuna, G.salicornia, G. verrucosa*, dan *Acanthopora*. Jenis yang memiliki kandungan antioksidan tertinggi adalah *Padina* sp. yaitu 81,31% dengan kadar klorofil-a sebesar 14,39 mg/L. Jenis yang memiliki kandungan antioksidan terendah adalah *Halimeda opuntia* 1,79% dengan kadar klorofil-a 8,83 mg/L.

Kata Kunci: Rumput Laut, Antioksidan, Klorofil-a, *Sargassum* sp, Bioaktif

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INTRODUCTION

Algae or seaweed are low-level plants whose stems, roots, and leaves cannot be distinguished, so they are often called talus. This type of seaweed consists of green algae (Chlorophyta), brown algae (Phaeophyta), and red algae (Rhodophyta). Taxonomically, algae are included in the Thallophyta group (talus plants) because the roots, stems, and leaves cannot be clearly distinguished. The shape of the talus varies; it can be round and bagged, flat, and some are hairy. Parts of the body are called talus, parts that resemble roots attached to a substrate are called holdfast, parts that resemble stems are called stalks (stipe), and parts that resemble leaves for photosynthesis are called blades (Sarita et al., 2021). Pereira (2021), seaweed can transform sunlight into energy, capture carbon dioxide (CO_2), and release oxygen for the environment.

Brown algae have talus with a broad morphology, consisting of branched filaments with a very complex arrangement. Green algae usually have talus in the form of branched and unbranched filaments; some are leaf-shaped. Red algae are a group of algae whose species have different shapes and color variations. The size of the talus in red algae is usually not too large, and the shape of the talus is cylindrical, flat, and sheet-like. There are simple branching systems (filaments) and complex branching systems (Meriam et al., 2016). The algae body structure consists of 3 main parts: the first is called the blade, which is a flat leaf-like structure that is usually wide; second, the stipe, which is a structure that resembles a flexible stick and serves as a wave barrier; and the third, holdfast, which is a part that resembles a root and aims to attach the body to the substrate. Seaweeds have been shown to produce a wide range of compounds, some of which have been reported to have diverse biological activities. These marine algae have been used as food or as new developments for food sources and medicines (Dharmayanti et al., 2019).

Muluk Beach is located in Sengkol Village, Pujut District, Central Lombok Regency, Nusa Tenggara Barat. In this area, a group of people depend on their lives from fishing, raising livestock, and farmers with relatively low incomes. The local community also conducts other cultivation activities, such as seaweed cultivation. Muluk Beach is an area that has a variety of macroalgae and is a reasonably large coral reef area. Information on macroalgae inventory and identification is still lacking. Therefore, it is necessary to conduct a survey again to find out what types of macroalgae are found in the waters of Muluk Beach. This study aimed to analyze the diversity and antioxidants of seaweed growing wild in Muluk Beach waters.

MATERIALS AND METHOD

Place and time

The research was conducted from February 1 to 30, 2024. This research is located at Muluk Beach, Sengkol Village, Pujut District, Central Lombok Regency (Figure 1). The research methods used in this study were survey methods and laboratory experiments. The survey was conducted to observe samples in the field directly. The experimental method was carried out to identify the type of seaweed, chlorophyll, and antioxidant content.

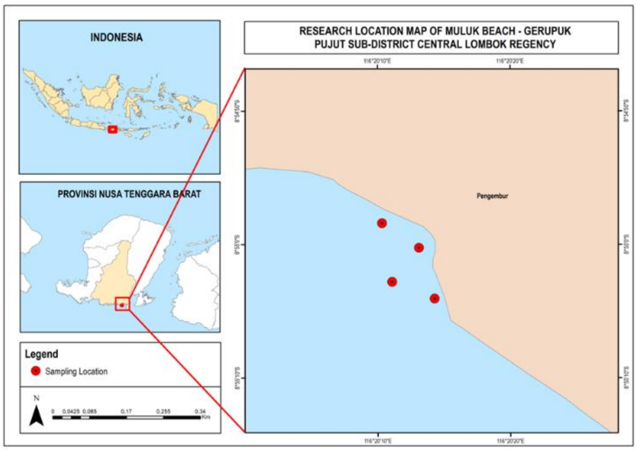

Figure 1. Map of research location

Tools and materials

The tools used in this research are a digital camera/HP, pH meter, refractometer, lux meter, dissolved oxygen meter, test kit (nitrate, phosphate, ammonia), measuring board, plastic clip, label, and stationery.

Seaweed sampling method

Macro algae samples were taken at locations considered representative of Muluk beach waters. Samples were taken in the tidal area, and sampling was done at the lowest tide.

RESULT AND DISCUSSION

The following are seaweed on Muluk beach, Sengkol village, Pujut sub-district, Central Lombok regency.

Figure 2. *Padina* sp

Figure 3. *Gracilaria coronopifolia*

Figure 4. *Sargassum cristaefolium*

Figure 5. *Gracilaria* sp

Figure 6. *Caulerpa taxifolia*

Figure 7. *Ulva intestinalis*

Figure 8. *Halimeda opuntia*

Figure 9. *Ulva*

Figure 10. *Codium*

Figure 11. *Halimeda tuna*

Figure 12. *Gracilaria salicornia*

Figure 13. *Gracilaria verrucosa*

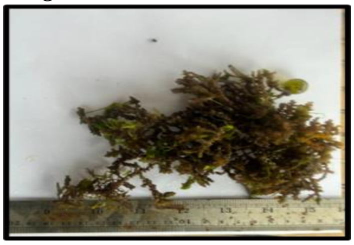

Figure 14. *Acanthophora*

Padina sp (Figure 2) has a sheet-like shape like a fan, light brown to dark brown color, dichotomous branching, and disc-like attachment type. Benita et al. (2018), *Padina* sp body contains two parts: the thallus, divided into 8, and sometimes more, whitish to brownish fronds, and the holdfast, consisting of flexible rhizoids for surface attachment. The fronds are fan or ear-shaped and can reach up to 15 cm in length in the summertime, becoming narrower towards the base, reaching up to 2 mm in width and about 1 cm in length. In winter, they are very small or do not grow at all. This follows the statement of Festi & Aba (2022), which says that the talus in *Padina* is fan-like, brown in color, the segments form thin sheets and wavy edges, and disc-shaped holdfast. In line with Aulia et al. (2021), the *Padina* sp found is fan-shaped. The leaves are thinly branched with lines that tend to be circular, and the tip of the talus tends to curve inward. The talus is greenish-brown, and the holdfasts are small, disk-shaped, and fibrous.

This type of grass has morphological characteristics with a cylindrical talus that is greenish brown or brownish yellow, growing on rocky substrates and coral fragments using small discs. It looks lush at the top of the clump. Based on these characteristics, this seaweed is included in the Rhodophyta species *G.coronopifolia* (Sarita et al., 2021). Windarsih et al. (2019), *G.coronopifolia* showed an erect or falling talus with a height of about 4,5-15 cm, laevis surface, purple, red, blackish, or greenish-yellow color, had cylindricaltalus on the axis with a diameter about 1.2-2.0 mm. The holdfast was like a disk attached to substrates. The branches of the talus were irregularly alternate, and the dichotomy with the base of branches was slightly narrow, short and growing irregularly on the talus axis. The branches are tapered to the tip and short (1.0-2.5 mm), a dichotomy with unequal size and pointed tip of branches. *G. coronopifolia* can be attached to coral reefs, sand, sponges, or epiphytes in seagrass, cosmopolitan, or spread. *G. coronopifolia* had also been widely cultivated in ponds. Windarsih et al. (2019), *G.coronopifolia* (Figure 3) can be consumed and developed as a functional food source. The utilization of this species in various industries has caused the scarcity of this species in the waters.

Based on the results of identification that has been done, the morphology that can be explained is *S. cristaefolium* (Figure 4), dark brown, cylindrical, branching like a tree, and adhesive in the form of rhizoids. This seaweed is characterized by bubbles (air pockets) that support the talus branches that float to the surface to be exposed to sunlight (Pakidi & Suwoyo, 2016). Santianez & trono (2013), Plant up to 57 cm long; substrate discoid, terete up to 5 mm long, 3 mm in diameter. Primary branches are smooth, slightly compacted, up to 56 cm long, and 2 mm in diameter. Secondary branches are soft and compressed somewhat to 20 cm long. Leaves thick and calcareous, horizontally adnate; broad to oblong up to 27.7 mm long, 15 mm wide; margins finely serrate; vesicles ovate to oblong, 4 mm long, 3 mm wide, cryptostomata absent; petiole terete near, sometimes flaring into vesicle forming ribs; petiole glabrous. Meanwhile, according to Yunizar et al. (2023), *S.cristaefolium* is a round, rough surface, green in color, rounded ends, thick textured, smooth, and slippery surface.

Gracilaria sp (Figure 5) is a seaweed from the family *Gracilariaceae* with more than 100 species worldwide that can be found in tropical waters ranging from intertidal to subtidal areas (Othman et al., 2018). *Gracilaria* sp has morphological characteristics: cylindrical talus, smooth and yellow, brown or greenish yellow. The talus is composed of strong tissue, branched with a length of approximately 250 mm, the center line of the branch is between 0.5 - 2.5 mm, the branching of the talus grows lengthwise to resemble hair, cylindrical and pointed branch ends (Wandira et al., 2018). Poh-keng et al. (2017) state that plants are erect and measure up to 20 cm in length. Several diameter 1-2 (-4) mm axes arise from a small discoid holdfast. Thalli are dense to scarcely branched. The branching is irregular, sometimes alternate or second in portions, and up to four orders or more. Branches are terete, constricted at the base, either slightly or deeply, and taper gradually toward acute or obtuse apices. Thalli texture is firm and cartilaginous. Color ranges from light or brownish green to olive black when fresh. According to Bhernama et al. (2021), *Gracilaria* sp can be used as a raw agar material with hydrocolloid properties in gelatin. Gelatin is a thickener raw material used in the food and cosmetic industries.

Caulerpa taxifolia (Figure 6) is a seaweed found throughout Indonesia. The morphology of *C. taxifolia* can be seen from the shape of the elongated flat talus-like feathers that resemble fern leaves, and this plant is dark green. It grows horizontally, branched, and upright. *C. taxifolia* has leaves with a diameter of 6-8 mm and a stalk length of 3-15 cm in shallow waters, while in deeper waters, the stalk length can reach 20-60 cm (Septiyaningrum et al., 2020). Zaw et al. (2020), The results of morphological identification show that *C. taxifolia* is characterized by branch-like, flat, erect hairs 3-5 cm high and 1-2 mm in diameter. Rhizoids are attached to the substrate. The opposite branchlets are attached to the midrib, slightly curved upwards, and tapered at the base and tip. The midrib is slightly flattened and light green-yellow. Mannino et al. (2019) *C.taxifolia* has a wide ecological plasticity in various aquatic environmental conditions.

Ulva intestinalis is a seaweed from the family Ulvaceae. The morphology of *U. intestinalis* (Figure 7) has a talus in the form of small and thin sheets, green in color because it contains chloroplasts and a branched talus with talus size between 5-15 cm and live colonies. This alga has a holdfast or rhizoid in the form of fibers attached to various substrates (rocks, coral, sand). *U. intestinalis* is found in many coastal areas (Ramdan & Nuraeni, 2021). Mohebbi & Zarezadeh (2023), *Ulva* sp is a green alga with a wide talus morphology and high carotene content.

Messyasz et al. (2013), *U. intestinalis* is a brilliant grass-green seaweed inflated. These unevenly constricted tubular fronds can range in length from 10 to 30 cm and have a diameter of 618 mm with rounded ends. It is a summer annual that decomposes at the end of the season.

Halimeda opuntia (Figure 8) is a class of Chlorophyta and belongs to the genus Halimeda. *H. opuntia* has a clump-shaped talus grouped with green leaf-like segments consisting of shoots and branched kidney-shaped middle segments about 3-8 mm long, 4-10 mm wide, and 0.5-0.7 mm thick. This algae contains lime, and its color turns white when exposed to sunlight (Gazali et al., 2019). Asih et al. (2019) state that thalus characteristics are lush, erect, flattened, and overlapping, with trichotomous branching. In this type of algae, a filament is used as an attachment device with the characteristics of a calcareous blade that is stiff and green in color. Habitat of *H. opuntia* L. in sandy areas (Nazarudin et al., 2022), *H. opuntia* contains lipids, carotenoids, and chlorophyll-a and b. The antioxidant compounds owned are phenolics and flavonoids, with activities that can be categorized as high.

Ulva lactuca (Figure 9) is a seaweed included in the type of green algae with characteristics such as green and sheet-shaped, like a thin leaf shape with a smooth texture and wavy edges. This seaweed can be found along the shoreline up to a distance of 7 m from the shoreline. The usual substrate is attached to coral reef fragments and rocks. Amin et al. (2022), *U. lactuca* green seaweed, sometimes known as sea lettuce, is a member of the phylum Chlorophyta found in littoral and sublittoral zones. It is found along the coast in the intertidal zone with calm waters (depths of about 10 m). It has a sheet-like shape with a light green to dark green color. According to Sarita et al. (2021), high levels of antioxidants in this seaweed can neutralize free radical toxins to protect the body from various diseases. Putra et al. (2024), *Ulva* grows wild on the coastline, rocks on the beach, and coral substrate. *Ulva* production depends on the season and tides. *U.lactuca* has a wide water temperature and salinity tolerance, making it more adaptable.

Codium (Figure 10) is a dark green seaweed with thick sponge-like leaves. The texture of this seaweed is smooth and elastic but very similar to velvet. This seaweed forms a collection of solid stems with slightly rounded ends. It can be found in tidal areas attached to rock substrates and coral reefs. The green alga *Codium is fragile and* has a siphonaceous thallus differentiated in the medulla and cortex. Microscopically, the medulla consists of impregnated multinucleated filaments, and the cortex consists of several bladder-like structures (utricula), which can distinguish the species. This alga is commonly found in rocky substrates and sand and tolerates various environmental conditions. Miguel et al. (2023) that codium has antibacterial compounds that can heal wounds.

Halimeda tuna (Figure 11) is a seaweed with a light green talus color that is shaped like a fan with talus branching called dichotomy and a tuber-like holdfast shape, and *H. tuna* is found attached to sandy areas and coral reef substrates (Festi et al., 2022). Nemcova et al. (2023) *Halimeda* thalli are composed of calcified segments separated by non-calcified nodes. The entire thallus consists of a single branched cell (siphonous thallus). Linear arrays of segments are strung together by medullary siphons that branch to form peripheral utricles. Segments are added consequently, and their production is seasonal, reaching its maximum in summer. The peripheral (primary) utricles adhere to each other and form a closed inter-utricular space (IUS) where aragonite microcrystals precipitate. The size and shape of peripheral utricles, which have a honeycomb structure when viewed from above, vary among species and represent one of the necessary identification features. According to Ramdhan et al. (2021), H. tuna is a seaweed used as an antibacterial drug and animal feed. Husni et al. (2024), *Halimeda* is a green alga with bioactive compounds, including polyphenols, diterpenes, fatty acids, and sterols, showing anticancer activity.

Gracilaria salicornia is an alga with a cylindrical or flat talus shape and branches ranging from simple to very complex and lush. Talus *G. salicornia* (Figure 12) is slightly smaller, with a smooth or mottled surface, and the length can reach 30 cm. This seaweed grows on coral reef flats with clean water. *G. salicornia* is an algae used in the food industry as a raw material for agar production (Sarita et al., 2021). Meinita et al. (2023), It has a dark green to greenish brown color, an erect talus up to 6.5 cm long, and six articulated internodes. The base of the internodes is thinned, the tip blunt widened or club-shaped, and the texture soft to slightly cartilaginous and smooth. Stem irregularly discoid, dome-shaped, with an ostiolus at the top. Susanti et al. (2023), *G.salicornia* has a habitat in the intertidal zone, and this red alga contains agar, which various industries can use.

Gracilaria verrucosa (Figure 13) includes seaweed whose plants are branched and even dense, the branches are slender to coarse, terete-shaped to rope, sturdy, and often cartilaginous, really developing from the apical cells to form a parenchyma medulla and a narrow small-celled assimilative cortex that may have fine colorless hairs, the rope can reach 30 cm and is pink. Mature *G.verrucosa* plants from Peter the Great Bay are brown, dark olive, or dark red. Thalli are erect, cylindrical, up to 25–30 cm tall, and attached to substrata by a discoid holdfast of 1–4 mm in diameter, with several thalli arising from a holdfast. The main axes are 1.5–2 mm in diameter, usually with 3–4 orders of lateral branches of various sizes at irregular intervals in an alternate to unilateral pattern. The branches are generally slightly constricted at their bases. The cortex has one to three layers of well-pigmented cells. Outer cortical cells are radially elongated, ovoid, and 4.5–7 mm in diameter. *G. verrucosa* is a rich source of protein, vitamins, minerals, and carbohydrates and is an alga that contains gelatin. The advantage of this seaweed is that it is not only a source of nutrition but can also be used as a natural food for fish and other animals (Soekendarsi, 2019). Hakim et al. (2023), *G. verrucosa* contains the highest percentage of compounds, namely glycerol (36,81%), hexadecanoic acid (20,74%), and cholesterol (4,35%), which are believed to accelerate the wound healing process by supporting the hemostasis and proliferation phases.

Acanthophora spicifera (Figure 14.) is a seaweed with a short talus ranging from 1-5 cm. The talus is branched, shaped like a thorn, and cylindrical, brownish green. This seaweed has a holdfast in the form of fibers, lives in the sea, is often found on the coastal substrate of coral sand, and lives in colonies (Ramdan & Nuraeni 2021). Esa et al. (2014), This genus is characterized by its cartilaginous or membranaceous, consisting of alternate or irregularly divided, erect, terete or flattened branches of intermediate growth and similar but shorter branches of determinate growth having a cortex composed of small polygonal cells. The brittle nature of the branches often results in fragmentation, which contributes to widespread distribution. This red alga is prominently found on the shallow reef 49 flat in water less than 0.5 m deep at mean lower low water. Samrit et al. (2024), *A. spicifera* is a red alga with a rapid growth rate, so its presence is sometimes abundant. *A. spicifera* can absorb dissolved waste in water and be used to purify waste. According to Yulianti et al. (2015), *A. spicifera* seaweed has benefits, especially in industry, food, medicine, and energy

Antioxidant and chlorophyll-a level

Antioxidants can prevent oxidative reactions in body cells due to exposure to free radicals. Antioxidant test results on *Sargassum* sp seaweed showed results of 29,61%, while chlorophyll-a pigment testing resulted in 8,10 mg/L. According to Sedjati et al. (2018), the ability of antioxidants as free radical catchers is related to the ability of these antioxidants as proton and electron donors. Different phenolic compounds with different effects play a role in counteracting free radicals. *Sargassum* sp pigment content. Chlorophyll and carotenoids are considered as sources of antioxidants. Carotenoids and chlorophyll compounds belong to the class of potential antioxidant compounds. Extracts derived from *Sargassum* sp macroalgae are reported to have antioxidant, antimicrobial, and UV protection properties. Other studies have also described the potential of *Sargassum* sp macroalgae as a rich source of anti-inflammatory substances (Prasedya et al., 2020).

Table 1. Antioxidant and chlorophyll analysis results

No	Types of seaweed	Antioxidant content (%)	Chlorophyll-a content (mg/L)
1	*Padina* sp	81,31	14,39
2	*Gracilaria coronopifolia*	214	7,87
3	*Sargassum cristaefolium*	29,61	8,10
4	*Gracilaria* sp	21,65	14,70
5	*Caulerpa taxifolia*	31,36	6,50
6	*Ulva intestinalis*	41,59	15,08
7	*Halimeda opuntia*	1,79	8,83
8	*Ulva lactuca*	23,61	8,80
9	*Codium*	26,49	10,67
10	*Halimeda tuna*	28,74	13,64
11	*Gracilaria salicornia*	24,91	7,20
12	*Gracilaria verrucosa*	19,29	14,33
13	*Acanthophora*	19,05	11,22

Synthetic antioxidants are carcinogenic and, therefore, less safe for health. Thus, a natural source of antioxidants, such as *Padina* sp, which contains bioactive compounds such as phenolics, chlorophyll a, carotenoids, and β-carotene, is needed. Analysis of antioxidant content and chlorophyll test on Padina seaweed showed consecutive results of 81,31% and 14,39 mg/L. According to Hidayati et al. (2017), synthetic antioxidants are toxic, so it is essential to develop natural antioxidants. Natural antioxidants include various compounds, including phenolics (phenols and polyphenols), flavonoids, carotenoids, steroids, and thiol compounds. One of the abundant marine natural components that can be utilized as antioxidants is *Padina* sp.

Seaweed is one of the marine natural resources with high economic value, has an ecological role, and is an antioxidant producer because it contains bioactive compounds that can counteract free radicals, such as

G.coronopifolia seaweed, which can be utilized as a natural antioxidant. From the test results, the antioxidant value obtained was 2,14%, while the chlorophyll-a content value was 7,87 mg/L. According to Insani et al. (2022), antioxidants are compounds that can inhibit the oxidation of other molecules. The mechanism of action of antioxidants is to capture free radicals, inhibit chain initiation, inhibit peroxide decomposition, prevent continuous hydrogen abstraction, reduce power, and bind transition metal ion catalysts. Seaweed can inhibit fat peroxidation and reduce some of the effects of free radicals so that it can be used as a source of antioxidants.

Antioxidants are compounds that can activate the development of oxidation reactions by preventing the formation of free radicals. Based on the observation of antioxidant seaweed type, *H. tuna* reached 28,74%. Based on observing chlorophyll in seaweed, *H. tuna* reached 13,64 mg/L. Seaweed contains various antioxidants such as polysaccharides, minerals, vitamins, essential amino acids, indigestible carbohydrates, dietary fiber, and carotenoids. *H. opuntia* is a marine green seaweed found in shallow tropical marine environments. *Halimeda* sp consists of bioactive compounds such as polyphenols, diterpenes, fatty acids, and sterols, which exhibit significant cytotoxicity against cancer cells (Nazarudin et al., 2022).

Gracilaria verrucose seaweed is included in the red seaweed group, and based on the observation of antioxidants in seaweed type *G. verrucosa*, it reached 19,29%. Astra et al. (2022), *G. verrucosa* is known to have bioactive compounds that have potential as antioxidants that play a role in avoiding damage to body tissues due to free radicals / Reactive Oxygen Species (ROS). According to Pumas et al. (2012), pigments found in algae are believed to be used as antioxidants. Since environmental parameters strongly influence algal secondary metabolites, there are likely differences in antioxidant activity depending on the location. Rondonuwu et al. (2017) that the low ability of extracts to reduce DPPH is thought to be because the samples used still contain impurities such as mineral salts. The polarity of the methanol solvent used for extraction is also believed to affect the LC_{50} value. Antioxidant activity is strongly influenced by secondary metabolisms, such as phenolic compounds, which are semi-polar compounds that dissolve entirely in semi-polar solvents.

Based on observing chlorophyll in seaweed species, *G.verrucosa* reached 13,33 mg/L. According to Febrianto et al. (2019), the content of total chlorophyll and pigment accessories on *G. verrucosa* was higher than other red algae. The dark green color of the extraction results indicates that the sample contains much chlorophyll. During the maceration process, chlorophyll can escape from the cell wall. According to Prangdimurti et al. (2006), chlorophyll in plants has the potential as an antioxidant compound. According to Febrianto et al. (2019), the total chlorophyll content and additional pigments in *G.verrucosa* is higher than in other red algae. Pigments contained in seaweed have antioxidant properties.

Based on the observation of antioxidant seaweed type, *G. salicornia* reached 24,91%, and chlorophyll content reached 7,20 mg/L. The results showed that the ethanol extract of *Gracilaria* had the highest antioxidant activity and was classified as very good. This result follows the content of bioactive components in the previous explanation, namely ethanol extracts containing alkaloids, phenols, saponins, flavonoids, and triterpenoids acting as antioxidants (Purwaningsih & Deskawati, 2021). The strength of an extract's antioxidant activity is classified based on its ability to ward off free radicals. Lumbessy (2019), *G. salicornia* is one type of seaweed with the potential to be an antioxidant because it has high chlorophyll-a pigments.

Compounds that counteract free radicals are called antioxidants. The primary function of antioxidants found in fats and oils is to slow down the oxidation process. The human body can also produce antioxidant compounds, but it is still not enough to stop free radicals that occur in the body. Several types of plants contain antioxidants, including *Gracilaria spp*. Based on research conducted by Febrianto et al. (2019), *Gracilaria* sp contains secondary metabolites such as phenols, alkaloids, flavonoids, and other bioactive compounds that can function as antioxidants. Furthermore, according to Lestario et al. (2008), there is a considerable correlation between the phenolic content of Gracilaria with free radical capture activity and the ability to reduce it, which means that phenolic compounds in *Gracilaria* play a role in contributing to its antioxidant activity.

Several types of Caulerpa seaweed have antioxidant content, including *C. racemose* and *C. lentifera*. However, information on the content of *C. taxifolia* is still limited, so further research is needed on the antioxidant content contained in *C. taxifolia*. Various types of plants contain phenol and flavonoid compounds that function as antioxidants. Among them is *Ulva intestinalis* seaweed. This type of seaweed is rarely utilized because it is not very popular. However, *U. intestinalis* seaweed has antioxidant content that is beneficial for the health of the human body. Srikong et al. (2017) reported that *U. intestinalis* seaweed is widely used for animal feed and fertilizer. However, extracts from *U. intestinalis* seaweed show antioxidant and antibacterial properties.

Macroalgae have high economic value as a source of food and medicine for coastal communities.

Macroalgae have traditionally been used in agriculture as fertilizer to promote plant growth and as animal feed to improve animal health and productivity. Some macroalgae species contain antioxidants, including *Halimeda opuntia* seaweed. According to Gazali et al. (2019), *H. opuntia* extract shows that this macroalgae has high antioxidant activity.

Acanthophora is one of the red seaweeds that can be a bioactive compound used as a natural antioxidant. Based on the results of antioxidants obtained from the Achantopora seaweed type, it reached 19,05%. Jensen et al. (2001), each sampling location has characteristics and values of environmental parameters such as depth, temperature, and sunlight intensity that affect the composition of lipids and pigments in the sample so that the vitamin and antioxidant content states will give good results. The biosynthetic process of antioxidant compounds produces optimal compounds when environmental conditions are favorable. At the same time, the chlorophyll content obtained was 11,22 mg/L. Akbar et al. (2018) state chlorophyll can reduce free radicals due to chelated Mg metal and its porphyrin skeleton. The chelated metal makes free radicals tend to give electrons to the Mg metal so that it can neutralize the character of free radicals.

Water quality

Water quality is a very important factor in supporting seaweed survival. Water quality parameters were measured, including temperature, pH, DO, salinity, phosphate, nitrate, light intensity, and ammonia. The results of temperature measurements during the study were around 28.2°C. This indicates that the waters still have a good range of temperature values for seaweed growth. According to Khotijah et al. (2020), seaweed growth for optimal temperature ranges from 27-30°C. Temperature directly affects the life of algae, especially the photosynthesis process. Huge fluctuations put pressure on algae and affect its growth rate.

Table 2. Water quality measurement results

Parameters	Value	Feasibility
Temperature (°C)	28,2	27 – 30 (Alwi et al., 2022)
pH	7,8	7 – 9 (Atmanisa et al., 2020)
Dissolved Oxygen (mg/L)	6,0	≥4 (Atmanisa et al., 2020)
Salinity (ppt)	31	28 – 34 (Atmanisa et al., 2020)
phosphate (mg/L)	1	0,05 – 1
Nitrate (mg/L)	< 10	0,9 – 3,5 (Asni, 2015)
Light intensity (Lux)	119	500 – 1000 (Sitorus et al., 2020)

The degree of acidity obtained in this activity is around 7,8. This follows Atmanisa et al.'s (2020) opinion that the optimum pH value in seaweed cultivation activities is 7-9. In line with Anton's (2017) research, the range of pH obtained ranged from 7,5 - 8. DO range found during the research activities is 6,0 mg/L. The range of DO can still be said to be feasible for the growth of seaweed in Muluk Beach. It is almost the same as the research of Risnawati et al. (2018) that the value of DO that qualifies for seaweed can range from 4,5 – 9,8 mg/L.

The range of salinity values obtained is 31 ppt. The range of salinity values is at a decent limit to support seaweed growth. This follows the statement of Atmanisa et al. (2020), which is in the range of 28 - 34 ppt. Afandi et al. (2015), the higher the salinity (salt content), the greater the osmotic pressure on the water. In addition, the salinity content is also related to the osmoregulation process in the body. Low salinity causes damage to algae, characterized by the appearance of white at the tip of the plant.

Other important nutrients needed by seaweed are phosphate and nitrate. The phosphate content value obtained was 1 mg/L, while the nitrate content value obtained was <10 mg/L. Afandi et al. (2015) state that the optimum phosphate range for seaweed growth is 0,051-1,00 mg/L. So, it can be said that the phosphate value obtained during the activity is optimal. Phosphate is a nutrient element in coral waters sourced from water flow, animal waste, sediment contributions from reefs, mangroves, and seagrasses, and contributions from zooxanthella algae. However, the nitrate content obtained can still be feasible in line with Anton's (2017) statement that the nitrogen range suitable for seaweed growth is 0,9 – 3,5 ppm.

The study's measurement of light intensity obtained a value of 119 lux. The value obtained is suspected when checking that the water quality of the weather conditions has decreased so that the light intensity obtained is low. According to Sitorus et al. (2020), the value of light intensity that supports seaweed growth ranges from 500-1000 lux. This value affects the photosynthesis process.

CONCLUSION

Based on the results of research that have been done, seaweed in Sengkol Village, Pujut District, Central Lombok Regency, 13 types of seaweed grow wild in the waters of Muluk Beach, namely *Padina* sp, *G. coronopifolia*, *S.cristaefolium*, *Gracilaria* sp, *C.taxifolia*, *U.intestinalis*, *H.opuntia*, *U.lactuca*, *Codium* sp, *H.tuna*; *G.salicornia*; *G. verrucosa*, and *Acanthophora*.

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