



Bioactive Components of Three Seaweed Species from Hadji Panglima Tahil, Sulu Philippines

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Abstract: This study aimed to determine the bioactive composition and properties of three selected marine seaweeds: *Ulva reticulata*, *Halymenia durvillei* and *Sargassum cristaeifolium* from Hadji Panglima Tahil, Sulu Philippines. The proximate and heavy metal composition of the seaweeds were determined. Heavy metal analysis in seaweeds showed that zinc registered highest concentration (328.74 mg/kg) in *U. reticulata*. Other evaluated seaweed species registered lower concentrations of copper (Cu), mercury, and lead indicating that they could be eaten as source of Cu. The concentration reveals that these seaweeds could be source of the micronutrient, and copper. All other seaweeds are safe for human consumption. Nutritional proximate composition of seaweeds in this study revealed that the brown seaweed (i.e. *S. cristaeifolium*) collected from Hadji Panglima Tahil, Sulu Philippines had highest average composition in terms of moisture, lipids, and total soluble solids. Results on nutritional proximate composition of seaweed varies due to the effect of geographical location, time of collection and the weather condition. Dried samples of *U. reticulata* showed best antioxidant activity while *S. cristaeifolium* had least antioxidant activity. Sulu Philippines is one of the seaweeds suppliers in western Mindanao. Decades ago, seaweeds are known as food delicacy like *Caulerpa*, *Eucheuma* and *Gracilaria* spp. They are eaten raw while the industrial and medicinal uses of extracts from seaweeds were known later by inhabitants. There have been several feeding trials conducted to have the potential as source of aqua feed. Feeding the fishes with seaweed helps to prevent the occurrence of disease to certain extent. Seaweeds contain plenty of protein, vitamin and minerals. Moreover, seaweeds also contain potential bioactive compounds which exhibit antibacterial, antiviral and antifungal properties. The phytochemicals responsible for the bioactivities could be present in the seaweeds which based on literature. In addition to “positive” roles, seaweeds also play critical roles in reef degradation, particularly in ecological “phase shifts” where abundant reef-building corals are replaced by abundant fleshy seaweed. Indeed, the seaweeds screened in this study possess bioactive components and antioxidant which may be considered for future applications in medicine, cosmetics, and some heavy metals composition which may be considered for future applications in food industry.

Keywords: Seaweed, Bioactive Components, Feeds, Nutrition, Phytochemical, Heavy Metals

1. Introduction

Seaweeds are the only sources of phytochemicals namely: agar-agar, carrageenan and algin. They are also used as feedstuff for animal consumption [2]. Seaweeds contain different varies of inorganic and organic substances which can be used for human health for example: polyphenols, carotenoids and tocopherols, terpenes, ascorbic acid and alkaloid [5]. Due to high amounts of vitamins and minerals present in green seaweeds, they are used widely in agriculture, pharmaceutical, biomedical and nutraceutical industries [7].

In the Philippines, utilization of *Sargassum* by coastal populations include; 1. As cover for fishery products to prevent desiccation and maintain their freshness; 2. As food; 3. As fertilizer, insect repellent, flower inducer and animal feed; and 4. As therapeutic drink, among others. *Sargassum* biomass is also believed to have a great potential as feedstuff for alternative sources of energy, i.e. biofuel [11].

Sulu is one of the seaweeds suppliers in western Mindanao. Decades ago, seaweeds are known as food delicacy like

Caulerpa, *Eucheuma* and *Gracilaria* spp. Seaweed industry is considered as one of the major industries that benefits the majority of coastal fisher-folks. *Eucheuma* and *Kappaphycus* spp. are the potential seaweeds used for culture and farm in Sulu. Seaweeds like *Sargassum*, *Ulva* and *Halymenia* spp. are just flaking in the shoreline for no one knows their benefits. Other places like in Ilocos Norte, It is their favorite take home or “pasalubong” when they return back to their residences abroad [1].

Ecologically, the seaweed commodity provides a number of benefits to the surrounding environment against various environmental unfriendly catching activities, like, use of poisons and bombs in catching fish. Biologically, seaweed plays an important role as primary producer of organic materials and oxygen at the coastal environment. Economically, this is potential commodity to be developed, considering its nutrient content and pharmaceutical uses. It can be used as foodstuffs such as agar, vegetables, and snacks. It also produces algin materials, carrageenan and fluseran used in pharmaceutical, cosmetic, and textile industries, and as an alternative feeds to fish. Seaweeds also contain potential bioactive compounds which exhibit antibacterial, antiviral and antifungal properties [10].

This study was conducted to analyze the proximate heavy metal composition and phytochemical components of seaweeds viz, *Ulva reticulata*, *Sargassum cristaeifolium* and *Halymenia durvillei*, collected from Hadji Panglima Tahil, Sulu, Philippines.

Objective of the Study

The study generally aimed to determine the bioactive composition and properties of three selected marine species.

Specifically, it determined:

1. Proximate and heavy metal composition of selected marine seaweeds,
2. Phytochemical components of the *U. reticulata*, *S. cristaeifolium* and *H. durvillei*.

2. Materials and Methods

2.1. Collection of Samples

Seaweed samples of *Ulva reticulata*, *Sargassum cristaeifolium* and *Halymenia durvillei* were hand-picked from Hadji Panglima Tahil, Sulu. Seaweeds identification was based on their morphological characteristics. Immediately after collection, samples were cleaned and washed with seawater to remove extraneous matter such as epiphytes, sand particles, pebbles and shells and they were put in an iced container to maintain low temperate during transportation.

Samples were sorted and thoroughly cleaned with distilled water and dried under shady, open-air condition for one week and then oven dried for one hour at 50°C. Dried samples were ground in a miley mill and packed in zip-locked container and brought to the laboratory for chemical proximate analysis. Remaining powdered samples were then stored in -20°C freezer for further analysis. All

analyses of the seaweed samples were carried out in triplicates.

Seaweed is vast fishery resources found everywhere and anywhere on bodies of water around the world. Sulu Philippine are known site and for their abundance of seaweeds species. Sulu is known for culturing the seaweeds *Eucheuma*, *Gracilaria* and *Kappaphycus* spp. and these seaweed species are part of their livelihood and diets of the Suluanos. The rest of seaweeds are just waste natural product that can be seen floating and flaking along the shoreline. While in other places like in Ilocos Norte, seaweeds are also part of Ilocano diets and as well as a source of their livelihood but seaweeds are not cultured or farmed in the area.

2.2. Proximate Composition Analysis

Semi- dried seaweeds samples were submitted to the Regional Science and Technology Laboratory, Department of Science and Technology for proximate composition analysis. Nutrient composition of raw seaweeds was analyzed by Association of Official Analytical Chemists (AOAC) method. Percentage moisture, protein, lipid and ash were determined. The crude protein of the seaweeds was determined using the Micro-Kjeldahl method [13]. Estimation of fat content of experimental seaweeds was done using the Bligh and Dryer method [3]. Pulverized seaweed samples (3 g) were weighed and ignited in the crucible. Then they were transferred in the Muffle Furnace and heated at 550-600°C for 6-8 hours until the residue was white. Finally, percentage of moisture, protein, fat and ash content were calculated according to the following formula:

Calculation of moisture:

$$\text{Moisture (\%)} = \frac{\text{Weight loss}}{\text{Original weight of sample taken}} \times 100$$

Calculation of protein:

N_2 (%) = (Titration reading-blank reading) x strength of acid x 100/5×100/weight of the sample. Percentage of protein in the sample was calculated by multiplying % of N_2 with an empirical factor 6.25: Protein (%) = % of total N_2 × 6.2

Calculation of fat:

$$\text{Fat (\%)} = \frac{\text{Weight of the residues}}{\text{Weight of the residues}} \times 100$$

Calculation of ash:

$$\text{Ash (\%)} = \frac{\text{Weight of dry samples}}{\text{Weight of the samples taken}} \times 100$$

2.3. Determination of Chemical Composition of Seaweeds

Seaweed samples were brought and submitted to Region III Department of Science and Technology Feed Testing Center in Pampanga for heavy chemical analysis. Heavy metals like mercury, lead, zinc and copper content of the raw seaweeds were analyzed by their Association of Official Analytical Chemists (AOAC) methods of analysis with the application of different methods shown in Table 1.

Table 1. Methods used in the analysis of carbohydrates, sodium and total soluble sugar.

Parameter	TEST Method
Carbohydrates	By Computation % Carbohydrates = 100% - (% Ash + % Moisture + % Fat + % Protein) TM-230
Sodium	AOAC Methods of Analysis 18 th ed. Official Method 956.01 (Modified) Flame Photometric Method TM-206
Total Soluble Sugar	AOAC Methods of Analysis 18 th ed. Official Method 932.12 & 932.14°C and PNS 582 1982

Table 2. Test on nutritional components of seaweed.

PARAMETER	TEST METHOD
Ash Content	TM-201 AOAC Methods of Analysis 18 th ed.. Official Method 925.51A, Furnace Ashing 525°C, 12 hr TM-202
Crude Fat	Velp Fat Hydrolysing Unit & Fat Extractor Manuals Using Petroleum ether
Moisture Content	TM-203 AOAC Methods of Analysis 18 th ed. Official Method 930.04 & 930.15, Oven Drying 130°C, 2 hr
Crude Protein	TM- 204 AOAC Methods of Analysis 18 th ed. and Velp Scientica Distillation Apparatus Operation Manual, Factor for % Nitrogen content conversion to protein= 6.25

Table 3. Methods used in chemical analysis for seaweeds.

PARAMETER	TEST METHOD
Mercury	AOAC Methods of Analysis 18 th ed. Official Method 972.25 (Modified) Flameless Atomic Absorption Spectrophotometric Method, Thermal Decomposition & Amalgamation of DMA-80 Manual
Lead, Zinc and Copper	AOAC Methods of Analysis 18 th ed. Official Method 999.11 Atomic Absorption Spectrophotometric Method & Varian AAS Manual

3. Results and Discussion

3.1. Heavy Metals Uptakes of Seaweed

The aim was to measure concentrations of total copper (Cu), lead (Pb), mercury (Hg) and zinc (Zn) in three edible seaweed species from Hadji Panglima Tahil, Sulu Philippines. Heavy metal concentrations in three seaweeds of the metal analyzed, Zn registered highest concentration (328.74 mg/kg) in *U. reticulata* growing in the area. Other seaweeds registered lower concentration and other could be eaten as source of copper.

Lead and Hg are toxic heavy metals and they were also detected in seaweeds. *Ulva* seaweeds collected from the area were found to contain seemingly high level of Pb.

However, no maximum contaminant level values that were specifically set for Pb or Hg in seaweeds were found, so there was no guideline or standard value that could serve as reference to determine whether measured concentration is higher or lower than maximum allowable intake value.

In addition, results revealed in this study that levels of the heavy metals or trace elements in seaweeds in Sulu vary according to composition of seaweed uptakes of Hg, Pb, Zn and Cu. This could be due to effect of location, type of sediments, and salinity of seawater and weather condition during time of sampling.

3.2. Proximate Composition of the Seaweeds as Feeds

Ulva reticulata has high protein (17.91%) and ash content (37.38%). *Halymenia durvillei* is high in moisture content (11.07%) while *S. cristaefolium* is high in fiber (8.59%) and ash content (15.07%) on dry basis. Based on the FAO report (2009), protein contents of the green and red seaweeds are quite variable. Protein contents of the green seaweeds ranged from 6.00 to 26.00% while red ranged from 3.00 to 29.00%. This study found protein content of green and red seaweeds to be between these ranges.

Fresh *U. reticulata* from Tanzania was analyzed to have 25.70% crude protein, 18.30% ash and 38.50% crude fiber [12]. Oven dried meal red seaweeds from Philippines, *Kappaphycus alvarezii* and *Gracilaria heteroclada*, contain 3.2 and 17.3% crude protein, respectively [14].

Environmental condition in Hadji Panglima Tahil Sulu is conducive to growth of *H. durvillei* and *U. reticulata* in terms of better proximate composition. In case of *S. cristaefolium*, indicates that environmental condition can produce better proximate composition of this species of seaweeds. It has been established that seaweed meal increases fertility and birthrate of animals and improves color to salmonids [6].

There have been several feeding trials conducted to evaluate seaweeds as fish feed. They have been used as fresh and dried

meal incorporated as partial or complete replacement of fishmeal protein in pelleted form. Dietary inclusion levels in these studies ranged from 5-100% [8]. Addition of *Porphyras pheroplasts* to semi-purified diet of red sea bream (*Marantes corymbosa*) improved their specific growth rate [9]. When dried, *Gracilaria busrapastonis* replaced 5 or 10% of fish protein hydrolysate diet for European sea bass (*Dicentrarchus labrax*) specific growth rate improved [15].

Thus, seaweeds evaluated in present study also have the potential as source of aqua feed. Feeding the fishes with seaweed helps to prevent the occurrence of disease to certain extent. Seaweeds contain plenty of protein, vitamin and minerals. Most studies were on tilapia and submerged macrophytes were fed either in fresh form or as dried meal within pelleted diet. In addition, 4% of *Sargassum* meal to the feed of shrimp cultures reduced cholesterol contents of their muscle tissue by 29% quite desirable for shrimp grown for human consumption [4].

4. Summary and Conclusion

This study aimed to determine the bioactive components and properties of three selected marine seaweeds viz *Ulva reticulata*, *Halymenia durvillei* and *Sargassum cristaefolium* from Hadji Panglima Tahil, Sulu. The proximate and heavy metal compositions of the seaweeds were determined. Qualitative phytochemical screenings was applied.

Aside from determining proximate composition, this study also evaluated the heavy metal concentrations in seaweeds. Among the metals analyzed, zinc registered highest concentration (328.74 mg/kg) in *U. reticulata* growing in the area. Other evaluated seaweed species registered lower concentrations of copper (Cu), mercury (Hg), and lead (Pb).

The concentration reveals that these seaweeds could be source of the micronutrient, copper. In addition, except for *U. reticulata*, all other seaweeds are safe for human consumption and could be used as raw material for other purposes such as drug or cosmetics preparation

Lead and Hg are toxic heavy metals and they were also detected in the seaweeds. *Ulva reticulata* collected sample were found to contain seemingly high level of Pb.

However, no maximum contaminant level values that were specifically set for Pb or Hg in seaweeds were found, so there was no guideline or standard value that could serve as reference to determine whether the measured concentration is higher or lower than maximum allowable value.

Seaweed appears to be interesting source for medicinal and phytochemical studies. Presence of phytochemicals in three seaweeds observed in this study confirmed the presence of terpenoids in both ethanol and methanol extracts. Terpenoids are important as additive in the food industry and as a pharmaceutical agent in biomedicine. Tannins, saponins and coumarins were present in *U. reticulata* while alkaloids, flavonoids and xantho-proteins were absent in both methods.

This difference can be attributed to solubility of the active component in different solvents and methods of extraction were possible source of variation for the chemical

composition and bio-activity of the extracts..

In conclusion, the seaweeds screened in this study possess bioactive and some heavy metals composition which may be considered for future applications in food industry. In the next research studies, further investigation should be undertaken to characterize the other compounds residing in these types of seaweed as well as to evaluate the effects of each individual compound in fish and microorganism.

5. Recommendations

For heavy metals, conduct watershed assessment and evaluation that should include minimum identification pollutant source and identification of the critical area.

Enhancement of information dissemination to local farmers, for sustainable aquaculture, as seaweeds are known for their bioactive components in nutritional and pharmaceutical uses.

Encourage and support production of these seaweeds in terms of formulation of alternative or supplemental feeding on tilapia for sustainable aquaculture purposes.

Enhancement information on cosmetology, for seaweeds have therapeutically benefits for skin diseases like acne and melisma.

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