National Institute of Environmental Health Sciences

Superfund Research Program

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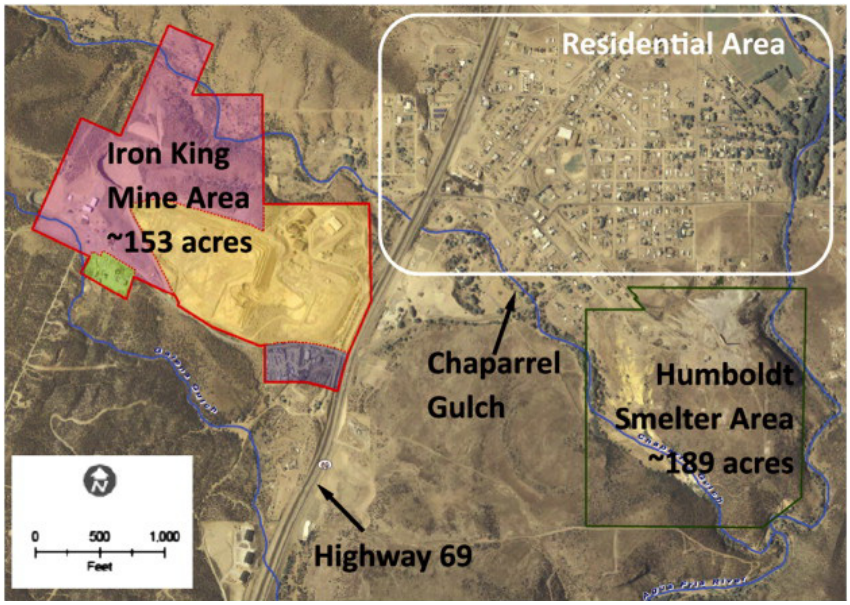
Arsenic Uptake in Homegrown Vegetables from Mining-Affected Soil

Arsenic uptake from soil into the edible portion of some plants presents a potential health hazard that may affect home gardeners near contaminated sites. By testing vegetables grown by local residents as well as those from a controlled greenhouse environment, Monica Ramirez-Andreotta, Ph.D., at the University of Arizona (UA) Superfund Research Program (SRP), found that the amount of arsenic accumulated in the edible portion of the plant in certain vegetable families is associated with the arsenic soil concentration.

Arsenic is a semi-metal element that is naturally found in the earth's soils and rocks. It is further released from industrial activities. Acute exposure to arsenic can lead to nausea, diarrhea, and numbness in hands and feet. Chronic low-level arsenic exposure has been linked to diabetes, hypopigmentation/hyperkeratosis, and a probable role in promoting cancer of the bladder, lung, skin, and prostate.

The Iron King Mine and Humboldt Smelter Superfund site, a previously operated mine and smelter in Arizona, contains large amounts of uncontrolled mine waste, called tailings, with elevated arsenic concentrations. Older mine tailings are prone to wind dispersion and water erosion, potentially elevating heavy metal concentrations in the soil in neighboring communities.



An aerial view of the Iron King Mine and Humboldt Smelter Superfund site, and the Dewey Humboldt, Arizona residential area. (Aerial photo source: Yavapai County, GIS, 2007. Basemap source: ESRI Street Map, 2006. EA Engineering, Science, and Technology, Inc., 2010. Modified by Ramirez-Andreotta with text overlaid.)

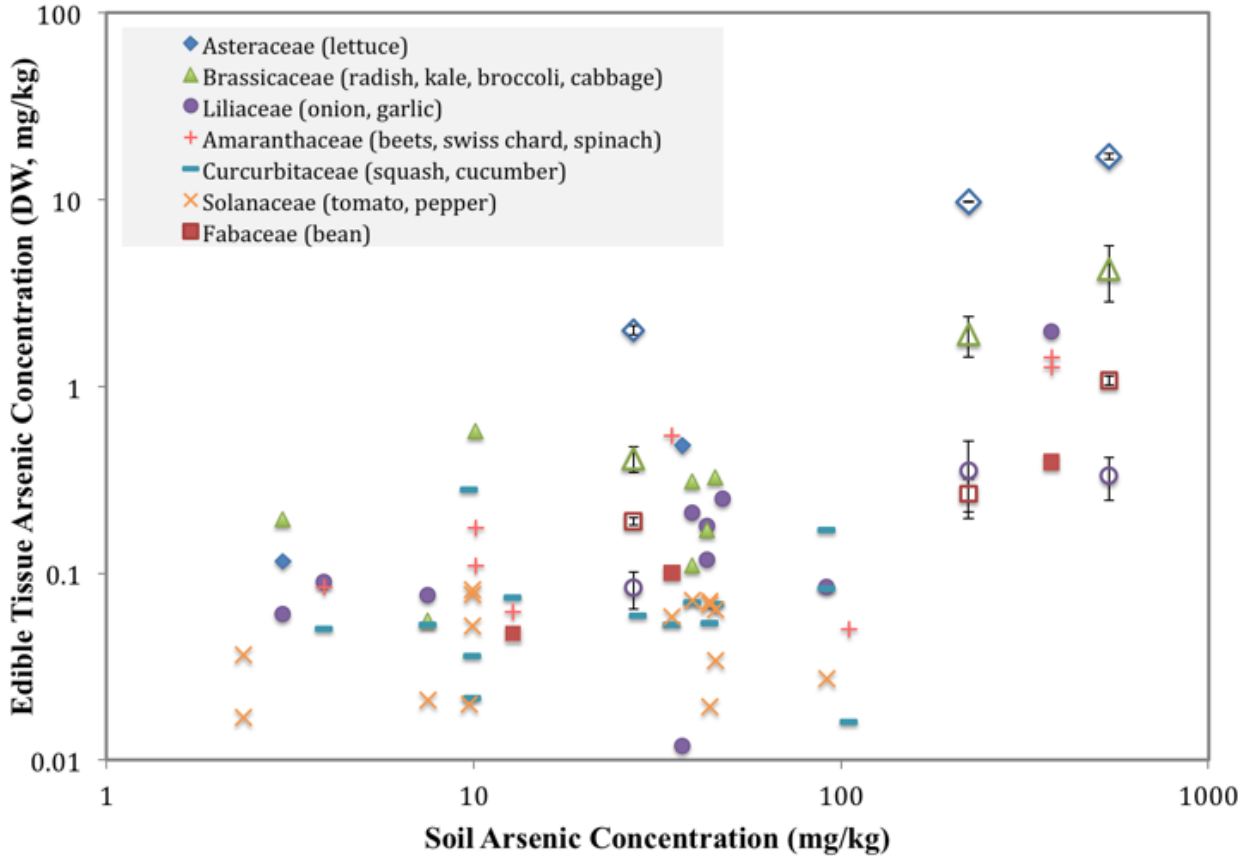
Ramirez-Andreotta, under the guidance of UA SRP Center Director Raina Maier, Ph.D., and Research Translation Director Mark Brusseau, Ph.D., recruited home gardeners in a community near the site to submit their soil, water, and vegetable samples to the UA SRP for analysis of arsenic concentrations. She also conducted a controlled greenhouse study to characterize the uptake of arsenic by different types of vegetables.

All vegetables accumulated arsenic, ranging from 0.01 to 23.0 mg/kg dry weight. When combining the greenhouse and the home garden study, Ramirez-Andreotta observed a significant linear correlation between the amount of arsenic accumulated in the edible portion of the plant and the arsenic soil concentration for the Asteraceae (lettuce), Brassicaceae (radish, broccoli, kale, and cabbage), Amaranthaceae (beets, spinach, swiss chard), and Fabaceae (bean) families.

The Asteraceae and Brassicaceae families were the top accumulators, concentrating more arsenic in their edible tissues than other families. Certain members of the Asteraceae and Brassicaceae families have been previously identified as hyperaccumulator plants, meaning they may have a genetic and physiological capacity to accumulate high amounts of metals.

The study recommends that home gardeners near smelter or mining operations that have high levels of metals in waste materials test their soils prior to gardening to determine existing soil arsenic concentrations. Gardeners should also be made aware that arsenic can accumulate considerably in certain vegetables.

“Particularly, it may be prudent for home gardeners who neighbor smelter or mining operations with high arsenic levels or who are in an arsenic endemic area to limit the use of vegetables from the Asteraceae and Brassicaceae families to reduce their dietary exposure to arsenic,” said Ramirez-Andreotta.



Arsenic concentration in the edible portion of common vegetables from the study as a function of soil arsenic concentration. Open symbols represent vegetables grown in the greenhouse. (Graph courtesy of Monica Ramirez-Andreotta)

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To learn more about this research, please refer to the following sources:

Ramirez-Andreotta M, Brusseau ML, Artiola JF, Maier RM. 2013. A greenhouse and field-based study to determine the accumulation of arsenic in common homegrown vegetables grown in mining-affected soils. Science of the Total Environment 443: 299-306. doi: 10.1016/j.scitotenv.2012.10.095