PRELIMINARY STUDY ON THE BIOACCUMULATION POTENTIAL OF SEAGRASS (*H. OVALIS*) FOR MERCURY IN SELECTED COASTAL BARANGAYS IN MALTA, DAVAO OCCIDENTAL

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ABSTRACT

Seagrass has a remarkable metal bioaccumulation capacity since it interacts directly with both the water column and the pore water through the leaves and roots as ionic uptake. Malita, Davao Occidental, has some extensive seagrass meadows that support populations of species like dugongs, turtles, and commercially and traditionally important fishes. This study aimed to determine the potential of seagrass in absorbing mercury. There were five species of seagrass observed in the study area (*Halophila ovalis, Halodule uninervis, Halodule pinifolia, Halophila minor*, and *Halophila spinolusa*). In New Argao, the highest mean percent cover (4.3%) and shoot density (519.2 shoots/m2) were obtained in *H. ovalis*, while the lowest mean percent cover (1.9%) and shoot density (197.87 shoots/m2) were recorded in Cullman. It was found that there were no significant differences in the density and abundance of *H. ovalis* between the sampling stations; however, there was a significant difference in the concentration of mercury between sampling stations. The mercury accumulation was observed to be high (41.9 ppb) and recorded from Tingolo, while in Culaman, the total quantity of mercury accumulated by *H. ovalis* was 21.5 ppb. There was a low positive correlation between mercury concentration and percent cover of *H. ovalis*, while a negative correlation (-0.518) was found between mercury concentration and shoot density. Because of the limited data available, conclusions about the relationships were not drawn. As to physicochemical parameters, the temperature, salinity, and pH recorded in all sampling stations were observed to be at their normal levels.

Keywords: Bioaccumulation potential, sea grass, mercury, coastal barangay, Malta

INTRODUCTION

Seagrasses are monocotyledonous vascular flowering plants that thrive in coastal and estuarine areas worldwide. They are unique and usually submerged in water. They possess a root system with stems buried within a soft substrate and exhibit both vegetative and sexual reproduction, with flowers fertilized by waterborne pollen (Phillips et al., 1992). These unique flowering plants grow fully in saline environments and belong to 12 genera, with some 58 species known. In many species, the leaves are long and narrow, grow by rhizome extension, and often form large meadows that resemble grassland underwater (Den Hartog, 1970).

Factors controlling seagrass distribution and condition are of increasing interest to the scientific community due to their ecological and economic value (Duarte, 1999). Seagrasses support important grazing and detrital food webs, stabilize sediments, and play a crucial role in global carbon and nutrient cycling. Furthermore, hundreds of planktonic, epibenthic, and infaunal species depend on grass beds for survival (Virnstein & Howard, 1987; Jackson et al., 2006). These aquatic plants are capable of capturing and storing a large amount of carbon from the atmosphere. Similar to how trees take carbon from the air to build their trunks, seagrasses take carbon from the water to build their leaves and roots. As parts of the seagrass plants and associated organisms die and decay, they are buried and trapped in the sediments. It has been estimated that in this way, the world's seagrass meadows can capture up to 83 million metric tons of carbon each year (Reynolds et al., 2017).

Seagrasses have a remarkable capacity for metal bioaccumulation, as they interact directly with both the water column and pore water through their leaves and roots via ionic uptake. Consequently, the results of the study can reflect the overall health of coastal waters (Llagostera et al., 2011). As marine angiosperms, sea grasses interact with sediments through their roots and rhizomes, as well as with the water column through their leaves (Romero et al., 2005). Therefore, the accumulation and distribution of heavy metals were not only found in the roots but also the rhizomes and leaves.

Malita, Davao Occidental, has extensive seagrass meadows that support populations of species such as dugongs, turtles, and commercially and traditionally important fish. However, the continuously increasing pollution will cause the seagrasses to die off once pollution reaches lethal levels, and this intertidal habitat will be lost for good, as there is little opportunity for the habitat itself to migrate (Hadley, 2009). This study aims to determine the potential of seagrass to absorb mercury in the seagrass meadows of Malita, Davao Occidental.

METHOD

Research Locale

The study area of this research was Malita, Davao Occidental. Malita is a 1st-class municipality and the capital town of Davao Occidental, Philippines. It has 30 barangays. It is the main economic center of Davao Occidental, where agriculture and fisheries are the main industries. In particular, Brgy. Culaman (6°24'4"N 125°36'25"E), Brgy. New Argao (6°22'33"N 125°36'38"E) and Brgy. Tingolo (6°21'37"N 125°37'25" E) is our coastal barangay (Fig. 3) and is known for dugongs, sea turtles, and more since the seagrass ecosystem and coral reefs are abundant. Moreover, livestock and agricultural plantations like banana, coconut, and durian were present in these coastal areas. Industrial development, such as the Davao San Miguel power station, also known as the Malita power station, is a 628-megawatt (MW) coal-fired power plant located at Brgy. Cullman.

Figure 1. *Map of study areas in Malita, Davao Occidental*

Collection of Sea Grass Samples

Samples were collected in the subtidal zone of the coastal barangays in Malita, Davao Occidental, specifically Barangay. Cullman, Brgy. New Argao and Brgy Tingolo. Seagrass species were collected in their entirety, including roots, rhizomes, and leaves. Following Sanchez et al. (2000), the samples collected were rinsed with seawater to remove sediment from the roots and rhizomes. The samples were then packed in clean plastic bags, sealed, and frozen at -20°c before analysis. They were subsequently transported to Davao Analytical Laboratories, Inc., Matina, Davao City, for analysis.

Identification of Seagrass Species.

The identification of seagrass species was undertaken in the laboratory, utilizing pictures and a dichotomous key to the species of Philippine Seagrass (Calumpong & Meñez, 1997).

Determination of Sea Grass Percent Cover

To determine the percentage cover of the seagrass, the researchers used the transect line quadrat method. This method involved determining the point of seagrass occurrence up to the outer limit where seagrass disappeared. Next, the researchers laid quadrats on the seagrass along the 50-meter transect line, positioned perpendicular to the shoreline. The categories developed by Saito and Atobe (1970) were used to record the percent cover of the seagrass species per quadrat. The process was repeated for each species in the quadrat. The table below shows the classes of dominance used to record the percentage cover of seagrass species in the three sampling stations.

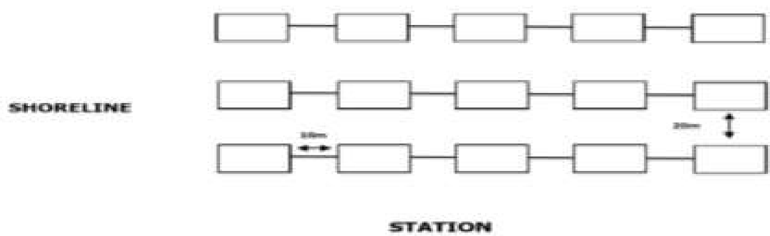
$$C = \frac{\sum(M_1 \; x \; F_1)}{\sum f}$$

Where:
M1 = midpoint percentage of class (i)
F1 = Frequency (number of sectors with the class dominance)
f = frequency of the class

Table 3. *Criteria for categorizing the percent cover of seagrass*

Class	Amount of % Covered	Covered	Mean
5	½ to all	50-100	75
4	¼ to ½	25-50	37.5
3	1/8 to ¼	12.5-25	18.75
2	1/16 to 1/8	6.25-12.5	9.38
1	Less than 1/16	<6.25	3.13
0	Absent	0	0

Figure 2. *Sampling Layout*



Determination of Shoot Density of *H. ovalis*.

The transect line quadrat method was used to determine the above-ground shoot density of the seagrass. In this method, the researcher determined the point of seagrass occurrence up to the outer limit where seagrass disappeared. Second, the 50-meter transect line was used as a guide in laying the metal quadrat. The transects were positioned perpendicular to the shoreline. Then, shoots of each species that were within 25 grids of the quadrant were counted and recorded. The process was repeated for each species in the quadrat. The formula given by Odum (1971) was adopted.

Where,

$$Density = \frac{number\ of\ individuals\ of\ a\ species}{area\ (m^2)}$$

Mercury Analysis in Sea Grass Sample

Regarding the mercury accumulation analysis, the samples were delivered to Davao Analytical Laboratories, Inc. in Matina, Davao City, on May 10, 2018. Cold vapor atomic absorption spectroscopy was used to analyze the mercury content.

Physico–Chemical Parameters.

Physicochemical parameters were determined in each sampling site. Water temperature, salinity, and pH values were recorded at each station.

Statistical Analyses

Analysis of Variance (ANOVA) was used to determine the significant difference in the percent cover, shoot density, and mercury accumulation level of seagrasses in the three sampling stations. Also, Tukey's test was employed to find out which specific groups' means compared with each other were different. Pearson's correlation coefficients of mercury concentration to the percent cover and shoot density of seagrass were determined using the Statistical Package for the Social Sciences (SPSS version 17).

RESULTS AND DISCUSSION

Seagrass species identified

Using the dichotomous key for the identification of seagrass species as presented in Calumpong and Meñez (1997), five species of seagrasses were found in the study area, namely Halophila ovalis, Halodule unnerves, Halodule pinifolia, Halophila minor, and Halophila spinulosa. However, only in the third station (Brgy Tingolo) is the presence of all species of seagrasses. H. spinulosa was not observed in Stations 1 and 2 (Table 4).

Table 4. *The occurrence of seagrass species in the study area*

Seagrass Species	Cullman	New Argao	Tingolo
Halophila ovalis	√	√	√
Halodule unnerves	√	√	√
Halodule pinifolia	√	√	√
Halophila minor	√	√	√
Halophila spinulosa	-	-	√

Legend: - = represents absence √ = represents presence

Percent Cover of *H. ovalis*.

The *H. ovalis* showed the highest mean percent cover of seagrass (4.3%) in Brgy. New Argao while Brgy. Culaman had the lowest mean percent cover of 1.91 (Fig. 5). The substrate of the area could be the reason for its low percent cover since H. ovalis requires a wide variety of substrates, such as mud, living corals, or coral rubble and sand, where the plant could occasionally be almost completely buried. According to Kou and Den Hartog (2001), H. ovalis is abundant seagrass in tropical and warm temperate areas, occasionally found in pure stands or may grow together with H. minor, H. unnerves, H. pinifolia, and H. spinulosa, and these seagrass species were also observed. There was no significant difference in the mean percent cover of H. ovalis among sampling stations. However, in a study conducted by Noel et al. (2013), they stated that among the dominant seagrass species identified, Halophila ovalis had the highest percent frequency of occurrence, with 64%, which could be found in all areas in Davao Gulf.

Shoot Density of *H. ovalis*.

Brgy. New Argao also had the highest mean shoot density of H. ovalis, with 519.2 shoots/m^2, while Brgy. Culaman obtained the lowest value, 197.87 shoots/m^2. The density of H. ovalis may be influenced by various factors, including substrate conditions, seasons, tides, wave energy strength, and the content of organic matter in the sediment, among others (Short & Coles, 2001). There was no significant difference in the shoot density of H. ovalis among sampling stations.

Mercury Accumulation in *H. ovalis*.

According to Patra et al. (2000), mercury poisoning has become a problem of current interest as a result of environmental pollution on a global scale, and its concentrations in the stems and leaves of plants are always greater when the metal is introduced in organic form. The level of mercury in the plants should not be higher than 20ng/g. Figure 7 shows the mercury accumulation in *H. ovalis*, where the concentration was high in Brgy. Tingolo with 41.9 ppb compared to the other two stations—conversely, Brgy. Culaman had the lowest mercury concentration, and there was a significant difference in the levels of mercury among sampling stations. Natural emissions of mercury form two-thirds of the input; artificial releases form about one-third. Considerable amounts of mercury may be added to agricultural land with sludge, fertilizers, lime, and manures. These were the possible and acceptable factors why Brgy. Tingolo had the highest level of mercury accumulation. Acidic rainfalls caused by coal-fired power plants, possibly more often, fell in Tingolo since coal-fired power plants emit large quantities of sulfur dioxide and mercury. Patra et al. (2000) also cited that mercury obtained from the so-called dry deposition can be rinsed out from the surface of living plants by atmospheric precipitation. However, throughout the vegetation period, the level of mercury in plant tissues increases both due to dry and wet deposition, more intensely than in the surrounding soil. This is also caused by mercury mobility in the air-soil-plant system and its accumulation by certain plant species. There was a positive but weak uphill relationship between variables (0.302) between mercury accumulation and percent over in H. ovalis. At the same time, a correlation between mercury accumulation and shoot density of H. ovalis obtained a value of -.518, which indicates a moderate negative relationship.

Physico-chemical Parameters. As shown in Table 5, the physicochemical parameters results were in normal conditions.

Table 5. *Physico-chemical parameters in the study area*

Parameters	**Station 1**	**Station 2**	**Station 3**
Temperature	32^0C	29^0C	30^0C
Ph	7.16ppm	7.04ppm	7.85ppm
Salinity	35ppt	35ppt	35ppt

CONCLUSION

There were five species of seagrass found in the study areas due to the soft type of substrate present. Brgy. New Argao has the highest mean percent cover (4.3%) and shoot density (519.2 shoots/m2), while Brgy. Culaman (Station 1) obtained the lowest record of mean percent cover (1.91%) and shoot density of 197.87 shoots/m2. This reflects the patchiness of seagrass stands the cover of seagrass within the patches or both aspects. Mercury accumulation in H. ovalis is reported to be highest in Brgy. Tingolo (41.9ppb), followed by Brgy.

New Argao (22.65ppb) and Brgy. Culaman (21.5ppb). These signify that H. ovalis can accumulate mercury content and exceed the standard level of 20 ppb. There is no significant difference in the percent cover and shoot density of H. ovalis, while a significant difference is observed in the levels of mercury accumulation. There is a positive relationship between the percent cover and mercury concentration of H. ovalis, while a negative relationship is between the shoot density and mercury concentration of H. ovalis. Physico-chemical parameters results were in normal condition.

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