The arsenic removal efficiency of *Eleocharis macrostachya* in constructed wetlands with subsurface flow.

M.A. Olmos-Marquez[1], A. Benavides[1], M. Rosette[2], M.T. Alarcón-Herrera[1]

[1]Centro de Investigación en Materiales Avanzados, Ave. Miguel de Cervantes #120,Chihuahua, Chih., C.P. 31109, México. (**mario.olmos@cimav.edu.mx**, **alejandro.benavides@cimav.edu.mx** **teresa.alarcon@cimav.edu.mx**).
[2]Facultad de Zootecnia de la UACH, Perif. Francisco R.. Almada S/N, Chihuahua, Chih; C.P. 31114, México (**mine_rosette@hotmail.com**).

INTRODUCTION

Arsenic is a metalloid naturally present in the underground sources of human drinking water, with the damage to public health that this entails. At present, reverse osmosis is the most popular arsenic removal process. The greatest limitation of this process is the amount of water that the process rejects, sometimes in the order of 50%. This feature and the system's high operation cost make it prohibitively expensive for many communities, especially in rural areas; it is therefore necessary to find alternatives for arsenic removal. Constructed wetlands have been considered a viable option for As removal in previous studies by our work group and other researchers (Alarcón-Herrera et al., 2007; Núñez-Montoya et al., 2007; Elless et al., 2005). The objective of the present study was to determine the efficiency of *E. macrostachya* at removing arsenic from a system of constructed wetlands with subsurface flow, as well as the plant's acclimatization and tolerance to high As concentrations, in order to verify the feasibility of using it at a greater scale for the treatment of the water rejected by reverse osmosis systems.

METHODOLOGY

Experimental design

The experiment was performed over a period of 7.5 months in a system with three prototype constructed wetland units, all operating with subsurface flow. The employed support medium was silty sand. Two of the units (H1 and H2) were planted with 27 groups of *E. macrostachya* plants, with an average of 50 individuals per group and a separation of 0.10m between groups. The third unit was used as a blank (H3), with a silty sand substrate but no plants. Two influx arsenic concentrations (0.1 and 0.5mgL^{-1}) and two retention times (2.3 and 1.0 d^{-1}) were used during the experiment.

Sampling and analysis of water, soil and plants

Water samples were collected at the entrance and exit of the wetlands throughout the experiment. An atomic absorption spectrophotometry equipment with hydride generation was used for the analysis of the water samples and the plant samples with low arsenic concentration, after acid digestion in a microwave oven. A sampling of soil and plants (roots and stems) was performed on the wetlands at the end of the experiment, in order to determine the total arsenic content. A plasma emission spectrophotometer (ICP-OES) was used for the soil and plant analysis, as well as that of samples with high arsenic concentrations.

Monitoring the acclimatization and tolerance of E. macrostachya to arsenic.

Counts of the number of individuals per wetland were used to determine the level of tolerance and reproduction of the plant to the As concentrations used during the experiment. Regular

measurements were performed on 81 previously identified individuals at different stages of the experiment, in order to determine the growth and acclimatization of the plants subject to different arsenic concentrations.

RESULTS AND DISCUSSION

Arsenic removal from the treated water shows 99% efficiency for the test period with the highest feedwater concentration (0.5mgL^{-1}), and 89% efficiency for the test stage with the lowest As concentration (0.1mgL^{-1}). Based on these results, one can deduce that the concentration at the system entrance has a heavy influence on the system's operation efficiency; higher entry concentrations lead to higher arsenic removal efficiency (Figure 1). The removal efficiency of the wetland with no plants (H3) was of only 23% at the end of the experiment, which shows the importance of the plants in arsenic removal.

The system as a whole (soil + plants) was capable of efficiently removing arsenic from water, and even of keeping As concentrations in the treated water under 0.025mgL^{-1}, the maximum value allowed for drinking water in Mexico (NOM-127-SSA-1994). The maximum reproduction percentage presented by the plants in both wetlands was greater than 116%, and the maximum height it reached was 200cm. The arsenic concentrations at the end of the experiment in the roots of the plant and in the system soil were 48 and 13 mg-kg^{-1}, respectively, indicating that the plant retained 3.7 times the amount of As retained by the soil around it.

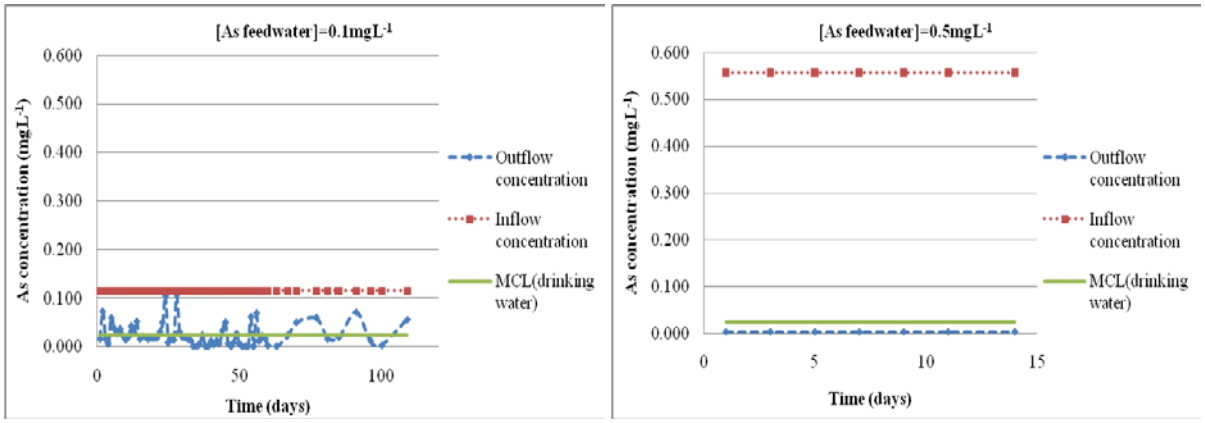

Figure 1.-Influence on treatment efficiency of the arsenic concentration in the wetland feedwater.

CONCLUSIONS

The obtained results show that constructed wetlands have a high potential for reducing high arsenic concentrations in water. Because of this, they can be used both for arsenic removal from drinking water and for the treatment of water rejected by reverse osmosis systems.

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