

Concentrations of Lead, Cadmium and Barium in Urban Garden-Grown Vegetables: The Impact of Soil Variables

The [Healthy Soils, Healthy Communities](#) study of metals concentrations in urban garden-grown vegetables has been published in the journal *Environmental Pollution*. The study evaluated levels of three metals – lead, cadmium and barium – in 195 pairs of soil and vegetable samples from urban gardens in New York City and Buffalo, NY. Urban soils can have higher levels of lead and other contaminants because of human activities including fossil fuel combustion, incineration, and past use of leaded gasoline and paint containing lead and other metals. Lead and barium, in particular, have been found at levels above health-based guidance values in [New York City community garden soils](#), but it was unknown how much was getting into the vegetables. Cadmium was of interest because it can be taken up by vegetables even at relatively low soil concentrations, even though levels in soil rarely exceeded guidance values.

The soil and vegetable samples were collected in 2011 and 2012. The *Healthy Soils* team shared soil and vegetable testing results, [interpretation](#), and advice on [healthy gardening practices](#) with participating gardeners at that time.

Overall, the study found that levels of lead, cadmium, and barium in urban garden produce were generally below health-based guidance values. Levels of metals differed significantly among crop types. Herbs (such as thyme) and leafy crops (such as lettuce) had the highest levels, followed by root crops (such as carrots), then fruits (such as tomatoes and peppers). The study found almost no relationship between levels of metals in kitchen-washed vegetables and levels in the soil in which they were grown.

Because the U.S. does not have health-based standards for metals in garden produce, the study considered [European food standards](#) as guidance values for evaluating the vegetable results. The study also compared levels of metals in the urban vegetables to those the U.S. Food and Drug Administration has measured in supermarket produce. It should be noted, however, that the laboratory methods used to test the urban vegetables were different from those used to test store-bought vegetables, resulting in some uncertainty in this comparison.

While lead levels in the urban garden vegetables tended to be higher than levels in store-bought produce, lead was below guidance values in almost all fruiting vegetables (79 of 80 samples, or 99%), most leafy vegetables (61 of 67 samples; 91%), and about half of the root vegetables tested (17 of 32 samples, or 53%). Cadmium levels were below guidance values in all but one of the 195 vegetable samples and were generally comparable to the levels found in store-bought vegetables. Barium levels were compared to levels in a small survey of store-bought leafy and root vegetables (the U.S. Food and Drug Administration does not report barium levels in supermarket produce). Leafy vegetables from the urban gardens tended to contain more barium than their store-bought counterparts, but root vegetables did not. There are no European standards for barium in produce.

The study also included estimates of the amount of soil that remained stuck to the washed vegetables. Ounce for ounce, herbs, with their smaller leaves and greater surface area relative to other crops, hold onto about twice as much soil as leafy vegetables, and can have more than ten times as much adhered soil as fruiting vegetables. Our data suggest that adhered soil might be the primary source of lead in the vegetables, while plant uptake through roots could be more important for barium.

Although lead levels in most of the urban vegetables tested in this study were below health-based guidance values, urban gardeners can still benefit from steps to reduce exposure. The study supports advice to choose crops carefully (fruiting crops had by far the lowest levels of metals), and to wash garden produce well to remove soil particles. These healthy gardening practices and others, outlined in the *Healthy Soils* tip sheet "[What Gardeners Can Do: 10 Best Practices for Healthy Gardening](#)" and [other resources](#), can help gardeners reduce exposure and enjoy the many health benefits of eating fresh garden-grown fruits and vegetables.

The full article is available to journal subscribers on the [journal's website](#), and you can also read it on the [NYS DOH website](#).

Internet resources and references linked from page 1:

[Healthy Soils, Healthy Communities](http://cwmi.css.cornell.edu/healthsoils.htm) webpage: <http://cwmi.css.cornell.edu/healthsoils.htm>

Lead levels in [NYC community garden soils](http://devweb.health.ny.gov/environmental/outdoors/garden/soilpaper.htm):

<http://devweb.health.ny.gov/environmental/outdoors/garden/soilpaper.htm>

[Interpretation](http://cwmi.css.cornell.edu/UnderstandingTestResultsMetalsSoilsVeg.pdf) of soil & vegetable results: <http://cwmi.css.cornell.edu/UnderstandingTestResultsMetalsSoilsVeg.pdf>

Advice on [healthy gardening practices](http://cwmi.css.cornell.edu/healthsoils-3.htm): <http://cwmi.css.cornell.edu/healthsoils-3.htm>

[European food standards](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:364:0005:0024:EN:PDF): <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:364:0005:0024:EN:PDF>

[U.S. Food and Drug Administration](http://www.fda.gov/Food/FoodScienceResearch/TotalDietStudy/default.htm) testing of market produce:

<http://www.fda.gov/Food/FoodScienceResearch/TotalDietStudy/default.htm>

["What Gardeners Can Do"](http://cwmi.css.cornell.edu/WhatGardenersCanDoEnglish.pdf) tip sheet: <http://cwmi.css.cornell.edu/WhatGardenersCanDoEnglish.pdf>

[Other healthy gardening resources](http://cwmi.css.cornell.edu/healthsoils-3.htm): <http://cwmi.css.cornell.edu/healthsoils-3.htm>

Full *Environmental Pollution* article on [journal's website](http://dx.doi.org/10.1016/j.envpol.2014.07.036): <http://dx.doi.org/10.1016/j.envpol.2014.07.036>

Full article on [NYS DOH website](http://www.health.ny.gov/environmental/outdoors/garden/docs/vegpaper.pdf): <http://www.health.ny.gov/environmental/outdoors/garden/docs/vegpaper.pdf>