Removal of As(III) and As(V) from aqueous solution via tomato seedling (Solanum lycopersicum) phytoremediation

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Abstract

Solanum lycopersicum has shown effectiveness at removing pollutants present in the environment and was investigated on its capacity to remove As(III) and As(V) ions from solution. The tomato seedlings are germinated for two weeks, exposed to sunlight for one week and placed in nutrient solution for three weeks while exposed to UV light. The seedlings are then contaminated with arsenite and arsenate at concentrations of 1 ppm, 2 ppm, and 5ppm arsenic. The capacity of tomato seedlings to absorb and store arsenic was determined based on a dry mass bias.

Introduction

Residential soil has been contaminated with arsenic for years due to usage of herbicides, pesticides, insecticides, and many industrial activities. Due to their high toxicity, it has been shown that arsenic (III) and arsenic (V) can lead to multiple health threats such as liver disease, cancer, coma or even death.

Fortunately, phytoremediation is a cost-effective and non-invasive technique that has been employed to remove contaminants from the soil and groundwater.

Methods

Germination Process	Seeds are placed in the incubator for 2 weeks and the seedlings grow for 4 weeks with air supply and UV light
Arsenic Treatments	Tomato Seedlings are contaminated for two weeks with arsenate and arsenite at different concentrations (1ppm, 2ppm and 5 ppm)
Lyophilization	Samples were lyophilized for three days in a freeze dry system (Labconco)
Digestion	Samples are ground and digested with conc. HNO3 and H2O2 for several hours.

ICP-OES	
Replicates	3
Plasma Flow	15 L/min
Auxiliary Flow	0.2 L/min
Nebulizer Flow	0.55 L/min
Sample Flow	1.50 mL/min
Injector	2.0mm alumina

Results

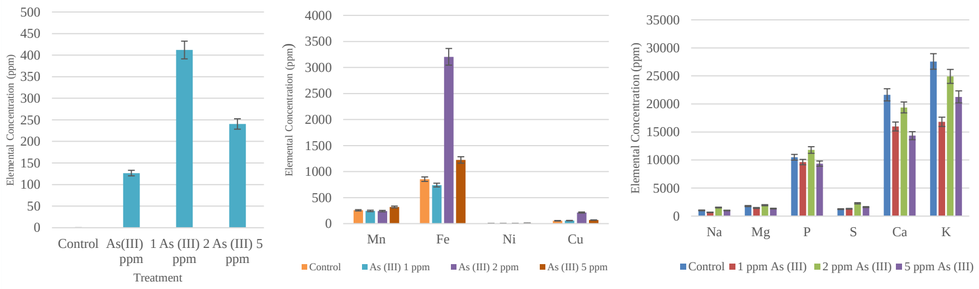

Figure 1: A. As(III) accumulated in roots of Solanum Lycopersicum. **B.** Concentration of macronutrients accumulated in Solanum Lycopersicum after treatment with As(III). **C.** Micronutrients accumulated in Solanum Lycopersicum with As(III).

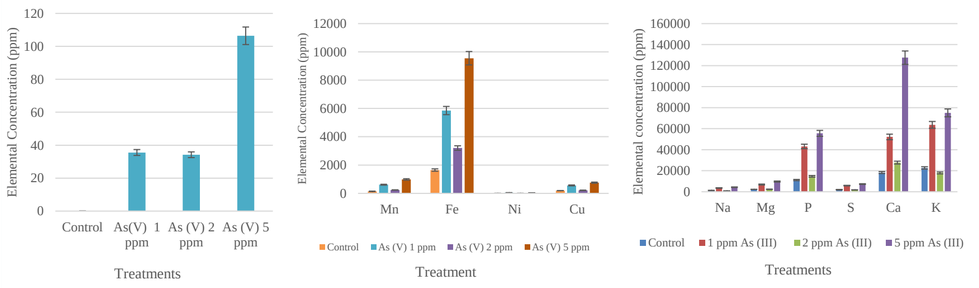

Figure 2: A. As(V) accumulated in roots of Solanum Lycopersicum. **B.** Concentration of macronutrients accumulated in Solanum Lycopersicum after treatment with As(V). **C.** Micronutrients accumulated in Solanum Lycopersicum after treatment with As(V).

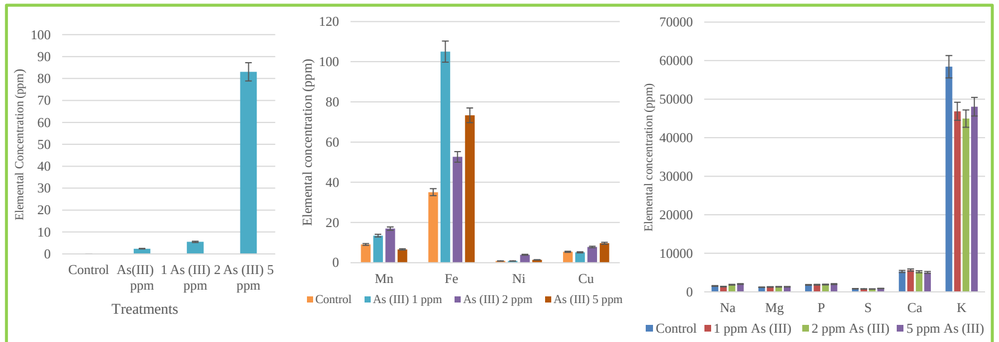

Figure 3: A. As(III) accumulated in Stems of Solanum Lycopersicum. **B.** Concentration of macronutrients accumulated in Solanum Lycopersicum stems after treatment with As(III). **C.** Micronutrients accumulated in Solanum Lycopersicum stems after treatment with As(III).

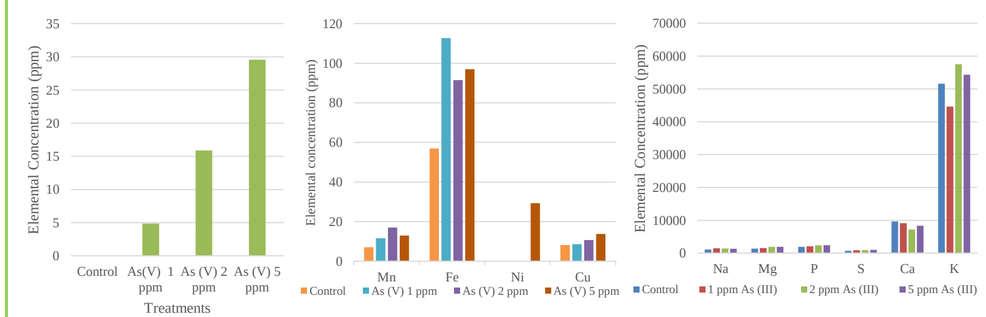

Figure 4: A. As(V) accumulated in Stems of Solanum Lycopersicum. **B.** Concentration of macronutrients accumulated in Solanum Lycopersicum stems after treatment with As(V). **C.** Micronutrients accumulated in Solanum Lycopersicum stems after treatment with As(V).

Results

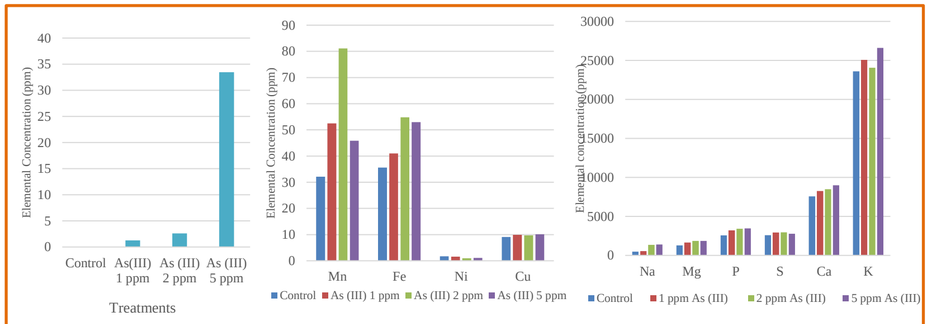

Figure 5: A. As(III) accumulated in leaves of Solanum L. **B.** Concentration of macronutrients accumulated in Solanum L. leaves after treatment with As(III). **C.** Micronutrients accumulated in Solanum L. leaves after treatment with As(III).

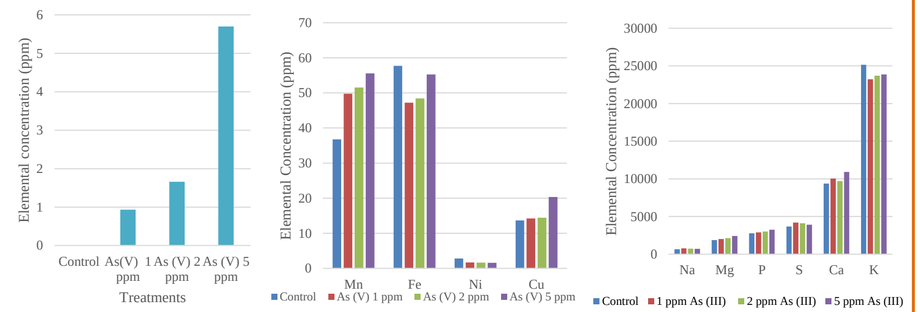

Figure 6: A. As(V) accumulated in leaves of Solanum L. **B.** Concentration of macronutrients accumulated in Solanum L. leaves after treatment with As(V). **C.** Micronutrients accumulated in Solanum L. leaves after treatment with As(V).

Discussion

- As (III) accumulated in roots of Solanum Lycopersicum is higher for the 2 ppm treatment. As (V) accumulated in roots of Solanum Lycopersicum is higher for the 5 ppm treatment. Overall, roots of tomato seedlings remove more As (III) than As (V) from aqueous solutions
- Small amounts of Arsenic are translocated to the stem of tomato seedlings. Seedlings contaminated with 5ppm of As (III) uptake the highest amount of arsenic.
- Even smaller amounts of arsenic are translocated to the leaves of Solanum L. The highest amount belongs to the treatment of 5ppm As(III).
- Fe and P concentrations increase when roots absorb more arsenic.
- Stem accumulates more Fe when in contact with high amounts of arsenic, Ni uptake increases when tomato seedling is contaminated with 2 ppm As (V) treatments.
- Iron uptake by tomato seedlings increases when the plant is exposed to As (III) and (V). Most macro and micronutrients uptake increases when Solanum L. is exposed to As (III) and (V). However, K accumulation in leaves decreases when plant is exposed to As(V).

Acknowledgements

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