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Morphological, phyto-physicochemical and nutritional characteristics of seaweeds in Cagayan

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Abstract

This study presents a comprehensive analysis of the morphological, phyto-physicochemical, and nutritional attributes of seaweed species found in the coastal waters of Cagayan, Philippines particularly in Barangay Sta Cruz, Gonzaga. Specifically six seaweeds were studied namely: Sea palm (*Caulerpac taxifolia*), Sea lettuce (*Ulva lactuca linnaeus*), Sea hair (*Chaetamorpha crassa*), Ar-arusip (*Caulerpa lentillifera*), Guraman (*Gracilaria blodgetti*) and Lab-labig (*Glacilaria tertorii*) were used in the study. These Seaweeds play a pivotal role in marine ecosystems and offer substantial economic potential. However, detailed characterization of local seaweed species is essential for informed resource management and industrial applications. Phytochemical analysis was performed to determine the presence and quantity of bioactive compounds. Additionally, physicochemical properties such as pH, salinity, and nutrient content of the surrounding seawater were measured both on site and laboratory test to provide context for the observed seaweed characteristics. Furthermore, nutritional profiling was carried out using proximate analysis to ascertain the content of essential nutrients and dietary fiber in the selected seaweed species. Results indicated significant variations in the secondary metabolites and nutrient composition among species, highlighting their potential as valuable dietary supplements and functional food ingredients. Secondary metabolites found among the seaweeds include flavonoids and terpenoids among five species, saponins in four species, alkaloids in two species while anthocyanin is found only in Ar-arusip and phenol in Guraman. On the other hand, proximate analysis showed that among the three edible seaweeds Ar-arusip has the highest crude protein, crude fiber and crude fat compared with Guraman and Lab-labig. Also, the physico-chemical analysis of soil and water habitat of the seaweeds corresponds with the normal standard for marine waters. On-site and laboratory test of the physicochemical analysis of seaweed water provides valuable information about the environmental conditions that influence seaweed growth and health. This data is crucial for making informed decisions regarding seaweed resource management, conservation efforts, and sustainable utilization in various industries. This comprehensive study offers valuable insights into the diversity and potential applications of seaweed resources in Cagayan. The data generated will be invaluable for local stakeholders, including aquaculturists, conservationists, and industrialists, in making informed decisions regarding sustainable resource utilization and development.

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Introduction

The Philippines is known for its rich flora, and its marine algae are significant and diversified natural vegetable production. There are 1,291 taxa of marine macrobenthic algae with 306 published names of taxa (including species, varieties, and forms) of greens, 234 names of browns, and 751 names reds currently listed respectively on the Philippines littoral zones (Ang *et al.*, 2013). Many of these species (350 species) are of economic importance as food, sources of industrial products such as polysaccharides, bioactive and nutritional natural products, and growth-promoting substances. People from the Asian regions, especially the Philippines, have depended on their needs on the sea. Due to the fact, the coastal areas have a massive seaweed supply; thus, seaweed farming is one of the livelihoods a fisher can have for sustainable economic development in the countryside (Trono and Largo, 2019). However, about 5% of these are economically important; most have still to be developed (Trono, 1999).

Seaweeds are limited to their distribution from the lower intertidal to the shallow subtidal zones in the marine environment. In general, the large forms are mainly concentrated in areas at, or a few meters below the 0 datum level. The differences in their vertical and horizontal distribution are reflective of their adaptability to the ambient conditions in the habitats. Thus, some species are found only in the sheltered bays and coves while others may be limited to the rocky exposed along the shore or margins of the reef. Many other species are found in a variety of intergrading environments the presence or absence of species in a habitat is therefore, the result of the combined and synergistic effects of the various physico-chemical factors on the distribution algae. These plants dominate the marine flora in wide ranging type of habitat associated with a high diverse form of animal life. Many of the rocky beaches, mudflats, estuaries, coral reefs and lagoons along the Philippines coast provide ideal habitats for the growth of seaweeds (Rao and Mantri 2006).

Seaweeds are an economically important food crop in the Philippines as they serve as both a food commodity and an income source for coastal communities. Aside from seaweed being a popular food domestically, seaweeds are also an important export commodity for the Philippines (Trono and Largo, 2019), with the industry second only to the tuna industry in terms of both export volume and value (DA-BFAR, 2020a). The limiting factor currently affecting the seaweed industry is outbreaks of diseases and pests (Critchley *et al.*, 2004; Vairappan *et al.*, 2008; Mateo *et al.*, 2020.) To the fisherfolk particularly in the Cagayan community, the huge local and global demand, increased gathering pressure, and natural and man-made threats make it imperative for resource managers to seek ways to ensure continuous production.

A fundamental problem hampering the rapid development of seaweeds resources in the Philippines and other tropical developing countries is the lack of information on the identity and diversity of economically important algal species. The most common problem in the development and utilization of natural resources for economically important algal species is the lack of information on the types of species, the amount of biomass available, where they occur and when it is most profitable to harvest.

Therefore, the results of the study will provide baseline information on the species composition, abundance and diversity of seaweeds and its Morphological and Chemical Characteristics of Seaweeds in Cagayan. It also beneficial as a baseline information for the further exploration of the potentials of locally available seaweeds. The result may also be used by policy as a basis for formulating good products out of the available species that are known to be edible.

Hence, this study was conducted to determine the species morphological, phyto-physico-chemical characteristics as well as nutrional analysis of seaweeds in Cagayan, Philippines.

Materials and methods

The collection of seaweed samples was conducted in the Municipality of Gonzaga, Cagayan particularly barangay Sta Cruz.

Seaweeds were pre- identified based on the following literature: "The seaweeds of Panay" by Hurtado *et al*. (2006), "Field guide and atlas of the seaweed resources of the Philippines by Trono (1997), and "Philippine seaweeds" by Trono and Ganzon-Fortes (1988). The seaweeds were observed and enumerated during the low tide from tidal flats of rocky area through their color and particular division or group to which they belong. The green seaweeds (Chlorophyta) were almost green, although some species may be yellow green or brownish green. The brown seaweeds (Phaeophyta) were usually light to dark brown, yellow brown, brownish red, orange brown but others may be bluish-green. Seaweeds that were red or purple even in part usually belong to Rhodophyta.

The species of seaweeds were characterized using the Algaebase. AlgaeBase is a database of information on algae that includes terrestrial, marine and freshwater organisms. At present, the data for the marine algae, particularly seaweeds, are the most complete. Samples of specimen were submitted to BFAR Region 2 Seaweeds Division for proper identification.

The collected specimens were air-dried for 14 days or until the moisture content was removed depending on the type of species. After that, it was grinded using a blender machine and stored in a ziplock. The samples were brought at Cagayan State University (CSU) Central Analytical Laboratory andrews Campus, Tuguegaro City for Phytochemical analysis of three edible and three non-edible seaweeds using ethanolic extraction with eight metabolites parameters and for proximate analysis at Regional Feed Chemical Analysis Laboratory (RFCAL), Department of Agriculture Regional Field Office No.02, Carig Sur, Tuguegarao City, Cagayan.

Phytochemical analysis of edible and non-edible seaweeds

Qualitative tests were performed on different extracts of seaweeds by employing standard protocols of Guevarra (2005) for the detection of alkaloids, saponins, tannins, terpenoids, steroids, phenols and flavonoids.

Proximate analysis of edible seaweeds

Samples of seaweeds were brought to the Cagayan Valley Integrated Agricultural Laboratory (CVIAL) at the regional Center, Carig, Tuguegarao City. The proximate composition of the sample was carried out in accordance with the Association of Official Analytical Chemists (AOAC, 2000) methods. The parameters assayed for included crude protein, crude fiber, ash, moisture, crude fat and crude carbohydrate (Nitrogen free extract). Mineral content of the samples was estimated by employing Atomic Absorption Spectroscopy for iron, magnesium, calcium, manganese, chromium, zinc, phosphorus; and Flame Emission Photometry for sodium and potassium (AOAC, 1990).

Collection of soil samples

Soil (silt) samples were taken randomly in the benthic portion of the seawater. Composite soil samples were taken. A pint of soil from 5 to 10 sites was collected throughout the field and these sub-samples were combined in a large bucket or plastic bag. The samples were mixed thoroughly, one kilo of soil sample was put in a ziplock, and the remaining soil was discarded. The sample was brought at Regional Soils Laboratory Department of Agriculture Regional Field Office No.02, Carig Sur, Tuguegarao City, Cagayan.

Collection of saltwater samples

The labeled bottles were rinsed with surface seawater. Seawater samples were collected on the seaweeds habitat within 1-2 m water depth. Then, the samples were poured into 1.5 L plastic bottles in triplicates. The saltwater samples were brought at Regional Soils Laboratory Department of Agriculture Regional Field Office No.02, Carig Sur, Tuguegarao City, Cagayan for Macronutrients Analysis of salt water.

Physicochemical assessment of seaweed water

The pH, Total Dissolved Solids (TDS) and temperature combo meter was used to measure its values at the same time on site. Secchi disc and tape measure was used to determine the water depth of the seaweed habitat.

pH analysis

Salt water sample was poured into a clean beaker and was determined by potentiometric pH meter. Potentiometric pH meter measured the voltage between two electrodes and displayed the result and converted into the corresponding pH value.

Nitrogen analysis

The salt water was analyzed by steam distillation for determination of nitrogen.

Phosphorus Analysis

Quantitative tests were performed on different seawater samples by employing Vanadomolybdate method for phosphorus analysis (Hesse, 1971).

Potassium analysis

The concentration of potassium in the unknown sample was determined by reading the concentration of the sample which corresponds to its emission intensity from the calibration curve. Saltwater samples were subjected to Flame Atomic Emission.

Results and discussion

This chapter presents the interpretation and analysis of data collected. The discussion is subdivided into three (5) parts: the Taxonomical Categories of the different Seaweeds Species, the Phytochemical Characteristics, its Nutritional Analysis, the Physico-chemical Analysis and lastly, the Macronutrients Analysis.

A total of six (6) different species of seaweeds were found. The sample selection was primarily based on common or vernacular name, their taxonomical characteristics and their edibility status (Table 1).

Table 1. List of seaweeds collected at Sta. Cruz, Gonzaga , Cagayan

No.	Seaweed species	Ilocano /Common name	Phylum	Edible/Nonedible
1	*Glacilaria tertorii*	Lab-labig	Rhodopyta	Edible
2	*Caulerpa lentillifera* J.Agardh 1837	Ar-arusip	Chlorophyta	Edible
3	*Gracilaria blodgetti* Harvey 1853	Guraman	Rhodopyta	Edible
4	*Chaetamorpha crassa* (C.Agardh) Kützing 1845	Nagkayasan/Sea Hair	Chlorophyta	Non-edible
5	*Caulerpa taxifolia* (M.Vahl) C.Agardh, 1817	Lukay-lukay/ Sea Palm	Chlorophyta	Non-edible
6	*Ulva lactuca* Linnaeus 1753	Sea Lettuce	Chloropyta	Non-edible

Morphology of the different species

Lab-labig (*Glacilaria tertorii*) is reddish brown colour when fresh with discoid holdfast; the branches were cylindrical, irregular, and arcuate and could grow up to 120 mm tall. Constriction was observed at the base of every branching and the tip either pointed or divided to two to five short stubby spinose branchlets. The medulla was composed of 4-5 layers of parenchymatous cells surrounded by 2-3 layers of small cortical cells (Fig. 1).

1.Taxonomic Classification:

Empire: Eukaryota
Kingdom: Plantae
Subkingdom: Biliphyta
Phylum: Rhodophyta
Subphylum: Eurhodophytina
Class: Florideophyceae
Subclass: Rhodymeniophycidae
Order: Gracilariales
Family: Gracilariaceae
Subfamily: Gracilarioideae
Genus: Glacilaria
Species: Glacilaria tertori

Fig. 1. Lab- Labig (*Glacilaria tertoii*)

It is insulated (senositic), branched, and formed with a divider during breeding. The whole body of Caulerpa sp consists of one cell with a lower part that spreads like a stolon that has rhizoid as a sticking device on the substrate. The color of thalus Caulerpa sp is green like leaf green so it is grouped into green algae (Chlorophyceae). This is because there are plastids in Caulerpa sp cells that contain chlorophyll a and b pigments as in the green leaves of higher plants. (Tapotubun *et al.*, 2005) (Fig. 2).

2. Taxonomic Classification:
Empire: Eukaryota
Kingdom: Plantae
Subkingdom: Viridiplantae
Infrakingdom: Chlorophyta infrakingdom
Phylum: Chlorophyta
Subphylum: Chlorophytina
Class: Ulvophyceae
Order: Bryopsidales
Family: Caulerpaceae
Genus: Caulerpa
Species: lentillifera J. Agardh 1837

Fig. 2. Ar-arusip (*Caulerpa lentilifera*)

It is reddish brown colour when fresh with discoid holdfast; the branches were cylindrical, irregular, and arcuate and could grow up to 120 mm tall. Constriction was observed at the base of every branching and the tip either pointed or divided to two to five short stubby spinose branchlets. The medulla was composed of 4-5 layers of parenchymatous cells surrounded by 2-3 layers of small cortical cells. (Tapotubun *et al.*, 2005) (Fig. 3).

3. Taxonomic Classification:
Empire: Eukaryota
Kingdom: Plantae
Subkingdom: Biliphyta
Phylum: Rhodophyta
Subphylum: Eurhodophytina
Class: Florideophyceae
Subclass: Rhodymeniophycidae
Order: Gracilariales
Family: Gracilariaceae
Subfamily: Gracilarioideae
Tribe: Gracilarieae
Genus: Gracilaria
Species: blodgettii Harvey 1853

Fig. 3. Guraman (*Gracilaria blodgetti*)

Thalli often loosely entangled, rough to the touch, grass green to dark green in color; filaments unbranched and contorted; cells cylindrical, 300- 650 µm in diameter, slightly constricted at the nodes, cell width 190-300 µm, cell length 2.0-2.5 times of width. (Trono, 1997; Lewmanomont and Ogawa, 1995) (Fig. 4).

4. Taxonomic Classification:
Empire: Eukaryota
Kingdom: Plantae
Subkingdom: Viridiplantae
Infrakingdom: Chlorophyta
Phylum: Chlorophyta
Subphylum: Chlorophytina
Class: Ulvophyceae
Order: Cladophorales
Family: Cladophoraceae
Genus: Chaetomorpha
Species: crassa (C.Agardh) Kützing 1845

Fig. 4. Nagkayasan or Sea Hair (*Chaetamorpha crassa*)

The fronds are flattened laterally and the small side branchlets are constricted at the base (where they attach to the midrib of each frond), are opposite in their attachment to the midrib (as opposed to alternating) and curve upwards and narrow towards the tip. Frond diameter is 6-8mm and frond length is usually 3-15cm in the shallows, 40-60cm in deeper situations but can grow up to 2.8m in height (NIMPIS, 2002). Also, the branchlets curve upwards and taper at the apex (Fig. 5).

5. Taxonomic Classification
Empire: Eukaryota
Kingdom: Plantae
Subkingdom: Viridiplantae
Infrakingdom: Chlorophyta
Phylum: Chlorophyta
Subphylum: Chlorophytina
Class: Ulvophyceae
Order: Bryopsidales
Family: Caulerpaceae
Genus: Caulerpa
Species: taxifolia (M.Vahl) C.Agardh, 1817

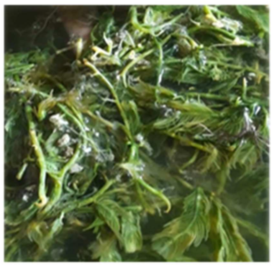

Fig. 5. Lukay-lukay/ Sea palm (*Caulerpa taxifolia*)

The thallus of ulvoid species is flat and blade-like and is composed of two layers of cells. There is no differentiation into tissues; all the cells of the plant are more or less alike except for the basal cells, which are elongated to form attachment rhizoids. Each cell contains one nucleus and has a cup-shaped chloroplast with a single or several pyrenoid (Fig. 6).

6. Taxonomic Classification:
Empire: Eukaryota
Kingdom: Plantae
Subkingdom: Viridiplantae
Infrakingdom: Chlorophyta
Phylum: Chlorophyta
Subphylum: Chlorophytina
Class: Ulvophyceae
Order: Ulvales
Family: Ulvaceae
Genus: Ulva
Species: Lactuca Linnaeus 1753

Fig. 6. Sea lettuce (*Ulva lactuca*)

Table 2 shows the qualitative method used for secondary metabolites assessment of three non-edible seaweeds namely: sea palm, sea lettuce and sea hair.

For alkaloids, among the three non-edible seaweeds, only sea lettuce was positive in Mayer's test for alkaloids and sea palm and sea hair were negative in

Mayer's test for alkaloids. It indicates that sea lettuce has naturally occurring organic nitrogen-containing bases while sea palm and sea hair do not contain nitrogenous compounds. Alkaloids are known for antispasmodic, antimalarial, analgesic, and diuretic activity (Ram *et al.*, 2015).

Table 2. Secondary metabolites of the three non-edible seaweeds

Secondary Metabolites	Alkaloids	Anthocyanin	Flavonoids	Phenols	Saponins	Steroids	Terpenoids
Method used / Seaweeds	Mayer's Test	NaOH Test	Shinoda Test	Ferric Chloride Test	Froth Test	Liebermann-Burchard Reaction	Salkowski Test
Sea palm	-	-	+	-	+	-	-
Sea lettuce	+	-	+	-	-	-	+
Sea hair	-	-	+	-	+	-	+

Legend:
(+)- presence of secondary metabolite
(-) –absence of secondary metabolite

For flavonoids, it shows that non-edible sea palm, sea lettuce and sea hair were positive in Shinoda test for flavonoids. These seaweeds manifest the general structure of a 15-carbon skeleton, which consists of two phenyl rings and a heterocyclic ring. These seaweeds have beneficial anti-inflammatory effects and they protect your cells from oxidative damage that can lead to disease. These dietary antioxidants can prevent the development of cardiovascular disease, diabetes, cancer, and cognitive diseases like Alzheimer's and dementia. Flavonoids are known for their antioxidant, anti-allergic, antibacterial, etc. (Ram *et al.*, 2015).

For saponins, it shows that non-edible sea palm and sea hair were positive in Froth test for saponin while sea lettuce was negative. It appears that sea palm and sea hair have strongly bitter-tasting, surface active compounds with a structure consisting of a steroid or triterpenoid aglycone (water non-soluble part) nucleus having 27 to 30 carbon atoms besides one or two sugar moieties (water soluble part) containing at least 6 or 12 carbon atoms respectively. Literature shows that saponins exhibit a biological role and medicinal properties such as hemolytic factor, anti-inflammatory, antibacterial, antifungal, antiviral, insecticidal, anticancer, cytotoxic, and molluscicidal action. In addition, saponins are reported to exhibit cholesterol-lowering action in animals and human (Ashour *et al.*, 2019).

For terpenoids, it shows that non-edible sea lettuce and sea hair were positive in Salkowski Test for terpenoids while sea palm was negative. Sea lettuce and sea hair exhibit naturally occurring organic chemicals derived from the 5-carbon compound isoprene, and the isoprene polymers called terpenes while sea palm does not have. Terpenoids are reported to have antiviral, anthelmintic, antibacterial, anticancer, antimalarial, anti-inflammatory properties (Ram *et al.*, 2015).

Sea Palm, Sea Lettuce and Sea hair were negative for anthocyanin, phenols and steroids qualitative test of secondary metabolites.

Table 3 shows the qualitative method used for secondary metabolites assessment of three edible seaweeds namely: Ar-arusip, Guraman and Lab-labig.

Table 3. Secondary metabolites of the three edible seaweed

Secondary Metabolites	Alkaloids	Anthocyanin	Flavonoids	Phenols	Saponins	Steroids	Terpenoids
Method used / Seaweeds	Mayer's Test	NaOH Test	Shinoda Test	Ferric Chloride Test	Froth Test	Liebermann-Burchard Reaction	Salkowski Test
Ar-arusip	-	+	-	-	-	-	+
Guraman	+	-	+	-	+	+	+
Lab-labig	-	-	+	-	+	-	+

Legend:
(+)- presence of secondary metabolite
(-) –absence of secondary metabolite

For alkaloids, it shows that among the three edible seaweeds, only Guraman was positive in Mayer's test for alkaloids while Ar-arusip and Lab-labig were negative in Mayer's test for alkaloids. It indicates that Guraman has naturally occurring organic nitrogen-containing bases while Ar-arusip and Lab-labig do not contain nitrogenous compounds. Alkaloids are naturally occurring organic nitrogen containing compounds that have many biological activities including anti-cancer (Abdulazeem *et al.*, 2018).

For anthocyanin, it shows that edible Ar-arusip was positive in Sodium Hydroxide Test for anthocyanin while Guraman and Lab-labig were negative. It reveals that Ar-arusip contains natural bioactive water-soluble pigments of phenolic compounds while Guraman and Lab-labig were lack of this secondary metabolite anthocyanin. There were reviews on the potential health benefits of plant-derived anthocyanin-rich foods, with a focus on the role of anthocyanins in obesity control, diabetes control, cardiovascular disease prevention(Tsuda, 2011).

For flavonoids, it shows that edible Guraman and Lab-labig were positive in Shinoda test for flavonoids while Ar-arusip was negative. These seaweeds have beneficial anti-inflammatory effects and they protect your cells from oxidative damage that can lead to disease (Maleki *et al.*, 2019). These dietary antioxidants can prevent the development of cardiovascular disease, diabetes, cancer, and cognitive diseases like Alzheimer's and dementia (Muldoon *et al.*, 1996; Kozlowska, 2019).

For saponins, it shows that edible Guraman and Lab-labig were positive in froth test for saponin while Ar-arusip was negative. It appears that Guraman and Lab-labig have strongly bitter-tasting. Literature shows that saponins exhibit a biological role and medicinal properties such as hemolytic factor,anti-inflammatory, antibacterial, antifungal, antiviral, insecticidal, anticancer, cytotoxic, and molluscicidal action. In addition, saponins are reported to exhibit cholesterol-lowering action in animals and human (Ashour *et al.*, 2019).

For steroids, it shows that only Guraman was positive in Liebermann-Burchard reaction for steroids while Ar-arusip and Lab-labig were negative. According to WebMD, plant sterols might help reduce cholesterol levels by limiting the amount of cholesterol that is able to enter the body. Some plant sterols might also reduce how much cholesterol is made in the body. People commonly use plant sterols for lowering cholesterol levels. Plant sterols are also used for heart disease, colon cancer, stomach cancer, obesity, heart attack, and many other conditions, but there is no good scientific evidence to support many of these other uses.

For terpenoids, it shows that edible Ar-arusip, Guraman and Lab-labig were positive in Salkowski Test for terpenoids. Many plants containing terpenoids are used in traditional medicine for their anti-inflammatory and pain-relieving properties. Terpenoids are reported to have antiviral, anthelmintic, antibacterial, anticancer, antimalarial and anti-inflammatory properties (Ram *et al.*, 2015). Ar-arusip, Guraman and Lab-labig were negative for phenols qualitative test for secondary metabolite

Nutritional analysis

In Table 4, the proximate composition of edible seaweeds revealed relatively high levels of nutrients. This suggesting that they may serve as good sources of energy. The high moisture content of seaweeds samples indicates that they may be easily susceptible to spoilage if not well preserved (Omoregie and Osagie, 2011). The ash content among the seaweeds show they may have appreciable amounts of mineral elements. The ash content of Lab-labbig was comparatively higher than those two edible seaweeds.

Table 4. Proximate analysis of three edible seaweed

Nutrients	Crude Protein(%)	Crude Fiber (%)	Crude Fat (%)	Moisture (%)	Ash (%)	Total Calories(kcal)	Calories from Fat(kcal)
Ar-arusip	12.61	10.23	1.09	25.71	25.08	51	8
Guraman	9.59	6.25	0.35	23.31	24.99	37	3
Lab-labig	7.66	2.30	0.36	30.74	33.09	29	3

In this study, there was an appreciable amount of protein in seaweed samples. Protein is an essential component of human diet needed for the replacement of dead tissues and for the supply of energy and adequate amount of required amino acids (Igile *et al.*, 2013).

The higher crude fiber content of Ar-arusip as compared to its counterpart indicates that it may aid digestion, absorption of water from the body and bulk stool. Fiber soften stool and therefore, prevents constipation (Ayoola and Adeyeye, 2009).

Consequently, the other edible seaweeds may be useful in the control of body weight, blood cholesterol and protection against colon cancer. The lower crude fat content observed in Guraman as against that of Ar-arusip and lab-labbig suggests that it can be easily incorporated in weight reducing diet.

Table 5. Physico-chemical assessment of seaweed water on site

Physical Parameters	pH	Temperature surface	Temperature bottom	TDS	Water depth
Water Sample		°C	°C	mg/l	m
AM	7.5	30.5	30.0	130	2.40
NT	7.5	31.0	31.0	129	1.47
PM	7.5	31.5	31.0	128	1.54
Total	22.4	93.0	92.0	387	5.41
Average	7.5	31.0	30.7	129	1.80

Table 5 shows the physical assessment of seaweed seawater on site in the morning, noon time and afternoon. Physicochemical analysis of seawater on-site is a critical component of seaweed research and resource management. It was revealed in the table that pH of the seaweed seawater was 7.5 which was within the range of normal seawater pH range. The majority of aquatic creatures prefer a pH range of 6.5-9.0, though some can live in water with pH levels outside of this range (Baker *et al.*, 1990). pH levels in seawater can impact the availability and uptake of essential nutrients by seaweeds. Variations in pH can also influence the solubility of certain minerals and ions, potentially affecting the overall nutrient content of seaweeds.

For temperature at the surface and at the bottom, it shows that the average temperature was 31.00C and 30.7°C respectively. Water temperature plays a crucial role in the metabolism and growth rates of seaweeds. It affects enzymatic reactions, photosynthesis, and respiration rates.

The average Total Dissolved Solids (TDS) of an average of 129 mg/L. This value is less than 35,400 mg/L of TDS found in typical seawater (Demir *et al.*, 1999). So, the seawater is less salty. Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions. Constant level of minerals in the water is necessary for aquatic life. Changes in the amounts of dissolved solids can be harmful because the density of total dissolved solids determines the flow of water in and out of an organism's cells. Concentration of total dissolved solids that are too high or too low may limit the growth and may lead to the death of many aquatic organisms. On the other hand, the average water depth was 1.80 m. Seawater depth is vertical distance between the sea floor and still water level. According to Food and Agriculture Organization (FAO), seaweeds close to the sea surface grow faster and healthier compared to that planted close to the sea bottom or in deep water.

In conclusion, on-site physicochemical analysis of seaweed water provides valuable information about the environmental conditions that influence seaweed growth and health. This data is crucial for making informed decisions regarding seaweed resource management, conservation efforts, and sustainable utilization in various industries.

Additionally, it helps researchers understand the broader ecological interactions within marine ecosystems.

Table 6. Macronutrients level of salt water

Sample Description	pH	MACRONUTRIENTS		
		Nitrogen, mg/L	Phosphorus, mg/L	Potassium, mg/L
Salt Water	8.14	1.84	1.23	1.47

Table 6 discusses the Analysis of the pH and macronutrient levels of saltwater which is essential for understanding the chemical composition and suitability of the aquatic environment for various organisms, including seaweeds. The pH of the seaweed seawater was 8.14 which was within the range of normal seawater pH range. The majority of aquatic creatures prefer a pH range of 6.5-9.0, though some can live in water with pH levels outside of this range (Baker *et al.*, 1990).

Different species of seaweeds have varying pH tolerances. Some species thrive in slightly acidic conditions, while others prefer alkaline environments. Understanding pH levels helps in identifying suitable habitats for different seaweed species.

On the other hand, Macronutrients are essential elements required in relatively large quantities by seaweeds and other marine organisms. Nitrogen, phosphorus, and potassium are crucial for processes like photosynthesis, growth, and reproduction. Nitrogen analysis shown in the table that the nitrogen level of salt water which was 1.84 mg/L. Various inorganic nitrogen compounds may be found. Phosphorus (P) level of salt water which was 1.23 mg/L. while, Potassium(K) level of salt water which was 1.47 mg/L. these could be indicated that nutrient availability in seawater is influenced by factors like weathering of rocks, runoff from land, and biological processes. Monitoring these levels helps assess the nutrient status of a marine ecosystem

Conclusion

Seaweeds, also known as macroalgae, comprise a diverse group of photosynthetic organisms that play crucial ecological roles in marine ecosystems. The present investigation present adequate data on their morphology which exhibits a wide range of forms and structures, reflecting their adaptation to various marine environments. The morphological characteristics of six (6) seaweeds species both edible and non-edible obtained from Sta Cruz, Gonzaga, Cagayan reveals that these broad groups, there is considerable diversity within each category, with thousands of species exhibiting unique adaptations to specific ecological niches. As to its chemical characteristics, It can be concluded that marine macro algae are a rich source of structurally novel and biologically active metabolites. Secondary or primary metabolites produced by these macro algae may be potential bioactive compounds of interest in the pharmaceutical industry and medicinal compounds. In addition, these seaweeds are rich sources of essential nutrients like vitamins, minerals, and trace elements. Understanding the phytochemical composition allows us to identify their nutritional content, making them potentially valuable supplements in human and animal diets. These could be employed as potential marine-sourced drugs and may be used in the pharmaceutical and food processing industries as sources of ingredients with appreciable medicinal value.

In conclusion, morphological characterization of seaweeds, phytochemical and proximal analysis of seaweeds is a multidisciplinary endeavor with far-reaching implications for human health, environmental sustainability, and economic development. It provides a scientific foundation for harnessing the potential of seaweeds in various industries while also promoting the conservation and responsible management of marine resources. Therefore, Marine macroalgae benefit people culturally, industrially, nutritionally, and ecologically.

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