ANALYZING THE DETOXIFICATION OF CR(VI) TO CR(III) AND MN(II) TO MN(III) THROUGH PHYTOREMEDIATION USING X-RAY ABSORPTION SPECTROSCOPY

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ABSTRACT

Our experiment's purpose is to identify the reduction of Chromium (VI) and oxidation of Manganese (II) within Helianthus Annuus via phytoremediation. Phytoremediation is a process that plants use to detoxify metals in soil or groundwater by altering their oxidation state. The experiment will involve the maturation of Helianthus Annuus in an environment saturated with Chromium (VI) and Manganese (II), which are delivered by manganese gluconate and potassium dichromate. The experiment will utilize the APS by employing the XANES method to produce data that shows the oxidation states of Chromium and Manganese within various sections of the flowers. The results are anticipated to show the reduction of Chromium (VI) to Chromium (III) and oxidation of Manganese (II) to Manganese (III) within the roots and leaves of the plants when compared to a control.

MOTIVATION

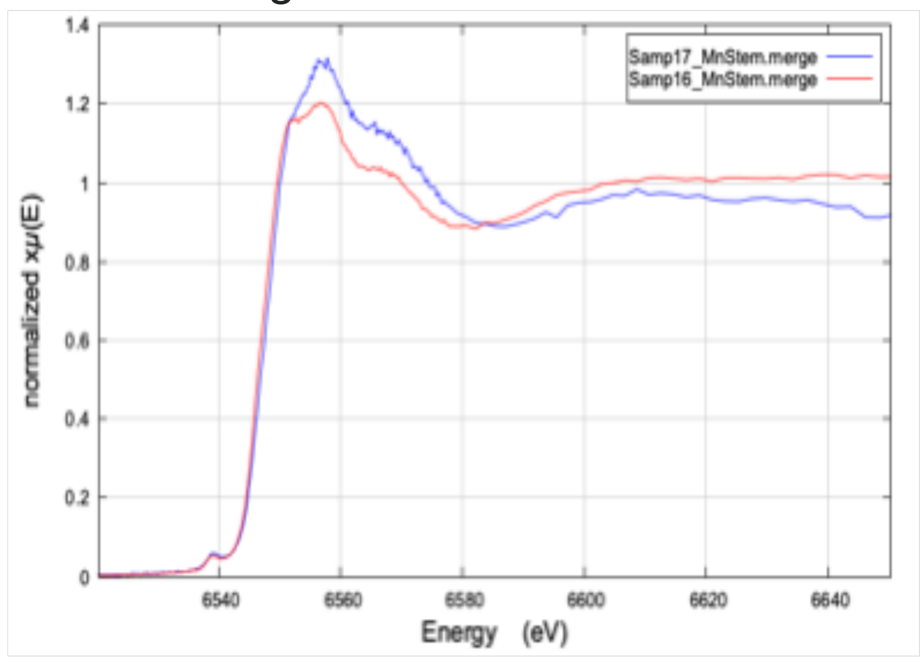
Chromium (VI) and manganese (II) are toxic metals that are known to be detrimental to the environment. They contaminate bodies of water and soil, making future growth difficult. Also, both metals have proven to be dangerous to several organisms, including humans. Cr (VI) has been known to cause stomach cancer, as well as skin burns and pneumonia. Furthermore, Mn (II) has been identified as a brain and respiratory carcinogen. Sunflowers are classified as hyperaccumulators, meaning they can absorb certain heavy metals through their roots without showing significant signs of toxicity. Due to this characteristic, our experiment tested if sunflowers would oxidize Mn (II) to Mn (III) and reduce Cr (VI) to Cr (II), less toxic states of these heavy metals.

SAMPLE PREP AND METHODS

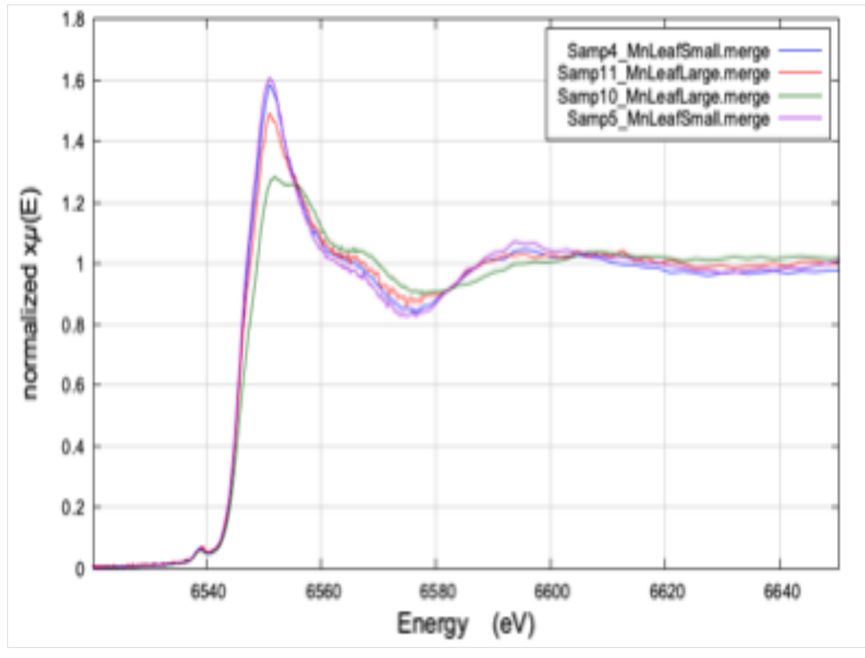
The plant chosen was sunflowers because of their classification under hyperaccumulators, otherwise known as plants that can absorb large amount of metals from the environment. Since they are also fast growing, the experiment was able to be completed within the allotted time for sample prep. Each plant was grown in an individual container and the growth of the plants every 2-3 days was recorded. Once the healthiest three plants were determined after a large stretch of time, the metal solutions began to be added daily. One plant received .1 M manganese (II) gluconate, another .1 M potassium dichromate, and the third was used as a control. These plants were then grown for an additional two weeks, continued flow of solution every 2-3 days. Once the day of research came, parts of the plants were broken off and placed into the accelerator, organized by stem, leaf, and root.

RESULTS

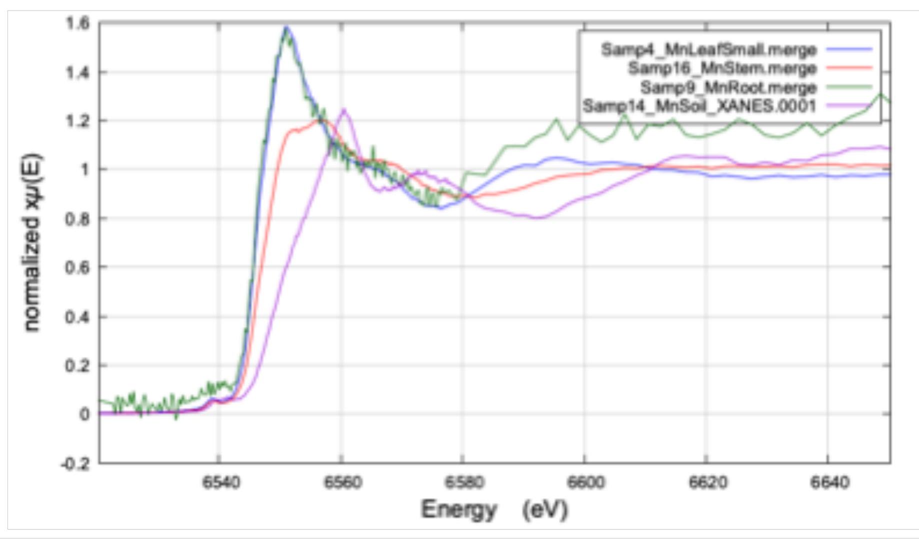
Cr- There was no detectable Cr in the stem nor the leaves of the sunflower plants. Indicated that while sunflowers are a hyperaccumulator, they are not effective at accumulating Cr.



Mn Stem (Figure 1)
The near-edge spectroscopy of the stem has an edge position that indicates the presences of Mn2O3.



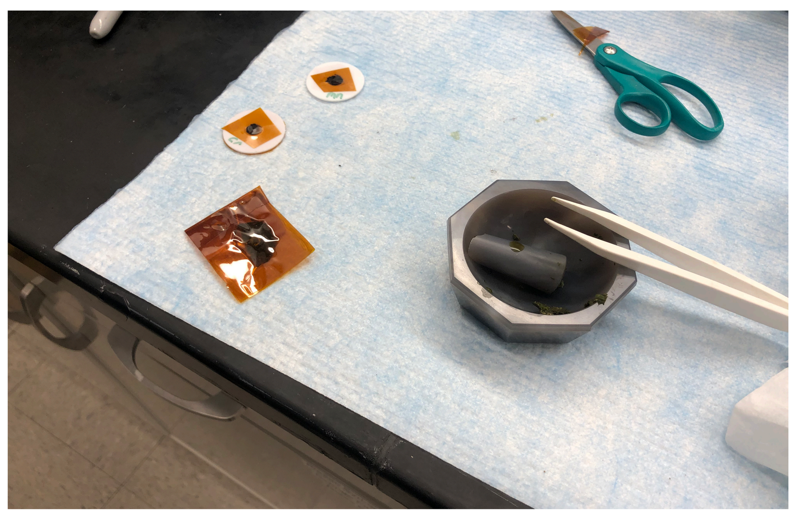
Mn Leaf (Figure 2)
The graph has an average edge position that indicates the presences of MnO. Compared to Figure 1, this difference in edge position shows that Mn has been oxidized from 3+ to 2+.



Comparison (Figure 3)
This graph directly compares the near-edge spectroscopy of the leaf, stem, root, and soil. There is a shift in edge position between the stem and the leaf of the sunflower showing an oxidation of Mn taking place in the plant.

CONCLUSION

The data indicated that there was no detectable Chromium accumulated in stem or leaves of the plant. Although sunflowers are hyperaccumulators, they are not effective at accumulating Chromium. There was, however, a presence of Manganese (II) in all parts of the plant. Through the data, the edge position indicated that oxidized Manganese is present in the stem and leaf as seen in the shift in edge position. The Manganese is oxidized within the stem and leaf as seen in the shift in edge position in comparison to the root and soil. Contrary to the hypothesis, sunflowers only oxidize Manganese, and have no noticeable effect when exposed to chromium . This proves that although sunflowers are hyperaccumulators, they can only uptake certain metals.



NEXT STEPS

According to the EPA's National Priorities List, chromium has been found in at least 66% of hazardous waste sites since 2007. Shown through the results of our experiment, the sunflowers did not absorb Cr (VI). Therefore, it can be assumed that sunflowers can survive in a chromium-contaminated environment, so while fields of sunflowers exposed to chromium VI may not help the environment through phytoremediation, they provide an opportunity to utilize the land contaminated by toxic chromium. Our data also shows that the sunflowers oxidized harmful Mn (II) into a less toxic oxidation state, Mn (III). Due to this quality, sunflowers could be planted in facilities that produce toxic Mn (II) waste, oxidizing it to Mn (III), therefore reducing the amount of toxic Manganese released into the environment.

ACKNOWLEDGEMENTS

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