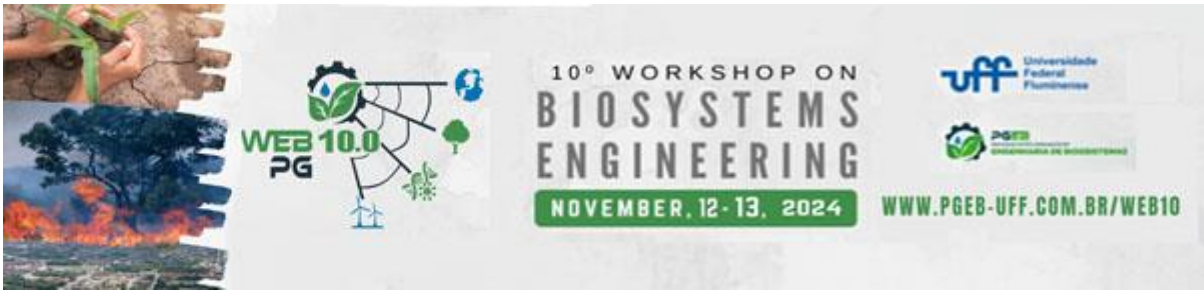


# INFLUENCE OF LEAD ON PH PARAMETERS AND ELECTRICAL CONDUCTIVITY OF WATER IN A PHYTOREMEDIATION PROCESS WITH MACROPHYTES

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**Abstract**

The increase in urbanization following the industrial revolution has led to a significant increase in the discharge of wastewater. One of the main pollutants most frequently found are heavy metals such as lead (Pb), which is harmful to the environment. Phytoremediation has emerged as a low-cost technology for decontaminating these environments. The effectiveness of this process depends on factors such as water pH and electrical conductivity (EC). The aim of this study was to assess how the pH and electrical conductivity parameters of the water were influenced by lead concentrations in a phytoremediation process using the macrophytes water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*). Twenty pots were used for each species, with the following Pb concentrations: 0 (control); 0.033; 1.65; 2.65; 3.3; mg.L-1. Water samples were taken at 8-day intervals and the pH and electrical conductivity parameters were analyzed in the laboratory 80 days after the end of the experiment. With regard to pH, it was possible to observe that there was statistical variability in all concentrations of the water hyacinth cultivation solution, except for 1.65 mg.L-1, while for the water lettuce solution there were no statistical differences on any day. As for the electrical conductivity, there was a similar behavior in the solutions of both species, with a statistical difference on the first day when compared to the others, which showed a much higher value, showing that there was a decrease in the solubility of metals in the medium over the 25 days due to natural evaporation.

**Keywords:** Eichhornia crassipes; Pistia stratiotes, Lead.

## INTRODUCTION

Population growth and urbanization following the industrial revolution have led to a significant increase in the discharge of wastewater from factories, which has aggravated water pollution worldwide. The main contaminants of water resources come mainly from industry, domestic sewage and agribusiness. One of the main pollutants found most frequently is heavy metals such as lead (Pb), which can be found solubilized or in particulate form and is harmful to water bodies and human health (DE LIMA et al., 2015).

To help decontaminate these environments, phytoremediation, also known as green remediation or agro-remediation, has emerged (SINGH; GUPTA; TIWARI, 2011). It is a technique that uses plants to degrade, extract, contain or immobilize contaminants in soils, surface water and groundwater.

The effectiveness of the phytoremediation process depends on several factors, such as water pH and electrical conductivity (EC). pH is a parameter that is directly linked to the availability and solubility of heavy metals in water. In conditions of extreme acidic or alkaline pH, the solubility of lead can increase or decrease, affecting the ability of macrophytes to absorb and accumulate this metal (LI; YU; LUAN, 2015). Electrical conductivity, on the other hand, gives the water's ability to conduct an electric current and is an important indicator of water quality, thus providing information on the presence of contaminants (JUSTINO, OLUKANNI, BABAREMU, 2022).

The aim of this study was to assess how the pH and electrical conductivity parameters of the water were influenced by lead concentrations in a phytoremediation process using the macrophytes water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*).

## MATERIALS AND METHODS

The experiment was conducted at the Gragoatá Campus of the Fluminense Federal University (UFF), in the municipality of Niterói-RJ, latitude 22º 54' 00“ S, longitude 43º 08' 00” W and altitude 8 m, in a greenhouse belonging to the Farmácia Viva herbal medicine program. The growing region has an Aw climate, according to the Köppen classification, which refers to a tropical climate with dry winters and rainy summers.

The experiment was carried out in plastic pots with a capacity of 20 L which were filled to a volume of 16 L with the water that supplies the greenhouse, where different concentrations of lead (Pb) were subsequently added. Two species of macrophytes were used, ***Eichhornia crassipes*** and ***Pistia stratiotes***, and only one plant was used in each pot.

The experimental design was entirely randomized and 20 pots were used per species, totaling 40 experimental units, with 4 replications per treatment. The experiment was separated into 5 treatments containing concentrations of: 0 (control); 0.033; 1.65; 2.65; 3.3; mg.L-1 of Sigma® brand lead nitrate, where the second concentration represents the maximum dose of lead contamination permitted by CONAMA for class 3 fresh surface water. The study period was 25 days, with no water replenishment and natural evaporation.

The parameters measured were pH and electrical conductivity, and for this purpose water samples were collected, following the guidelines of NBR 9898 of 1987, from the start of the experiment, at intervals of 8 days between each collection, using sterilized Falcon tubes, from 21/11/2023 to 15/12/2023. These samples were kept under refrigeration between 2º and 4ºC for a period of 80 days, due to the laboratory's material analysis line, for later analysis in the laboratory at the end of the experiment.

To assess the pH parameter, a Quimis manual pH meter was used, which was initially calibrated with a buffer solution with a pH equal to 7. Each sample was then calibrated individually and the electrode was cleaned with distilled water after each measurement to avoid contaminating the material.

For conductivity, a Digimed manual conductivity meter was used, which was initially calibrated with a standard solution. Each sample was then measured individually, and the electrode was cleaned with distilled water after each measurement in order to avoid contaminating the material. The results were presented on the mS.cm-1 scale (millisiemens per centimeter). At the end, all the results were analyzed statistically using the SISVAR® program.

## RESULTS AND DISCUSSION

With regard to the pH value, which measures the concentration of hydrogen ions ($H^+$) present in the solution, the water hyacinth macrophyte showed results below 7.0 on all days and for all treatments. It can be seen that there was statistical variability in all the concentrations of the solutions containing lead or not, except for 1.65 mg.L-1 (Figure 1a), which can be explained by the possible phytoremediation process of the plants (FREITAS et al., 2021). It is important to note that *Eichhornia crassipes* is a species that grows best at neutral to slightly alkaline pH (SOUZA et al., 2018). It is therefore possible to understand that the environment was not suitable for the plant's development.

Water lettuce, on the other hand, is a macrophyte that prefers a neutral to slightly acidic environment (VÁZQUEZ et al., 2021), which may favor its phytoremediation potential as it is in its suitable environment. Figure 1(b) shows that there were no statistical differences on any day for any of the treatments. The pH of the control solutions and those containing the other doses of lead remained at around 5.5 to 6.0, which made the environment extremely favorable for the development of this species.

Defining the pH range where the plant is being grown is extremely important for the development of the species and for the efficiency of the phytoremediation process (SALEEM et al., 2020). In this way, it can be said that the growing environment is favoring the development of ***Pistia statriotes*** and, consequently, its phytoremediation process.

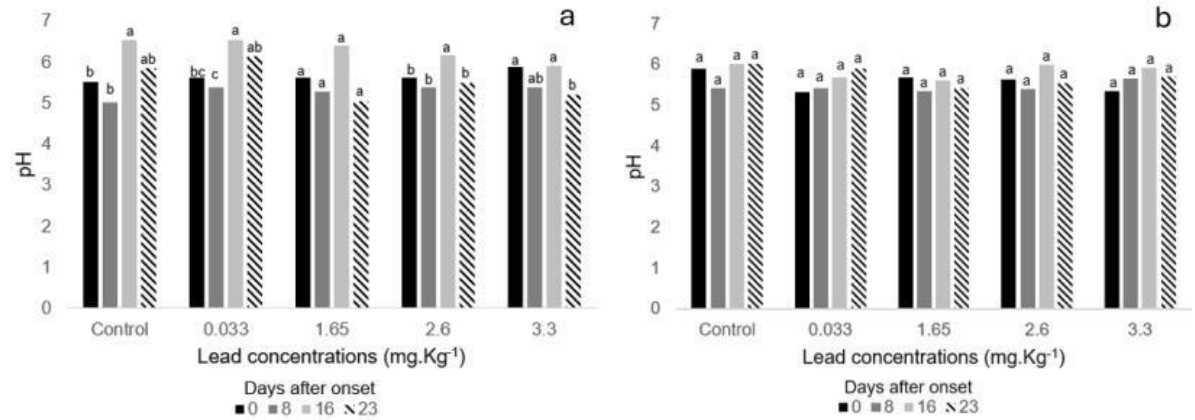


Figure 1: pH of the aqueous solution used to grow the macrophytes: a- water hyacinth (*Eichhornia crassipes*); b- water lettuce (*Pistia stratiotes*). The lead concentrations used were: 0 (control); 0.033; 1.26; 2.66; 3.3 (mg. L-1). Equal letters within concentrations do not differ statistically from each other using the Tukey test at 5%. Values represent the average of n=5

Electrical conductivity is an important parameter to monitor in the phytoremediation process. In processes involving contaminants such as heavy metals like lead, it is extremely important because the higher the electrical conductivity, the greater the presence of these metals in the medium (DEY et al., 2021).

In this sense, a similar behavior can be observed for the solutions of both species, *Eichhornia crassipes* and *Pistia statriotes*, in all treatments (Figure 2 ab). There was a statistical difference between the first day and the others, which showed a much higher value, showing that the solubility of the metal in the medium decreased over the 25 days. This can be explained by the fact that water was not replenished during this period, causing natural evapotranspiration and reducing the solubility of lead in the medium.

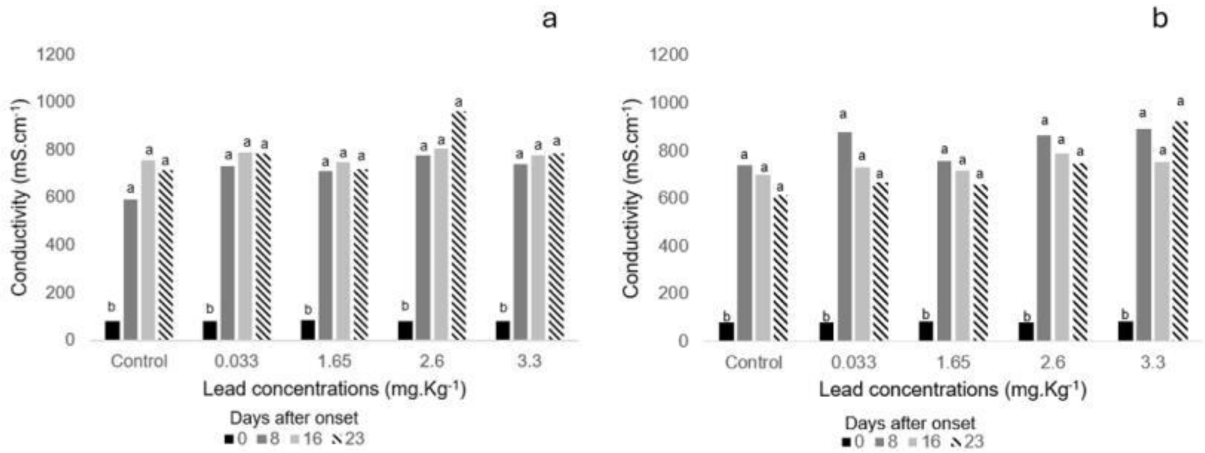


Figure 2: Electrical conductivity (mS.cm-1) of the aqueous solution used to grow the macrophytes; a- water

hyacinth (*Eichhornia crassipes*); b- water lettuce (*Pistia stratiotes*). The lead concentrations used were: 0 (control); 0.033; 1.26; 2.66; 3.3 (mg. L-1). Equal letters within concentrations do not differ statistically from each other using the Tukey test at 5%. Values represent the average of n=5

**CONSIDERATIONS**

Although the water hyacinth culture solutions, whether they contained lead or not, showed statistical differences for pH within the four treatments, all of them were below the reference value for optimum development. As for the conductivity parameter, all the concentrations showed statistical differences between the first and the remaining days.

On the other hand, the solutions used to grow water lettuce showed no statistical differences for pH, and the values are within the range indicated for the species. As for conductivity, it showed the same behavior as water hyacinth. Thus, it can only be said that the environment favors the development of *Pistia stratiotes*, which can help in the phytoremediation process.

**REFERENCES**


DE LIMA, D. P. et al. Heavy metal contamination in fish and water from cassiporé river Basin, state of Amapá, **Brazil. Acta Amazonica**, v. 45, n. 4, p. 405–414, 1 out. 2015.

DEY, M.; AKTER, A.; ISLAM, S.; DEY, S. C.; CHOUDHURY T. R.; FATEMA, K.J.; BEGUM, B.A. Assessment of contamination level, pollution risk and source apportionment of heavy metals in the Halda River water, Bangladesh. **Heliyon.** 2021 Dec 17;7(12): e08625.

JUSTINO, L. D.; OLUKANNI, D. O.; BABAREMU, K. O. Performance assessment of local aquatic macrophytes for domestic wastewater treatment in Nigerian communities: A review. **Heliyon**. 2022 Aug 12;8(8): e10093.

LI, J.; YU, H.; LUAN, Y. Meta-Analysis of the Copper, Zinc, and Cadmium Absorption Capacities of Aquatic Plants in Heavy Metal-Polluted Water. **Int J Environ Res Public Health**. 2015 Nov 26;12(12):14958-73. doi: 10.3390/ijerph121214959. PMID: 26703632; PMCID: PMC4690895.

SALEEM, M. H.; ALI, S.; HUSSAIN, S.; KAMRAN, M.; CHATTHA M.S.; AHMAD, S.; AQEEL, M.; RIZWAN, M.; ALJARBA N. H.; ALKAHTANI, S.; ABDEL-DAIM, M. M. **Flax *(Linum usitatissimum* L.): A Potential Candidate for Phytoremediation?** Biological and Economical Points of View. Plants (Basel). 2020 Apr 13;9(4): 496.

SINGH, D.; GUPTA, R.; TIWARI, A. Phytoremediation of lead from wastewater using aquatic plants. **International Journal of Biomedical Research**. [s.l: s.n.].

SOUZA, T. D.; BORGES, A. C.; MATOS, A. T.; VELOSO, R. W.; BRAGA A. F. Optimization of arsenic phytoremediation using *Eichhornia crassipe*s. **Int J Phytoremediation**. 2018 Sep 19;20(11):1129-1135.

VÁZQUEZ, J. G., HERNÁNDEZ-FERNÁNDEZ, L., HERNÁNDEZ, L., PÉREZ-BONACHEA, L., & CAMPBELL, R. (2021). Physiological and biochemical response of water lettuce (*Pistia stratiotes*) to short-term mild saline stress. **J Plant Physiol Pathol** 9: 10, 269, 2.

FREITAS, F.; VENDRUSCOLO, S.J.; SOARES, M.A.; BATTIROLA, L.D.; ANDRADE, R.L.T. Biomass of the macrophyte remedies and detoxifies Cd(II) and Pb(II) in aqueous solution. **Environ Monit Assess**. 2021 Jul 30;193(8):537.

**ACKNOWLEDGMENTS**

This study was carried out with the support of the Coordination for the Improvement of Higher Education Personnel (CAPES).

**PRESENTATION:** https://youtu.be/GZu22fzWSJI