ESRP: COMPARATIVE CHEMICAL ANALYSIS OF SOIL CONTAMINATION USING HYPERACCUMULATORS

What are the effects of growing vegetables in treated lumber raised beds vs. natural wood?

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INTRODUCTION

The research team chose this project because gardening became a common hobby during the beginning of the pandemic, and wanted to see if EPA-approved lumber treated with copper and other metal compounds was entirely safe or if there were risks associated with its use. The research team spoke to hardware store employees and discovered that lumber treated with micronized copper azole and western red cedar were the most common types of lumber bought for gardening.

The most popular type of lumber used by the common gardener was reported t be the treated lumber because it was cheaper, more weather/insect resistant, and longer-lasting compared to untreated lumber. Since 2003, the EPA made an agreement with preservative manufacturers to stop the production of CCA-treated wood. At this time the manufacturers started using micronized copper azole (CBA) and various other copper compounds to treat lumber. Even though these copper species are considered less toxic than CCA, they may still pose health risks. It is known that exposure at high concentrations of copper can induce abdominal pain, hematemesis, melena, jaundice, norexia, severe thirst, diarrhea, vomiting, altered mentation, headache, coma, tachycardia, depression, fatigue, irritability, excitation, and difficulty focusing.

At what exposure levels this is of concern is unclear. Although the amount of copper released by the treated wood to soil is likely low, some edible plants have the potential to hyperaccumulate Cu. We proposed to grow hyper accumulating plants in CBA contaminated soil in order to identify if these plants would absorb more copper or other heavy metals more readily. The research team hypothesized that if these plants were grown in planters made of treated lumber that they would show an increase in absorption of copper.

PROCEDURES

Two planter boxes were constructed using western red cedar and lumber treated with micronized copper azole. Seeds of *ipomea aquatica, brassica juncea* and *spinach oleracea* were planted in each box with standard potting soil and were left for observation in the LTHS greenhouse. The conditions of the plants were monitored daily as they were watered and kept within a controlled temperature. Several weeks later, the planter boxes were relocated indoors to continue their growth under grow lamps. To prepare the samples, plants were picked, rinsed, and the roots were removed. Cleaned plant samples were then stored in moist paper towels and delivered to the beamline

The team collected data at the APS at Argonne National Lab using beamline 13-ID-E. The incident beam had energy 11 keV, tuned using Si(111) monochromator. The 2 µm focused beam was used for analyses, focused using Kirkpatrick-Baez focusing mirrors. X-ray fluorescence data was collected using 4-element Vortex silicon drift detector.

Finally, we collected our data using LARCH. It allowed us to identify specific metals up taken in various parts of each leaf.

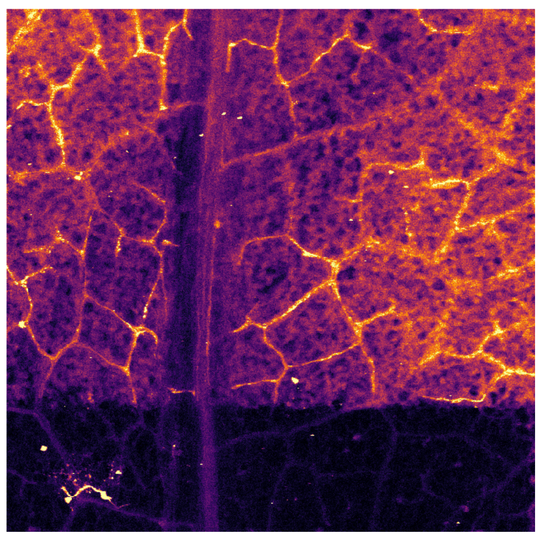

Figure 1: Spinach untreated map

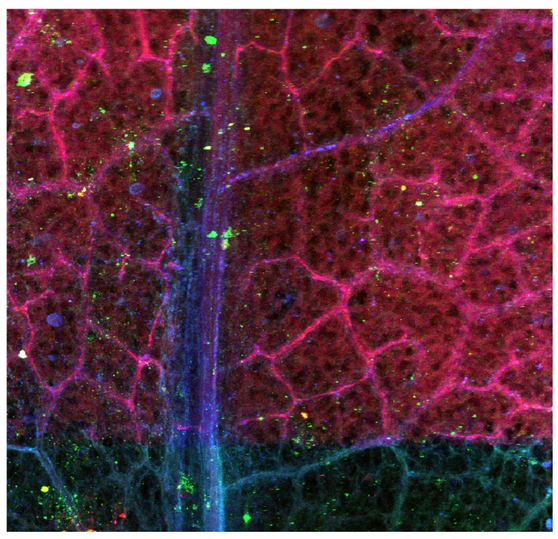

Figure 2: Spinach untreated 3 ROI map. ■ = Cu ■ = Fe ■ = Zn

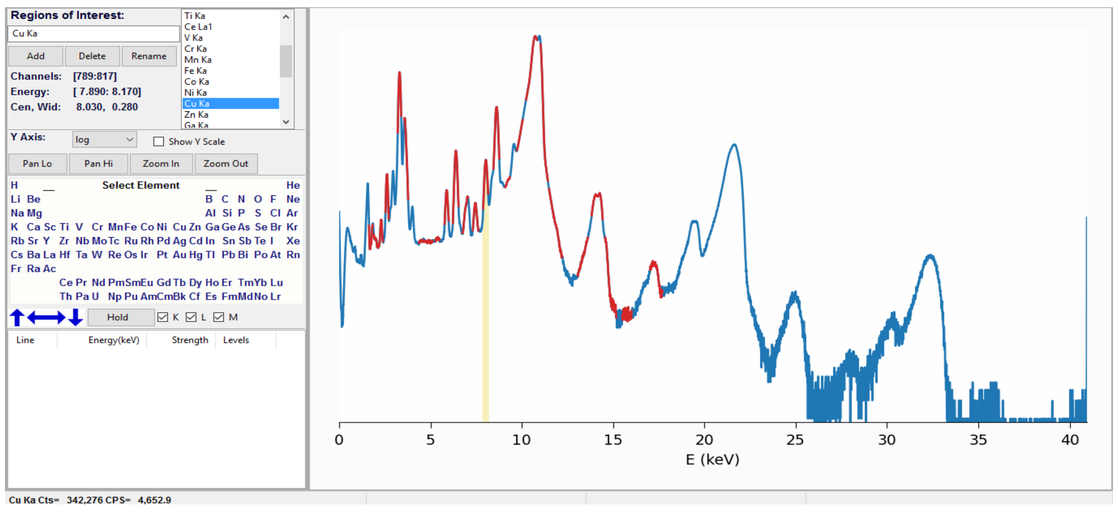

Figure 3: Sample data resulting from XRF in Larch showing data from Spinach untreated.

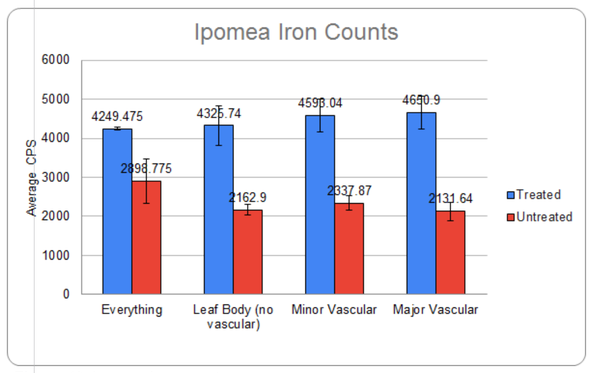

Figure 4*: Ipomea Iron counts

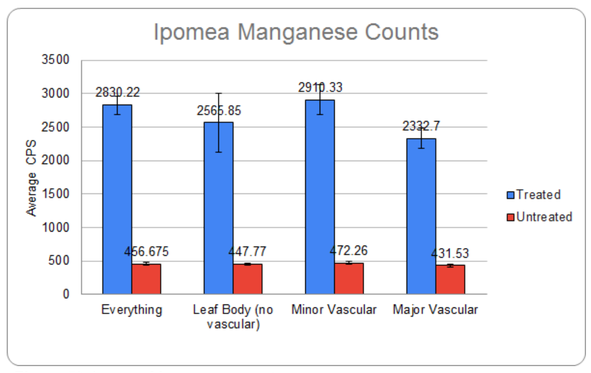

Figure 5*: Ipomea Manganese counts

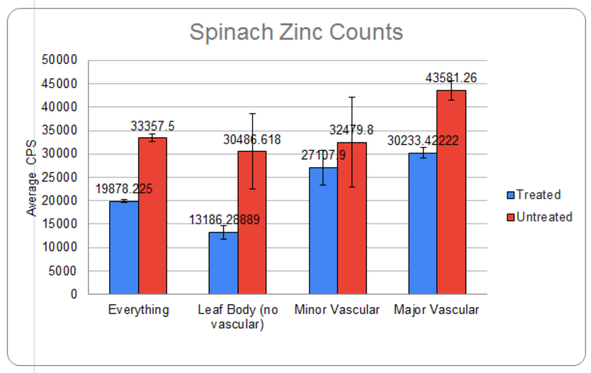

Figure 6*: Spinach Zinc counts

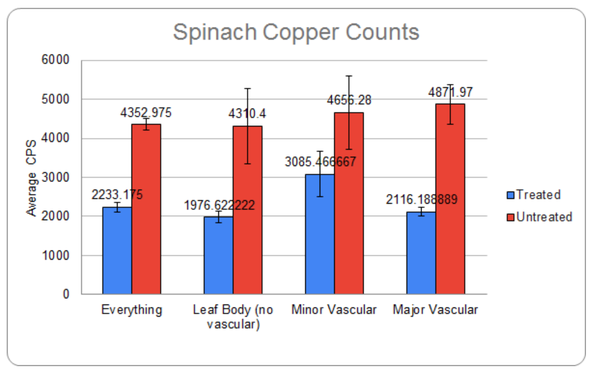

Figure 7*: Spinach Copper counts

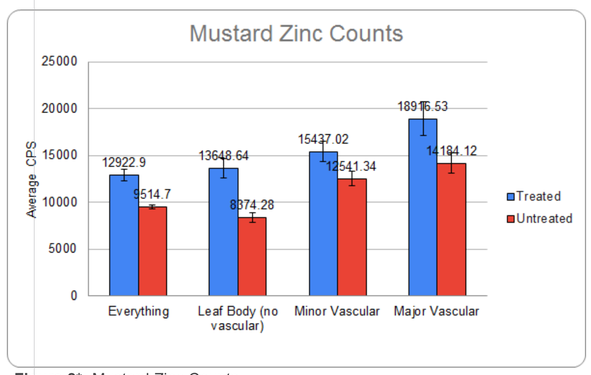

Figure 8*: Mustard Zinc Counts

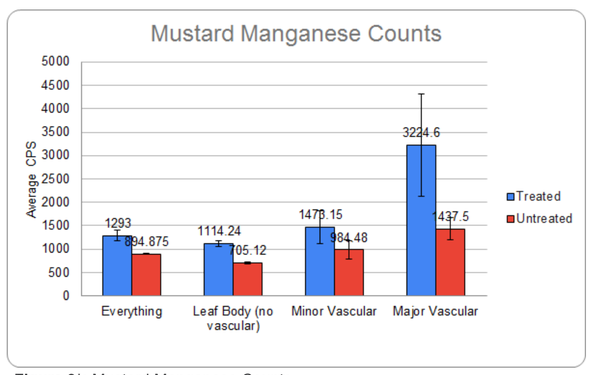

Figure 9*: Mustard Manganese Counts

** Error bars shown denote 95% confidence intervals of mean values*

CONCLUSIONS & NEXT STEPS

- Our research findings indicate several statistically significant results that show higher amounts of heavy metals in plants grown in treated lumber rather than untreated.
- Based on our research findings, changing the chemical composition of treated lumber may prevent the high levels of metal uptake, which could make the lumber safer to use.
- In the future, we could potentially obtain more samples of these plants and grow them for a longer period of time in order to increase exposure. We could also experiment with other plant options that may be known hyperaccumulators or explore with other types of lumber.
- Ultimately, continuing to analyze soil contamination using hyperaccumulators could contribute to research involving the effects of treated lumber on human health.
- For home gardeners especially, it may be important to avoid using treated lumber for gardening beds in order to avoid the uptake of heavy metals such as copper, zinc, manganese, and iron.

REFERENCES & ACKNOWLEDGMENTS

- Environmental Protection Agency. (2021, January 13). *Overview of Wood Preservative Chemicals*. EPA. https://www.epa.gov/ingredients-used-pesticide-products/overview-wood-preservativechemicals#:~:text=for%20residential%20applications.,ACQ,oxide%20and%20quaternary%20ammonium%20compounds.
- Hodgson, L. (2017, June 25). *Copper azole (CBA)*. Is Treated Wood Safe in the Vegetable Garden? https://laidbackgardener.blog/tag/copper-azole-cba/.
- Royer, A., & Sharman, T. (2020, October 1). *Copper Toxicity*.NCBI. https://www.ncbi.nlm.nih.gov/books/NBK557456/
- Stehouwer, R. (2021, April 3). *Environmental Soil Issues: Garden Use of Treated Lumber*. Penn State Extension. https://extension.psu.edu/environmental-soil-issues-garden-use-of-treated-lumber#:%7E:text=As%20the%20water%2C%20soil%2C%20or,(pH%206%2D8).
- Staff Writer, Springfield News-Leader. (2009, April 26). *Most Pressure-Treated Lumber No Longer Contains Arsenic*. Springfield News-Leader. https://eu.news-leader.com/story/life/home-garden/2009/04/26/most-pressure-treated-lumber-no-longer-contains-arsenic/77200928/

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