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HEAVY METAL CONCENTRATIONS OF SEAGRASSES *ENHALUS ACOROIDES* AND *THALASSIA HEMPRICHII* IN BUTUAN BAY, PHILIPPINES

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ABSTRACT

Environmental pollution of heavy metals is increasingly becoming a problem and nowadays become a great concern due to its adverse effects. Thus, it is essential to determine the heavy metal concentrations when considering seagrasses as resource of food stuffs and medicinal purposes. The heavy metal concentrations of the seagrasses in this study were determined using a Perkin Elmer AAnalyst 200 atomic absorption spectrophotometer with acetylene as gas fuel. The results of heavy metal concentrations of the seagrass *Thalassia hemprichii* were Zn > Cr > Pb > Cd (mg/kg), while *Enhalus acoroides* were Cr > Zn > Pb > Cd (mg/kg). The results revealed that the heavy metal concentrations of the seagrasses were all classified as non-polluted except for the chromium concentrations of the seagrass *Enhalus acoroides,* which was slightly polluted. The results could be utilized also in policy decisions to strengthen the Butuan Bay integrated coastal resource management in addressing other environmental issues considering seagrasses, an important food stuffs' resource in the area.

KEYWORDS: Seagrass, Bioaccumulation, Heavy Metal, Tropical, Philippines.

INTRODUCTION

Seagrass is rapidly becoming the method to determine the overall health and condition of aquatic environment (Ahmad, et al. 2015). Seagrass has a remarkable metal bioaccumulation capacity since it interacts directly with both water column and pore water through the leaves and roots as ionic uptake, hence, it can reflect the overall health of coastal water (Llagostera *et al.*, 2011). Seagrass ecosystems are considered to be one of the indicators of heavy metal pollution in the coastal waters and assessment of heavy metal concentration in the coastal waters can be made by using indicator organism, particularly algae and seagrasses. Heavy metals are natural constituents in nature, usually occurring in low concentration under normal condition. Pollution of coastal environment by trace and heavy metal contamination may occur via input from point sources (industrial and urban), and diffuse sources (natural run-off and atmosphere deposition) (El-Hasan *et al.*, 2006).

Heavy metals are usually present in trace amounts in natural waters but many of them are toxic even at very low concentrations. Heavy metals contamination is becoming a serious issue of concern around the world as it has gained momentum due to the increase in the use and processing of heavy metals during various activities to meet the needs of the rapid growing population (Masindi and Muendi, 2018). These metal elements deposited in coastal systems can become incorporated into the environment and may influence chemical and biological processes in the water column, sediments and biota (Hart, 1982). Heavy metals and toxic pollutants from industrial and mining industries could be the probable source to water pollution in CARAGA Region. Significant surface water quality issues in Butuan Bay is brought by mining, palm and coconut oil processing and wood based industries, domestic wastewater, solid waste, and agro-chemical use (DPWH, 2003).

This study determined the heavy metal concentrations of Chromium, Cadmium, Lead and Zinc of the seagrasses *Enhalus acoroides* and *Thalassia hemprichii* in coastal waters of Butuan Bay particularly in Gosoon, Carmen, Agusan Del Norte, Philippines. The results information generated in this study will have an important impact on the possible risk of bioaccumulation of heavy metals by consumption of different marine organisms depending on the seagrasses. The results could be utilized in policy decisions to strengthen the Butuan Bay integrated coastal resource management in addressing other environmental issues of Agusan River basin considering the seagrasses, an important food stuffs resource in the area.

MATERIALS AND METHODS

The species of seagrass used in the study was based on the survey of the availability of the various locations where seagrass grows abundantly. The seagrass samples were collected in the coastal waters adjacent to the marine sanctuary of Gosoon, Carmen, Agusan Del Norte, Philippines. The collected seagrasses were washed thoroughly with tap water to remove all sand particles, and epiphytes. The heavy metals present in the seagrass samples were analyzed using Atomic Absorption Spectrophotometric method. The solid samples were subjected to dry ashing, and about 5 grams of the seagrass samples were extracted with aqua regia digestion. This was digested with 30 ml of the acid for two hours on a hot plate. It was then filtered and cooled using Whatman number 42 filter paper, and diluted to 100 ml with deionized water. The concentrations of the heavy metals lead, cadmium and chromium were then determined using a Perkin Elmer AAnalyst 200 atomic absorption spectrophotometer with acetylene as gas fuel.

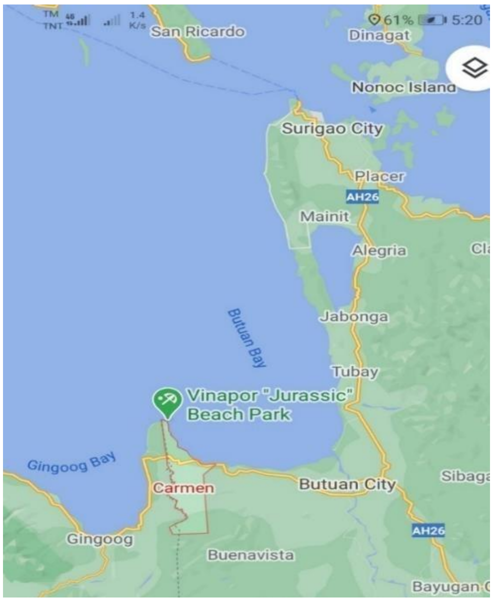

Figure 1: Map of Carmen, Agusan del Norte, Philippines Google map.

RESULTS AND DISCUSSIONS

Metal concentrations in seagrasses are influenced by several factors. According to Ledent *et al.* (1995), metal concentration shows a significant decrease with age, where metal concentration tended to be higher in young leaves than in adult leaves. Metals are actually not accumulated at levels much above those required for normal cell functioning but that there generally is a fairly close coupling between internal metal pools and leaves growth (Hemminga and Duarte, 2000). According to the Free Ion Activity Model (FIAM) proposed by Morel (1983), the interaction between heavy metals and aquatic organisms should be explained through chemical reaction of free and weakly complexed ionic species with geological membranes (Morel, 1983). Besides that, the concentration patterns in marine organisms are often varying specifically as can be predicted by toxicokinetic modeling (Luoma and Rainbow, 2005). As a result, different species of seagrass has greatly varying metal concentrations in the same body of ocean water (Kahle and Zauke, 2003) as cited by Besar et al., (2008). Metals introduced in soluble or colloidal forms into estuaries and coastal marine waters tend to either precipitate or absorb to suspended particulate matter and colloidal or dissolved organic matter (Salomons and Fostner, 1984).

Table 1: Heavy concentrations of the seagrasses *Enhalus acoroides* and *Thalassia hemprichii.*

Seagrass	Cd (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Zn (mg/kg)
T.hemprichii	0.899 ± 0.095	2.468 ± 0.503	11.353 ± 0.340	23.993 ± 1.026
E.acoroides	0.242 ±0.140	14.303± 3.50	25.133 ± 0.794	20.833 ± 0.799

Values are means ± SD for three determinations.

Table 1 shows the heavy metal concentrations of the seagrasses Enhalus acoroides and Thalassia hemprichii. Cadmium is a highly toxic element capable of causing severe toxicity even when it is at a low concentration of one mg/kg. The accumulation of cadmium in the human body may give rise to hepatic, pulmonary, renal, skeletal, reproductive effects, and even cancer. The highest and lowest Cadmium concentrations in seagrass species were found as 0.899 mg/kg in Thalassia hemprichii and 0.242 mg/kg in Enhalus acoroides. The Cadmium concentrations of the seagrasses were below the tolerable standard of cadmium metal content based on the Consensus-Based Sediment Guidelines CBSOG SQG*(2003), which is <0.99 and is classified as non-polluted.

Lead may be a non-essential heavy metal but may endure many adverse health effects, including neurotoxicity and nephrotoxicity. Exposure to high level of lead may cause anemia, weakness, and kidney and brain damage. Very high exposure to lead may also cause death. The highest and lowest lead concentrations in seagrass species were found as 2.468 mg/kg and 14.303 mg/kg in Thalassia hemprichii and Enhalus acoroides, respectively. The heavy metal concentrations of Pb of the seagrasses were below the tolerable standard of Pb metal content based on the United States Environmental Protection Agency (US EPA) and CBSOG SQG*(2003), which is <40 and is classified as non-polluted.

The presence of chromium in the diet can be of great importance due to its active involvement in lipid metabolism and insulin function. The highest and lowest chromium concentrations in seagrass species were found as 11.353 mg/kg in Thalassia hemprichii and 25.133 mg/kg in Enhalus acoroides. The Chromium concentration of the seagrass Thalassia hemprichii was below the tolerable standard of chromium metal concentrations based on the United States Environmental Protection Agency (US EPA), which is <25 and Consensus-Based Sediment Guidelines standard CBSOG SQG*(2003) which is <23 and is classified as non-polluted, while the chromium concentration of seagrass Enhalus acoroides was slightly higher on the tolerable standard of chromium metal concentrations based on the United States Environmental Protection Agency (US EPA), which is <25 and Consensus-Based Sediment Guidelines standard CBSOG SQG*(2003) which is <23 and is classified as polluted.

Zinc is one of the most commonly used metals and can enter the environment as a result of numerous industrial processes. Zinc is an essential heavy metal and its homeostasis reflects a balance between of dietary Zinc and loss of Zinc from the body. However, excessive exposure to Zinc can be harmful and have pathological consequences. It can also cause Zinc fever, a disease characterized by pulmonary inflammation.

The highest and lowest Zinc concentrations in seagrass species were found as 23.993 mg/kg and 20.833 mg/kg in Thalassia hemprichii and Enhalus acoroides, respectively. The heavy metal concentrations of Zn of the seagrasses were below the tolerable standard of Zn metal content based on the CBSOG SQG*(2003), which is <90 and is classified as non-polluted.

Similarly, in the study of Tupan *et. al*. (2014) of the seagrass *Thalassia hemprichii* in Ambon Island, Indonesia, the heavy metal concentrations of cadmium and lead was determined in the sediment of the water and seagrass part using Atomic Absorption Spectrophotometer. The results revealed that the concentrations of heavy metals of lead and cadmium were higher in sediments (0.135 to 0.309 Pbmg/kg and 0.107 to 0.190 Cd mg/kg) than in the seawater (0.013 to 0.084 Pb mg/kg and 0.032 to 0.071 Cd mg/kg). The highest metal concentrations of Pb and Cd were detected at the roots of 0.579 Pbmg/kg and 0.363 Cd mg/kg, then on leaves with values of 0.451 Pbmg/kg and 0.275 Cd mg/kg. These findings are supported by Smith (2018), who reported that heavy metals were detected in 79% of seagrass samples, including *Thalassia hemprichii* and *Enhalus acoroides*. Overall, 71% contained arsenic, 73% contained cadmium, 96% contained copper, 100% contained iron, 62% contained lead, 97% contained manganese, 74% contained mercury, 62% contained nickel, 48% contained selenium, and 100% contained zinc.

CONCLUSIONS

The results uncovered that the seagrasses have the ability to absorb and accumulate heavy metals on the tissues of roots, rhizomes and the leaves, hence, become good bioaccumulator as well as bioindicator for heavy metal pollution due to its specific anatomical responses to the pollutant. The heavy metal concentrations of the seagrasses were all classified as non-polluted except for the chromium concentration of the seagrass *Enhalus acoroides,* which was classified as slightly polluted. It is recommended that further study should be conducted also to find out the source of heavy metals pollution to the physical and biological aspects of the environment.

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