

# ESRP: Root Uptake of Chromium in Common Plants and Vegetables

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## Abstract

Chromium poisoning is an issue as it is found naturally in rocks, soil, plants, and volcanic dust. Contamination of water sources can occur from industrial chemical spills, proving to be detrimental to public health. The presence of chromium in soil samples from industrial waste has been noted in large quantities across the United States, namely in Hawaii, California, Wisconsin, and Michigan. Chromium has adverse effects on the human body and plants; chromium alters enzymatic activity in plants and disrupts water relations. Exposure to high levels of chromium causes cell membrane damage, root cell destruction, chlorosis in leaves, discoloration of leaves and veins, and poor mineral nutrition. Regarding the human body, chromium compounds are respiratory tract irritants and further increase the risk of lung, nasal, and sinus cancer.

## Motivation

- Chromium poses a potential threat to plants and humans.
- Exposure to high levels of chromium causes cell membrane damage, root cell destruction, chlorosis in leaves, discoloration of leaves and veins, and poor mineral nutrition.
- Contamination of water sources can occur due to industrial chemical spills, proving to be detrimental to public health.

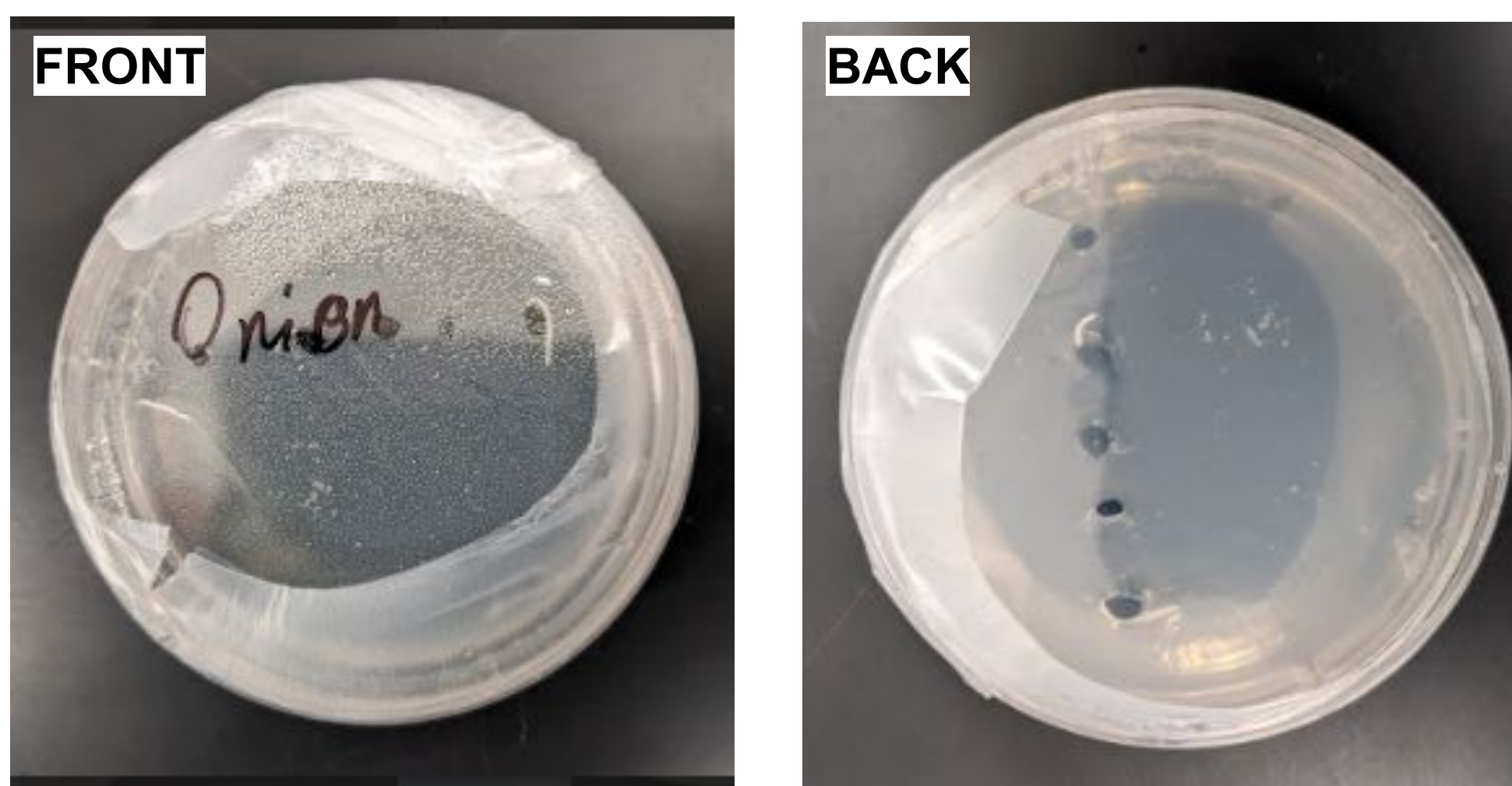
## Methods

Using the technology at the 2-ID-E beamline, students were able to examine the plant growth of arabisopsis, lettuce, tomato, turnip, and green scallions in agarose gels with an added toxic element of Chromium. The students looked at the elemental analysis from the scans to see the uptake locations and amount of the toxic elements in the plants and determined the long-term impacts of the element toxicity and its relation to the vitality of these common plants.

## ACKNOWLEDGMENTS

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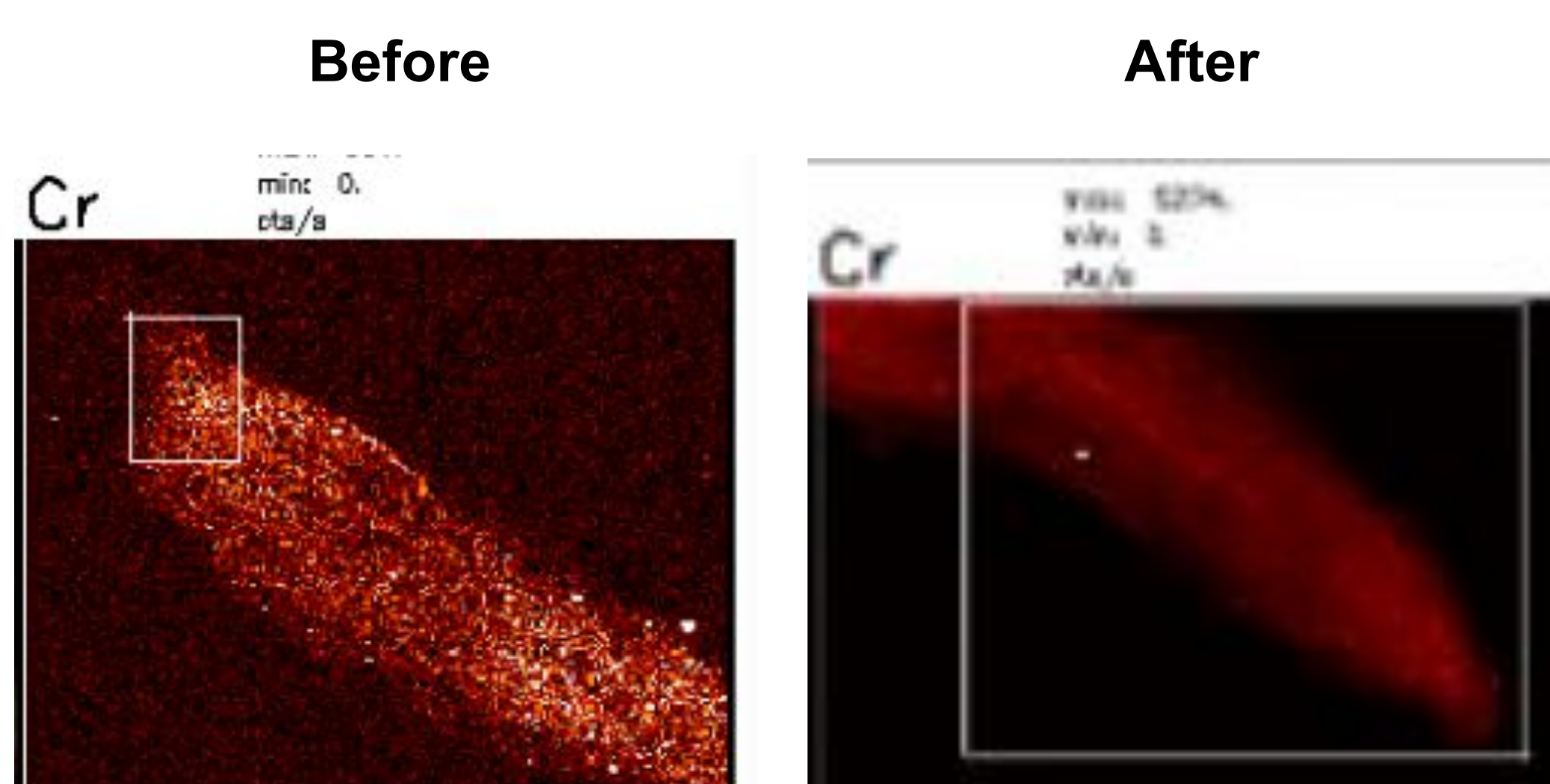
## Arabidopsis & Onion Samples



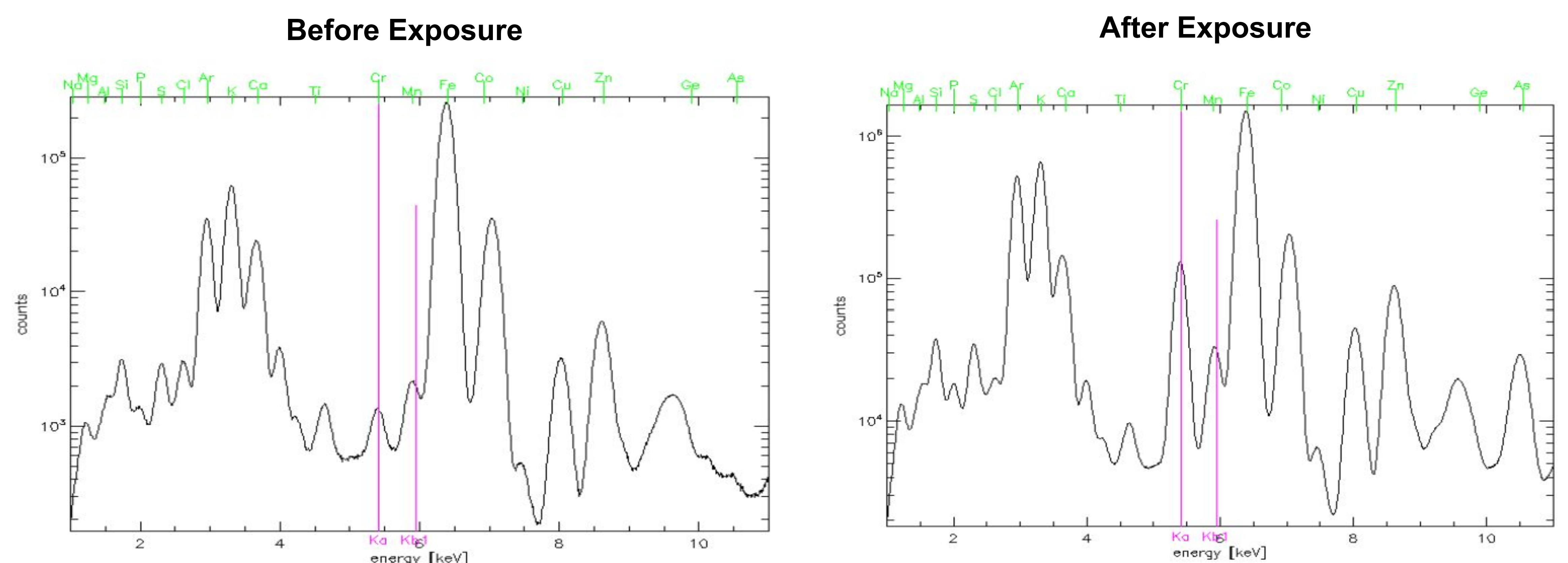
## Change in Cr:K Ratio

Sample after 1 hour Chromium	Chromium Uptake (ug/cm <sup>2</sup> )	Change in Cr:K Ratio (%)	Ranking of Chromium Uptake
Arabidopsis	2.380664368	0.05128751439	Control
Carrot	4.46654995	0.1067136996	2
Cilantro	1.5126438	0.02017600312	4
Onion	7.36218647	0.1981387243	1
Tomato	1.271917999	0.03402843061	5
Turnip	2.0644873	0.032010568	3

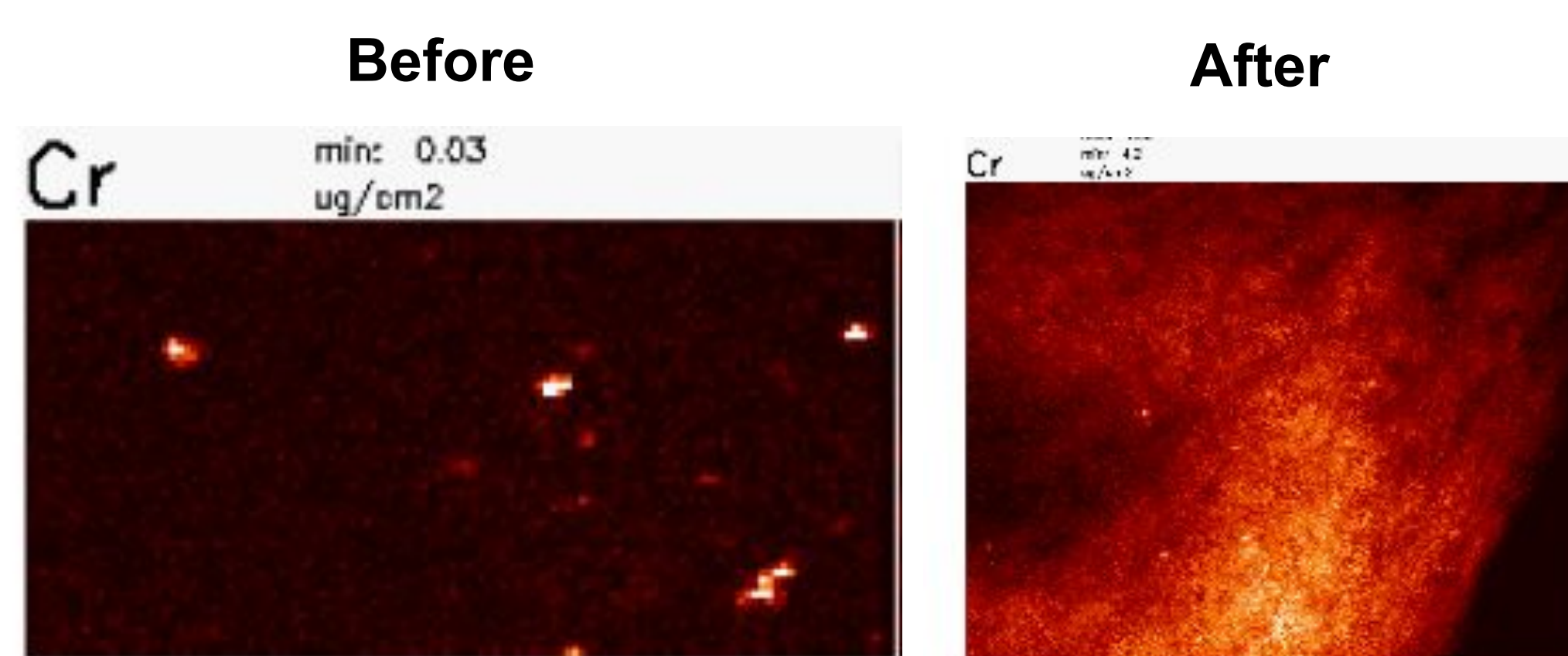
## Arabidopsis Results



## Arabidopsis Graphical Analysis



## Onion Results



## CONCLUSIONS

- All trials showed some chromium uptake in the roots of six different plant samples.
- The amount of chromium absorbed in all of the samples was insignificant since it was lower than what would cause harm to humans.
- Chromium uptake from greatest to least: Onion, Carrot, Arabidopsis, Turnip, Cilantro, and Tomato.

## NEXT STEPS

- For **future research**, there are **five** different avenues to look at:
- Changing the concentration and amount of time chromium is exposed to the plants
  - Uptake of the plant versus transportation of chromium and evaluating Chromium oxidation states within the plant
  - Chromium resistant plants
  - Retest the chromium uptake in the tomato plant and red pepper, as there were issues in the growing stages.

## REFERENCES

- "Chromium Bioaccumulation and Its Impacts on Plants: An Overview." NCBI, 13 January 2020. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7020214/>. Accessed 17 October 2022.
- Sutton, R. (2010, December 20). Chromium-6 in U.S. Tap Water | Environmental Working Group. EWG. Retrieved October 17, 2022, from <https://www.ewg.org/research/chromium-6-us-tap-water>
- Office of Dietary Supplements - Dietary Supplement Fact Sheet: Chromium. (2017). Nih.gov. <https://ods.od.nih.gov/factsheets/Chromium-HealthProfessional/>
- Chromium in diet. (2021, March 11). MedlinePlus. Retrieved October 17, 2022, from <https://medlineplus.gov/ency/article/002418.htm>
- "Chromium in the garden." CHROMIUM in the garden, [https://sites.nicholas.duke.edu/superfundcecl/files/2019/10/CRFS\\_v3.1.pdf](https://sites.nicholas.duke.edu/superfundcecl/files/2019/10/CRFS_v3.1.pdf). Accessed 27 October 2022.