

Risk and exposure hazards associated with edible garden plants grown in lead contaminated soils: A Chicago residential case study

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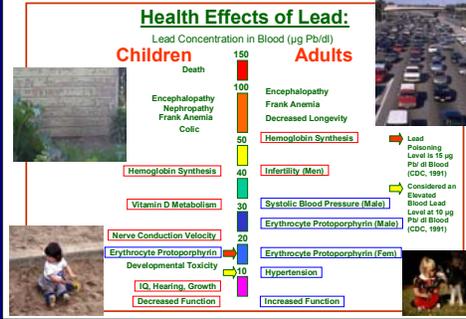
Abstract

In order to evaluate the potential risk due to the consumption of plants homegrown in gardens with lead contaminated soil and to guide the development of safety recommendations for urban gardening enthusiasts, a pilot study investigated the relationship between lead concentrations in urban garden soils and crops grown in these soils, particularly the levels of lead detected in the edible portions of the plant.

A pattern of lead transfer from soil through the root to the stem and leaves was found. This pattern is a concern particularly for urban garden plants in which the roots, stems, stalks, or leaves are consumed. Fruiting vegetables had lead concentrations less than the limit of detection. Depending on the soil lead concentration and specific plant, the lead contamination found in some leafy vegetables and herbs may exceed the body's daily excretion rate and contribute to the total body burden of lead, especially in children.

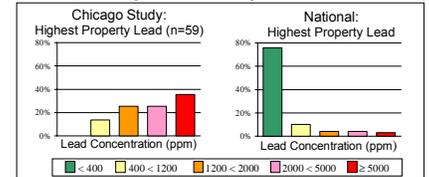
Motivation

- The potential health effects associated with contaminated urban soil and the occurrence of lead in the edible portion of the garden plants are of specific interest from a health point of view.



Background

- Lead is a widely distributed and highly toxic element in the environment
 - Lead does not dissipate, decay, or biodegrade
 - Contamination is especially acute in urban areas
 - In Chicago, soil lead ranged from 200 to 50,000 ppm



- Chicago has one of the highest rates of lead poisoning in the country (~12% of children tested)
- In recent years, urban gardening has become increasingly popular in nearly all socioeconomic groups in the United States.

Methods

- Although it is known that all plants accumulate lead to some extent, little investigation has been done on:
 - Relationship between soil lead and concentrations found in edible plants, or
 - Tendency of typical garden plants to translocate lead from roots to shoots

- Sampling of edible fruits, vegetables, herbs, and soils was conducted over a period of two summers
 - The entire plant was harvested and separated into sections including root, shoot, and edible fruit

Plant types collected*		
Fruiting Edibles		
Apple (2)	Grapes (4)	Squash, Butternut (1)
Beans (2)	Peppers, Bell (7)	Tomato (9)
Cantaloupe (1)	Peppers, Hot (10)	Watermelon (1)
Corn (2)	Strawberries (4)	Zucchini (1)
Cucumber (7)	Squash, Acorn (1)	
Leafy Edibles		
Basil (1)	Lemon Balm (1)	Rhubarb, Green (2)
Cabbage (3)	Mint (9)	Rhubarb, Red (2)
Cilantro (1)	Mustard Greens (1)	Sage (2)
Collard Greens (1)	Parsley (2)	Swiss Chard (2)
Coriander (1)	Red Chard(1)	Thyme (1)
Ipsacote (1)		
Root Edibles		
Carrot (1)	Onion (1)	Radish (2)

- Lead can be associated with plants grown in contaminated gardens as a result of lead contaminated dust adhering to the plant surface, or direct uptake of lead into the plant

Thus, the samples of harvested garden plants were prepared in two ways:

- Rinsed in tap water (to reflect lead deposited on the plant surface, combined with that incorporated into the plant tissue).
- Washed with a mild detergent solution, to remove adhered soil (to represent the lead incorporated into the actual plant tissue only).

Results

- Looked at 3 groups of edibles

Fruit & Fruiting vegetables:

- Only one vegetable, among the 52 sampled, was found to have a detectable lead level
- That one fruiting vegetable had been rinsed with water only

Leafy vegetables and herbs:

- 39% (12/31) showed lead in edible parts
- Detergent washing did not completely eliminate the lead
- 50% (8/16) of water-washed leafy edibles & 28% (4/15) of detergent-washed samples had lead detected

Root vegetables:

- Although only 4 were sampled, all of those analyzed exhibited detectable lead concentrations.

Conclusions

- Gardens are not usually regarded as potentially dangerous or toxic areas within a residential property; however, many urban garden soils are contaminated with hazardous levels of lead. This is particularly true in many neighborhoods of Chicago.
- The contribution of lead contaminated root crops, leafy vegetables, and herbs may contribute to lead poisoning if there is an exceedance of the daily natural excretion levels in adults and children.
 - Adults absorb approximately 11% of the ingested lead and excrete on average 50mg/day.
 - Children can absorb anywhere from 30-75% of ingested lead and excrete roughly 15 mg/day.



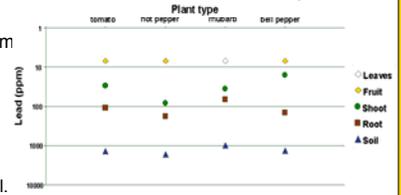
Results

- In general, all plants take up or accumulate lead to some extent, particularly in soils testing greater than 1000 ppm lead.

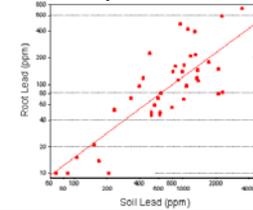
- A pattern of lead transference was identified from soil to root & into stem and leaves of urban garden plants.

- Lead absorption does not concentrate in the edible parts of fruit & fruiting vegetable plants.
 - Assuming thorough washing to remove any surface adhered soil.

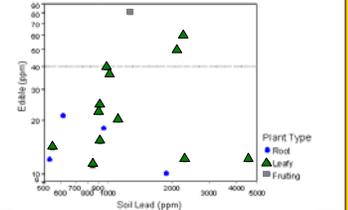
Movement of lead within the plant



Relationship of Root & Soil Lead



Relationship of Edible & Soil Lead



Recommendations for Urban Gardeners

- Survey the property to determine potential lead hazards, extent of contamination, and high-risk areas
- Plan to locate gardens away from buildings.
- Analyze lead concentration in soil samples from areas where vegetable gardens exist or are planned
- Do not grow food crops in a soil that is contaminated to levels greater than 400 ppm
- Instead, use either containers or raised beds, with a barrier between the clean and contaminated soil
- Where container or raised bed gardening is not possible, fruiting crops should be grown
- Root vegetables, leafy greens, and herbs should not be planted in contaminated soils
- Test new topsoil before using it and annually retest the garden soil to monitor for recontamination
- Do not compost plants grown in contaminated soils
- Use mulch or a weed tarp to reduce the potential for aerial soil dust deposition or soil splash up on crops