TRACE ELEMENT CONCENTRATIONS IN TUCSON KALE: COMMUNITY GARDENS VS. GROCERY

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ABSTRACT

This project examines trace elements in kale (part of the *Brassicaceae* family) from two sources in Tucson, Arizona: community gardens and grocery stores. The study assessed the kale's accumulation patterns Al, Cr, Ni, Cu, Zn, As, Se, Cd, Pb, and Mo in kale grown in urban settings and commercial farms. Median grocery concentrations exceeded median garden concentrations for all metals except Zn, Pb, and Mo. Using an exposure assessment, none of the samples analyzed had concentrations that reach the United States Environmental Protection Agency (US EPA) reference doses within one serving, but concentrations of Mo, Se, and Cd reached US EPA reference doses (0.005 mg/kg/day, 0.0003 mg/kg/day, and 0.001 mg/kg/day, respectively) within five-six servings.

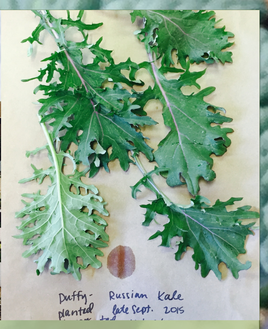
Introduction

Kale, part of the *Brassicaceae* family, is well known for being a "super food," and is widely grown by gardeners in Tucson. What many don't know is that leafy greens like kale can hyperaccumulate trace metals from soil (1,2). If kale is grown in soil that has high concentrations of toxic trace metals, the vegetable could accumulate these metals into its biomass and pose a health threat to its consumer.

This study evaluated kale from urban gardens across Tucson and from a combination of farms in California, Mexico, Arizona, and Minnesota. Urban soils may accumulate different pollutants because of varying historical land uses (residential, industry, commercial). In comparison, a long-standing, conventional farm may have contamination from pesticides, tractors, and ambient air pollution. In general, urban soils are likely to be contaminated via anthropogenic activities. The chemistry of soil that's been used for a combination of urban purposes has shown to be different than that of a long-standing, commercial farm (3).

Due to concerns about toxicity in urban settings, this study focuses mainly on Cd, Pb, and As. Other metals that were analyzed include: Al, Cr, Ni, Cu, Zn, Se, and Mo. Cd, Pb, and As are a main focus due to their more acute toxicity in the environment.

Methodology



Garden Selection

Gardens from the Community Gardens of Tucson database were invited to participate in the project via email. All email respondents were included in the study, totaling four gardens. These gardens were located throughout the Tucson area.

Sample Preparation

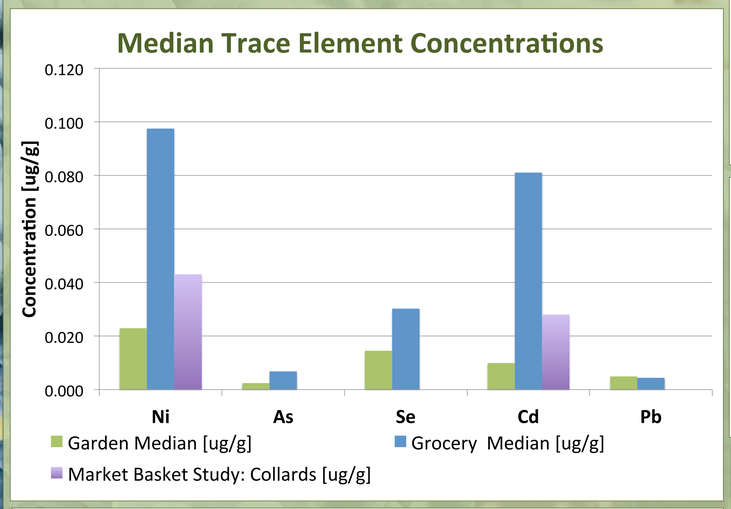
Four to five leaves of each kale sample were harvested. Samples were transported in sterile sample bags, washed in the lab for 30 seconds with deionized water, photographed for documentation, weighed, cut up into slices, and dehydrated at 60°C in an oven until they reached a constant mass. After the kale was fully dry, each sample was ground for a minimum of 30 seconds or until the sample was entirely ground.

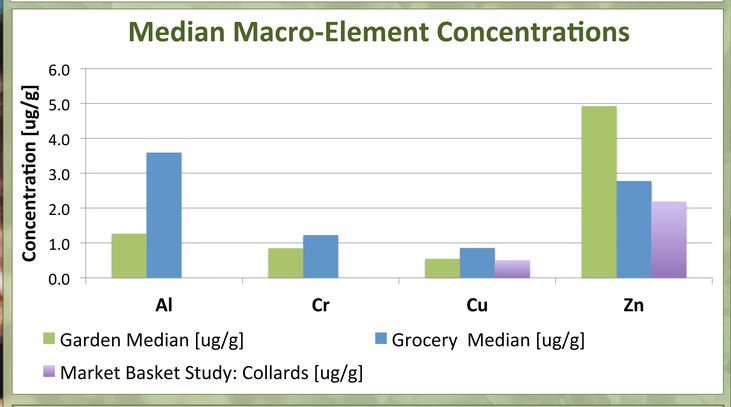
Chemical and Exposure Analysis

The dried and ground samples were sent to the Arizona Lab for Emerging Contaminants (ALEC) at the University of Arizona. Here, the samples were dissolved in nitric acid and analyzed via Inductively Coupled Plasma Mass Spectrometer for Al, Cr, Ni, Cu, Zn, As, Se, Cd, and Pb.

With each concentration reported from ALEC, an exposure assessment was performed to determine if the concentration of each element could be toxic to humans, and how many servings it would take every day to reach the USEPA reference dose for selected element.

Graphical Results

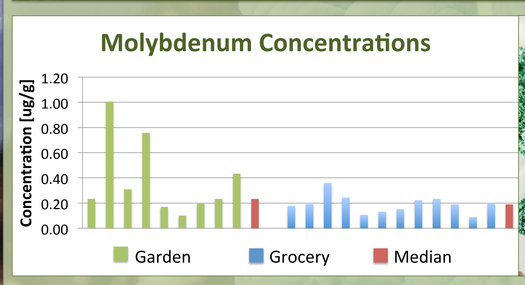


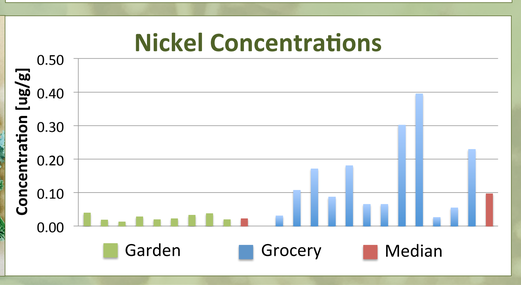


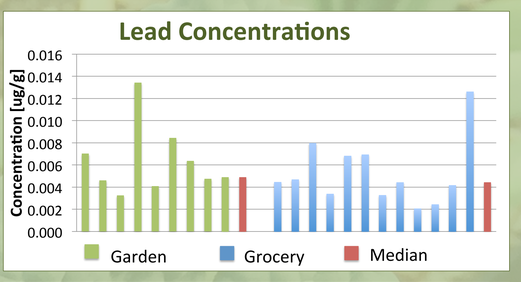
Comparing Metal Concentration Medians between US FDA Market Basket Collards with Grocery and Garden Kale

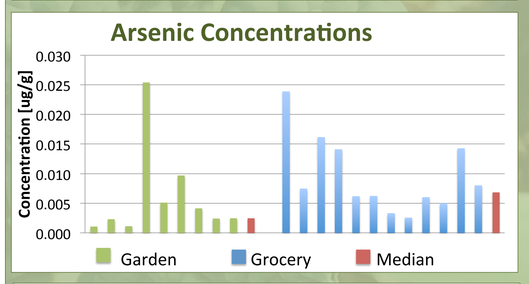
(Note– Market Basket Study did not include kale)

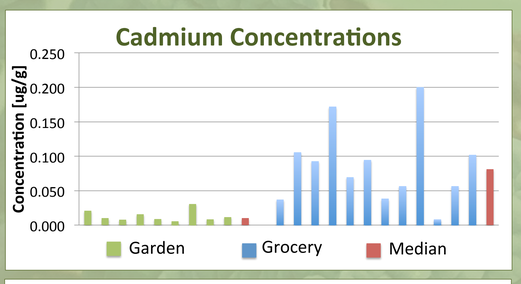
	Al	Cr	Ni	Cu	Zn	As	Se	Cd	Pb	Mo
Market Basket Study: Collards [ug/g]	-	-	0.043	0.500	2.190	0.000	0.000	0.028	0.000	0.000
Garden Median [ug/g]	1.263	0.854	0.023	**0.544**	**4.925**	**0.002**	**0.014**	0.010	**0.005**	**0.233**
Grocery Median [ug/g]	3.590	1.228	**0.098**	**0.855**	**2.777**	**0.007**	**0.030**	**0.081**	**0.004**	**0.189**

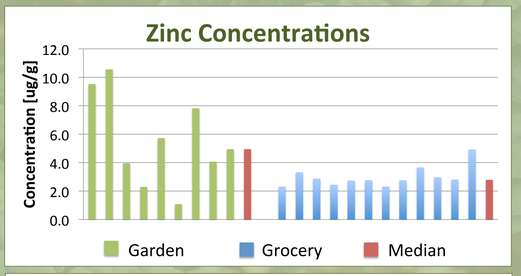


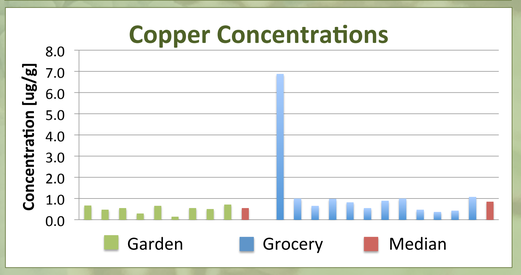












Conclusion

Overall, this study revealed a trend that grocery-bought kale in Tucson has higher concentrations of trace elements than garden-grown kale. The only elements that broke this pattern were Mo, Zn, and Pb (Pb had similar concentrations, but Mo and Zn were higher in gardens).

Compared to the US FDA Market Basket Study results on collards (same family as kale), most of the kale in this study had higher median concentrations. After completing exposure assessments for each metal, no kale samples reached US EPA reference doses within one serving. In the case of high kale consumption (five to six servings per day), certain samples would reach the reference doses of Mo, Se, and Cd. Overall, no concentrations warrant health concerns.

References

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