THE USE OF AQUATIC MACROPHYTES FOR BIORREMEDIATION OF THE CASQUEIRO AND CUBATÃO RIVERS, CUBATÃO, SP

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ABSTRACT

Aquatic macrophytes, adapted to aquatic environments, are vital for ecosystems, influencing metabolism, nutrient cycling, and energy flow. These plants can absorb and store anthropogenic waste long-term, aiding in water purification. This study assessed three species of aquatic macrophytes in two rivers with different characteristics to evaluate their ability to absorb heavy metals and identify pollutants. Over a one-month period, the macrophytes were monitored and subjected to quantitative analysis using Total Reflection X-Ray Fluorescence (TXRF). The findings revealed significant variations in heavy metal absorption capacities among the different species. During the 30-day observation, all three species bioaccumulated substantial concentrations of heavy metals, though the levels varied. The study concludes that aquatic macrophytes are effective in absorbing heavy metals, highlighting their potential for use in the recovery and decontamination of aquatic ecosystems.

Keywords: macrophytes, heavy metals, bioaccumulation, absorption, bioremediation.

1 INTRODUCTION

Environmental contamination by heavy metals continues to be a challenge, despite decades of intense research. Remediation strategies such as physical, chemical and biological methods, although effective, are difficult to apply, expensive and can alter the properties of soil and water. Biotechnological solutions, such as phytoremediation, are showing promise, offering economical and viable alternatives for removing contaminants (CAMESELLE; GOUVEIA; URRÉJOLA, 2019). For example, Eichhornia crassipes can biodegrade inorganic pollutants concentrating various metal ions, such as copper (Cu), Cd, Cr, lead (Pb) and zinc (Zn) and has shown high efficiency in removing pollutants from water through bioaccumulation in its plant tissues (SHARMA et al., 2018). Samples were collected from the Casqueiro and Cubatão rivers in the Baixada Santista Metropolitan Region to assess the potential for restoring these bodies of water through phytoremediation with aquatic macrophytes, with the aim of making them usable and sustainable for local communities and for native fauna and flora. The principle of phytoremediation involves the ability of plants to tolerate the accumulation of heavy metals, maintaining their cellular functions even in the presence of these elements (COBBETT; GOLDSBROUGH, 2002). The macrophyte species used were: water hyacinth (Eichhornia crassipes), water lettuce (Pistia stratiotes) and Salvinia auriculata, which were assessed for their absorption of heavy metals from the Cubatão and Casqueiro rivers.

2 MATERIAL & METHODS

During the study, we sought to carry out a comprehensive and uniform sampling, using materials representative of the degree of pollution in the rivers. The samples were collected from the Casqueiro and Cubatão rivers, in Cubatão/SP, in the fall from Lagoa da Saudade, in Santos/SP, aquatic plants were collected with the aim of observing the influence of aquatic macrophytes on the bioremediation of heavy metals in rivers polluted by complex effluents. The study covered the municipality of Cubatão, in the metropolitan region of Baixada Santista, SP, which has a tropical climate, according to Pinton et al. (2003). The objective was to verify the heavy metals that the three species of aquatic macrophytes: water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*) and salvinia (*Salvinia auriculata*) were able to absorb. Samples of the polluted rivers were collected on the banks where access was possible. Data on pH, temperature, density and salinity were recorded. In the Casqueiro River, the values were: pH 7.8; average temperature 28.1°C; density 1015 kg/m³; salinity 21 ppm. In the Cubatão River, the values were: pH 9.2; average temperature 23.3°C; density 1007 kg/m³; salinity 15 ppm. After 30 days of storing the plants in polypropylene boxes with river water, the macrophytes were dried in an oven at 50°C for 48 hours, macerated to a powder, and 200 mg of each sample were placed in plastic eppendorf tubes. The masses of the macrophytes after drying and maceration were: 102.8 mg of water lettuce, 100.2 mg of salvinia, 100.9 mg of water hyacinth from the Casqueiro River; 101.8 mg of water lettuce, 100.4 mg of salvinia, 101.3 mg of water hyacinth from the Cubatão River. Triton X-100 1%, gallium (standard) and silicon were added to the tubes, which were analyzed by total X-ray fluorescence (TXRF) for 4 hours, with 120 minutes per sample. The TXRF analyzed all the chemical elements absorbed by the macrophytes, presenting the results in colored graphs. This portable spectrometer enabled rapid

quantitative microanalysis of chemical elements, identifying the contaminants absorbed by the macrophytes in the waters of the Casqueiro and Cubatão rivers after 30 days of exposure.

Figure 1: Where the aquatic plants were collected

Figure 2: Casqueiro River and Cubatão River water collection sites

Figure 3: The macrophyte species were observed for 30 days.

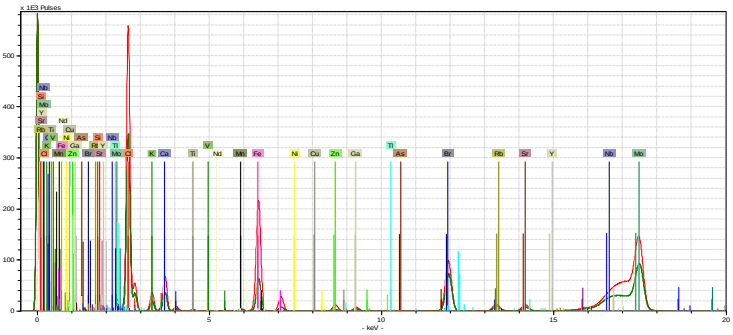
Figure 4: Preparation for the drying stage in the oven at 50ºC.

Figure 5: Maceration of the aquatic plants for analysis.

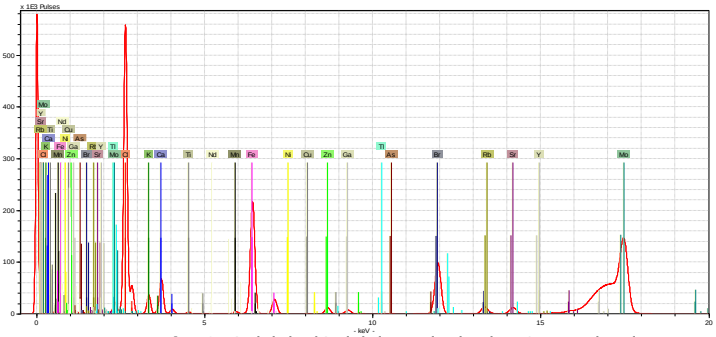
Figure 6: Plants analyzed.

3 RESULTS & DISCUSSION

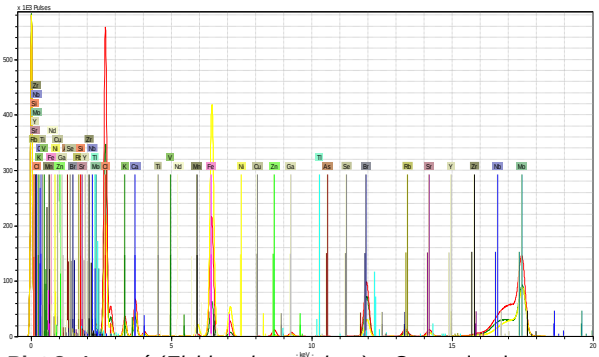
Among the observations made, it was found that during the 30 days that the three species remained in the polypropylene boxes they bioaccumulated many substances such as chlorine (Cl), iron (Fe), zinc (Zn), nobelium (No) and zirconium (Zr), in high concentrations as shown in the graphs of the two rivers with the three species of macrophytes studied. We also observed that each graph showed a different concentration level from the other with the same three species of macrophyte, because of how much heavy metal each macrophyte can absorb. This will help in the future to identify which species of aquatic macrophyte is best adapted to each environment. The graphs show that all three species of macrophyte were able to biocumulate different substances of heavy metals found in both rivers. Remembering that these metals in certain quantities are essential for the survival of the macrophytes, exceeding this limit amount can cause harm to them and to the fauna and flora in their surroundings, even to the communities that live on stilts where these macrophytes are found.



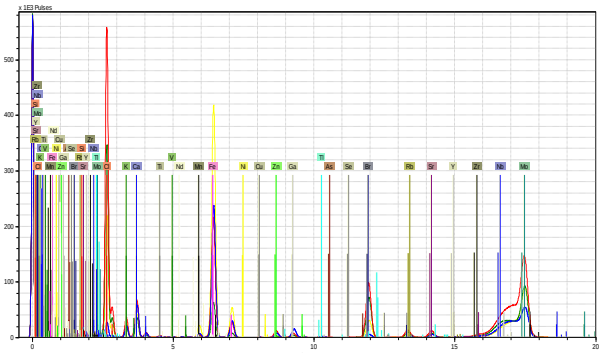
Plot 1: Alface d'água (*Pistia stratiotes*) – Casqueiro river



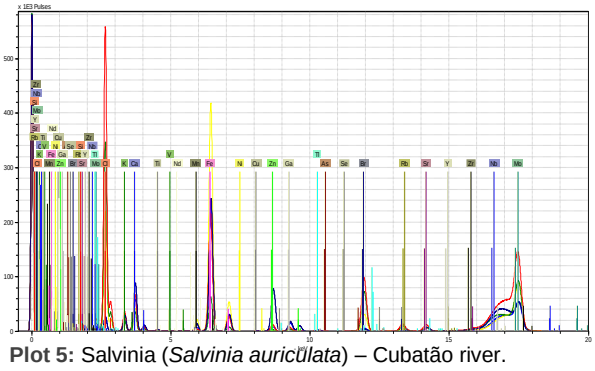
Plot 2: Salvinia (*Salvinia auriculata*) – Casqueiro river



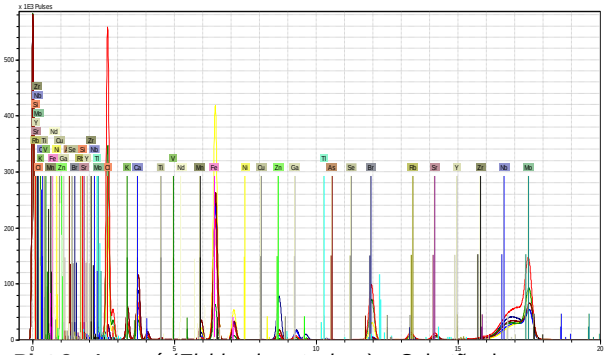
Plot 3: Aguapé (*Eichhornia crassipes*) – Casqueiro river



Plot 4: Alface d'água (*Pistia stratiotes*) – Cubatão river



Plot 5: Salvinia (*Salvinia auriculata*) – Cubatão river.



Plot 6: Aguapé (*Eichhonia crassipes*) – Cubatão river

CONCLUSION

The Total X-ray Reflectance Fluorescence (TXRF) technique was used to analyze and identify the heavy metals and chemical elements absorbed by aquatic macrophytes. The main objective is to explore the potential of these plants for future environmental remediation programs aimed at improving the water conditions of the two rivers investigated. This approach seeks to contribute to the restoration of the surrounding environment, as well as to the recovery of water quality in the rivers, which are currently subject to pollution from human activities.

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