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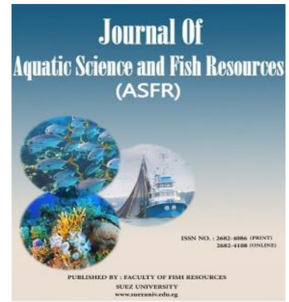

Monitoring of Some Heavy Metals in the Water and Three Submerged Plants in the Southern Part of Lake Manzala

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ABSTRACT

Due to their potential to absorb and accumulate toxic heavy metals, three species of submerged aquatic plants, namely Potamogeton pectinatus, Ceratophyllum demerssum, and Myriophyllum spicatum, were collected from ten different locations at the southern part of Lake Manzala and checked for the presence of heavy metals contents (Zn, Fe, Cu, Ni, Pb, and Cd); the values of contents, were expressed as mg/g dry weight of the analyzed plant. The studied metals were also detected in water samples. Potamogeton pectinatus and Myriophyllum spicatum are the most active in absorbing of Pb, Cd, Zn, Ni and Cu, respectively. Ceratophyllum demerssum immensely absorbed Fe and Pb. The present study reveals that the submerged plants critically absorb and displace heavy metals from marine environments and they probably reduced the effect of high concentrations of these metals on the lake ecosystem. The submerged plants could be used as bioindicators; bioaccumulating agents for heavy metals in polluted water. It can be used in the sustainable management of water streams.

1. Introduction

Benthos and aquatic macrophytes are outstanding biological filters. They can effectively purify water streams by capturing the dissolved toxins and metals within their tissues. Most of anthropogenic activities produce heavy metals as side effects that are released back into the environment (Shreadah et al,.2006; Nafea 2019a). Heavy metals are chemicals that are defined as toxic materials that are released into water, sediments, and the environment (Younis et al,.2018; Asamudo et al, 2005, Zou et al,.2019). Most of higher plants can dominate metal-enriched environments and some of them can accumulate very high concentrations of toxic metals within their tissues, somehow vital for their development (Nafea, 2019 a). These metals and semimetals include As, Mg, Cd, Mn, Pb, Zn, Cu, Mo, Ni, Cr, and Co. Theses metals are severely toxic or poisonous even in low concentrations (Harris and Santos, 2000).

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Heavy metals result from anthropological and industrial means, atmospheric pollution, and shore erosion. As ecological toxins, heavy metals immensely harm terrestrial and aquatic ecosystems (Guilizzoni, 1991; Nafea and Sera, 2020).

Aquatic macrophytes maintain a high potential of scavenging heavy metals from sediments and water (Younis and Nafea 2015). They also pose as biological filters for living materials–bound metals.

Accumulator species–Biomonitoring of pollutants relies heavily on plants with a high capacity of accumulating specific pollutants in concentration values surpassing that of the surrounding waters (Nafea, 2005; Younis et al., 2014; Nafea, 2016). Pollutants are present with high concentrations in organisms and sediments due to the environmental pollution level of the environment, whether past or recent pollution. On the other hand, pollutant concentrations in water are only indicative of the current season or timeframe when sampling occurred (Radwan and Shokier 2005).

The present study aims to assess the levels of heavy metals in water and the submerged aquatic plants in the southern part of Lake Manzala to be used in the monitoring of pollution to maintain a perpetual development and management of Lake Manzala.

2. Materials and methods

2.1. The Study Area

Lake Manzala is a transitional zone between land and sea located at the Northern Delta Wetlands of Egypt at River Nile's eastern side (Demitta branch). The lake interconnects with the sea through three narrow inlets (New and Old Elgamel and Eldepa). It lies between latitudes (31° 6' 30.4'' - 31° 29' 54.4'' N) and longitudes (31° 50' 13.8''- 32° 14' 52.1'' E). Fish farms, drains, villages, and agricultural lands frame the borders surrounding the lake, alongside ElSalam canal. The lake is a water reservoir used for irrigation (Donia and Hussein, 2004).

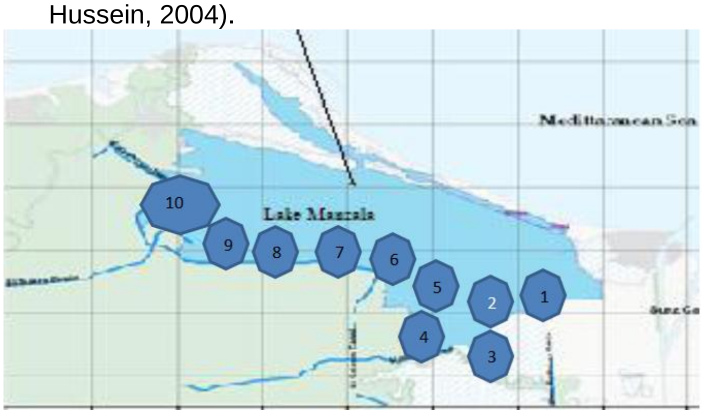

Figure 1. Location map of the study area (Lake Manzala)

The lake suffers from anthropogenic activities and sewage water containing toxic pollutants including heavy metals (Nafea, 2005).

Methods

The primary focus of the study was on investigating heavy metal contents in aquatic plants and surrounding water (the submerged aquatic plants were Ceratophyllum demerssum, Potamogeton pectinatus and Myriophyllum spicatum). The plant samples collection was carried out in the spring season from ten sites (five samples were investigated for each species) and water samples were collected from the same localities and then filtered through a Whatman glass-fiber filter (0.45 μm). Afterward, they were stored in a 0.5-L polypropylene bottle. 1.0 ml of concentrated nitric acid was added to each sample. Determination of metals in water adhered to the solvent extraction method (APHA, 1998).

Air-dried specimens for each species and sediments were mixed and analyzed for heavy metals via wet-digested means in a combination of concentrated nitric acid and perchloric acid (4:1 v/v) (Sawicka-Kapusta, 1978). The samples were assayed with a Perkin Elmer model 2380 Atomic Adsorption Spectrophotometer (A.A.S.). Bioaccumulation was taken into consideration and gauged according to Klavinš et al. (1998) as follows: BAF = M_tissue / M_water, where M_tissue is the concentration of metal in the plant tissue and M_water is the concentration of metal in water.

3. Result and Discussion

The southern part of Lake Manzala is subjected to pollution load through many drains and anthropogenic activities (Nafea, 2005; Nafea, 2019b).

Potamogeton pectinatus L. belonging to the family Potamogetonaceae, Ceratophyllum demerssum L. to Ceratophyllaceae, and Myriophyllum spicatum L. to Mriophyllaceae are the main submerged aquatic plants prevalent in the southern part of Lake Manzala (Nafea, 2005; Nafea and Zyada 2005).

The mean heavy metal concentrations in sediments, water, and plant specimens collected from the ten sites, as shown in Figures 2, 3, and 4, revealed that copper (Cu) was present in water and sediments in high concentration compared with the tested plants by 22.7, 32.6, and 7.3, respectively. While Fe was present with high concentrations in all the collected samples as in Figures 2, 3, and 4. Pb metal was recorded with higher contents in Potamogeton pectinatus, Myriophyllum spicatum and Ceratophyllum demerssum than in water and sediment as in Figures 2, 3, and 4. On the other hand, Ni was recorded with low values in water, sediments, and plant samples.

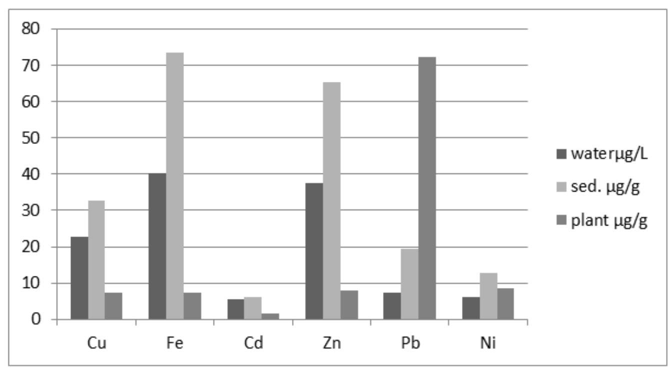

Figure 2. The mean heavy metal concentration in water, sediments, and Ceratophyllum demerssum

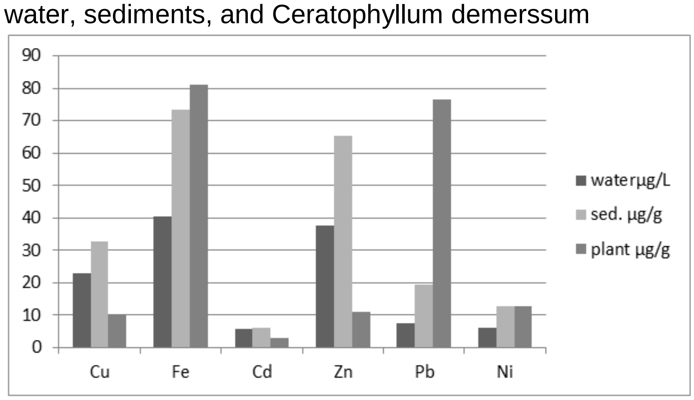

Figure 3. The mean heavy metals concentration in water, sediments, and Potamogeton pectinatus

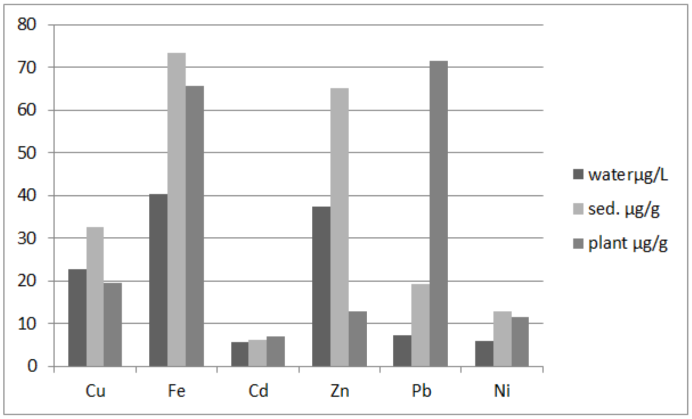

Figure 4. The mean heavy metals concentration in water, sediments, and Myriophyllum spicatum

The bioaccumulation factor for the different investigated heavy metals by submerged aquatic plants was as showed in Figures 5, 6, and 7. It was explained that Ceratophyllum demerssum accumulated a higher amount of Pb than Potamogeton pectinatus and Myriophyllum spicatum with percentages of 81%, 66%, and 34%, respectively. Ceratophyllum demerssum, Potamogeton pectinatus and Myriophyllum spicatum are good agents for biomonitoring Pb in water and could be used in bioremoving this metal from polluted water resources (Younis and Nafea, 2012 & 2015). Ni was Bio accumulated with higher values of 34% in Myriophyllum spicatum than the other tested plants Ceratophyllum demerssum and Potamogeton pectinatus which amounted to 12% and 13%, respectively. So, Myriophyllum spicatum could prove to be a good bioindicator and a bioaccumulation agent for the removal of Ni in water streams (Nafea and Zyada, 2015; Nafea, 2016).

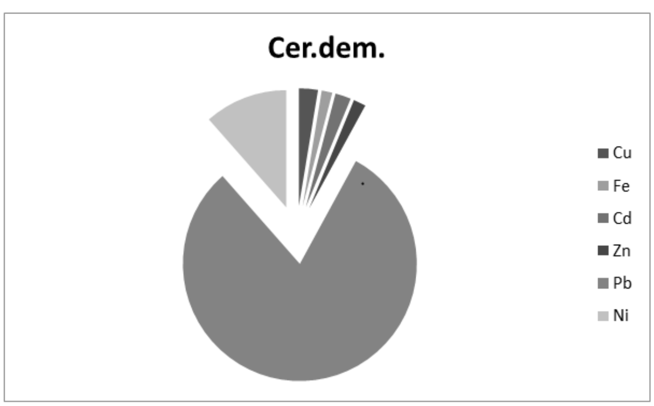

Figure 5. Bioaccumulation factor by Ceratophyllum demerssum

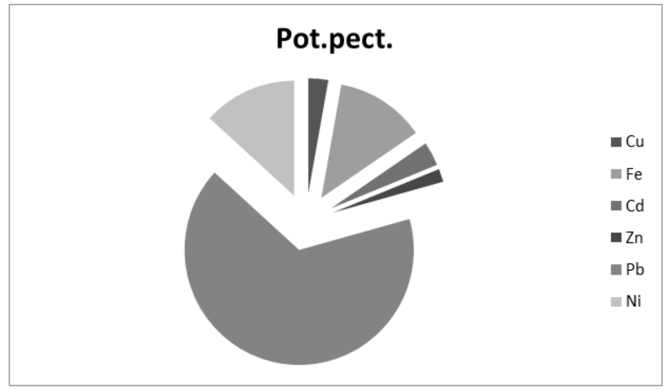

Figure 6. Bioaccumulation factor by Potamogeton pectinatus

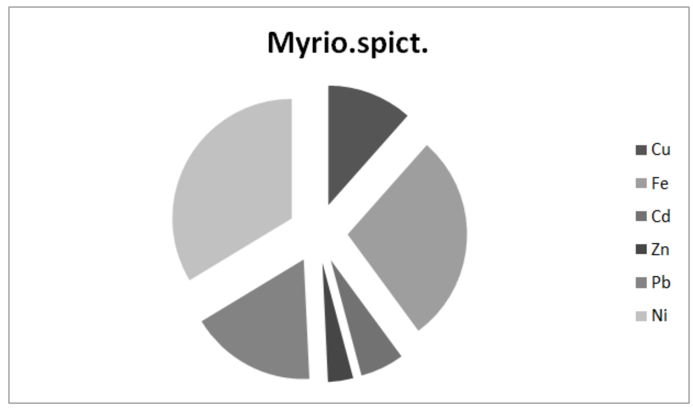

Figure 7. Bioaccumulation factor by Myriophyllum spicatum

From Figures 5, 6, and 7, it was observed that Myriophyllum spicatum is the best submerged aquatic plant for absorbing and accumulation for almost all heavy metals compared with the other tested submerged plants (Potamogeton pectinatus and Ceratophyllum demerssum) and could be used in biomonitoring programs and pollution control for waste-polluted water bodies as a sustainable treatment strategy and shows promise for wide-scale trials (Soliman, et al,.2018; Nafea, 2019a; Nafea and Sera, 2020).

Conclusion

In summary, it should be stated that the submerged aquatic plants (Myriophyllum spicatum, Potamogeton pectinatus, and Ceratophyllum demerssum) can grow in water polluted with a high content of heavy metals and absorb and accumulate Cu, Cd, Pb, Ni, Fe, and Zn in their tissues in large amounts. These plants could be used in bioremediation and natural treatment of polluted water and the restoration and rehabilitation programs as low-cost safe tools and bioremediation agents. Also, these plants could be used in phytoremediation and treatment of polluted and contaminated water in a safe and less costly manner.

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