Root Uptake of Cobalt in Common Vegetables

Utilizing Fluorescence Mapping to Visualize Cobalt's Distribution in Vegetable Plants

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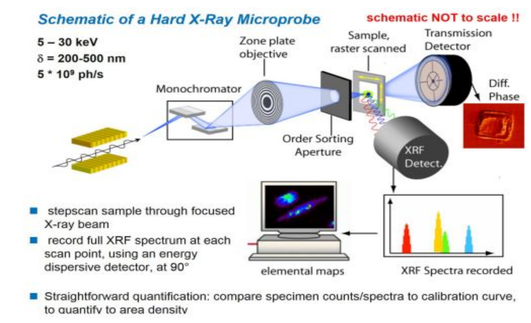
ABSTRACT

Purpose: To examine how vegetable plants uptake Cobalt (Co) and adapt in its presence

- *Measured* Co distribution within cucumber, corn, squash
- *Used* X-ray fluorescent microscopy to measure distributions of Cobalt within plants
- *Studied* plant uptake and response to toxic Cobalt

1. A sample of metallic Cobalt

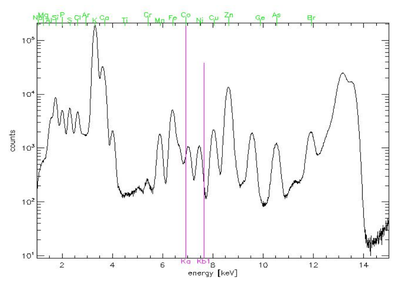


2. Process of X-Ray Fluorescence Microscopy

MOTIVATION

- At concentrations > 1.8 mg/L, cobalt can potentially induce **asthma, hard metal lung disease,** and **increased risk of cancer** (Wahlquivst et al., 2020)
- Given the effects of Cobalt poisoning in communities, we want to **study the mechanism** by which plants take up and transport metals to enter the human body
- For this study, we chose cucumber, corn, squash, and *Arabidopsis thaliana* plants

4. Norilsk, Russia, (major producer of Cobalt and other potentially toxic materials)



5. Elemental (XRF) Spectra of Corn Exposed to Cobalt

DATA ANALYSIS

Absolute Uptake of Cobalt (from High Resolution Images)

Largest Absolute Uptake

Smallest Absolute Uptake

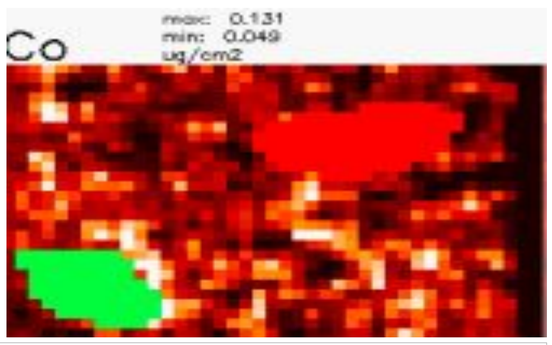
Δ[Co]	Cucumber	Corn	Squash	A. Thaliana
After **1 hr**	0.19325463	0.10916596	0.07196211	0.050608
After **2 hrs**	0.58428769	0.10106241	0.63738781	0.20812257

Relative Uptake of Cobalt (from High Resolution Images)

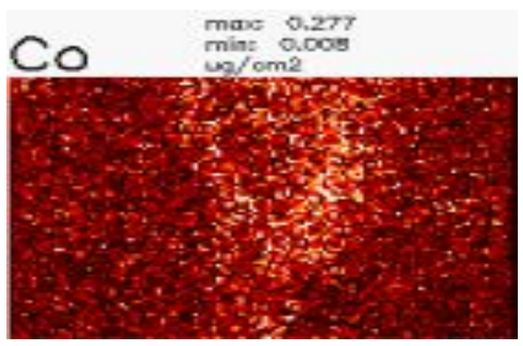
Largest Relative Uptake

Smallest Relative Uptake

[Co]/[K]	Cucumber	Corn	Squash	A. thaliana
After **1 hr**	0.00133779	0.00130097	0.0022101	0.00315087
After **2 hrs**	0.00843901	0.00222363	0.00705981	0.01182854



6. Distribution of Cobalt in Treated (Experimental) Corn at a High Resolution.



7. Distribution of Cobalt in Untreated (Control) Corn at a High Resolution

3. Prepared Cucumber in Growth Solution for further use in control & treatment groups.

METHODS

- Plants were put in 1% agar 1% sucrose growth medium in plastic petri dishes
- 1.5-2 mm root tips from plants were cut, but experimental plants were exposed to cobalt for 1 hour of incubation.

CONCLUSIONS

After comparing the Cobalt uptakes in our experimental plants, we found that:

- By factoring in the thickness of the plant root using a **Co/K ratio**, we can create a relative scale of uptake
- **Corn and Squash** roots took in the least amount of cobalt when exposed for longer periods of time
- It is **safest to plant and consume** corn and squash in potentially cobalt contaminated environments

POTENTIAL ERRORS

- ***Pileup Effect*** created…
  - False signals of cobalt
    - Due to overlap of Fe K-Beta & Co K-alpha
- ***Natural Variability*** of plants
  - Different stages of germination
    - Varies uptake mechanisms

NEXT STEPS

- ***Introduce*** other plants to cobalt and examine possible shifts in root uptake of the toxin
- ***Grow*** specific plants that are more resistant to specific metals in farms near mines

ACKNOWLEDGEMENTS

- Argonne National Laboratory's Exemplary Student Research Program
- APS User Office
- U.S. Department of Energy
- Mrs. Vanessa Troiani and the Administration of Metea Valley High School
- Dr. Olga Antipova and her team at Argonne
- Based on Dr. Olga Antipova's "Studies of Nickel Uptake by Plants Using X-ray Fluorescence Mapping" (2019)

1. Benjah-bmm27 (https://commons.wikimedia.org/wiki/File:Cobalt-sample.jpg), "Cobalt-sample," marked as public domain, more details on Wikimedia Commons: https://commons.wikimedia.org/wiki/Template:PD-user
4. Ninara from Helsinki, Finland (https://commons.wikimedia.org/wiki/File:4Y1A0093_Norilsk_(28929420786).jpg), "4Y1A0093 Norilsk (28929420786)", https://creativecommons.org/licenses/by/2.0/legalcode

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