

Assessing Garden Crops as an Exposure Route for Soil Mercury

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We are investigating mercury uptake from soil into garden crops and the significance of this potential route of human exposure to mercury. Our objective is to determine if soil-mercury is taken-up by vegetables at concentrations sufficient to be a health risk. Locations for two experimental vegetable gardens were identified at the Augusta Forestry Center, which is about 16 river-km downstream from Waynesboro, VA, along the South River. The 15 x 15 m floodplain garden had soil mercury concentrations ranging from 4.2 to 78 mg Hg·kg⁻¹ dry weight in the surface 15 cm. A control garden located outside of the 100-year floodplain of the South River but relatively close to the floodplain garden had total soil mercury concentrations that ranged from 0.16 mg Hg·kg⁻¹ to less than the Limit of Quantitation (LOQ was no greater than 0.12 mg Hg·kg⁻¹ dry wt.). The soil mercury concentrations were determined in soil samples collected in November 2003 after the first growing season.

Each crop in the floodplain garden was planted in four replicate plots using a completely randomized design in 2003 and a randomized complete block design in 2004. The plots in the control garden were not replicated during the 2003 growing season; however, duplicate plots have been planted for 2004. Fully-grown, edible portions of lettuce, squash, cabbage, green pepper, spinach, tomato, sweet corn, onion, radish, and carrot were harvested in 2003. In 2004, beets, turnips, potatoes, scallions, cauliflower, bush peas, and bush beans were added to list of crops planted. Sweet corn was not planted in 2004 to make room for the additional crops.

In 2003, mercury concentrations in fresh tissue samples were generally less than the MDL (Method Detection Limit of 0.003-mg Hg·kg⁻¹ plant tissue [wet weight basis]). Twenty-five of 53 samples from the floodplain garden and 9 of 12 samples from the control garden had non-detectable concentrations of mercury. Of the 31 samples with mercury concentrations greater than the MDL, all but three were less than the LOQ, which was about 0.1-mg Hg·kg⁻¹ (wet weight basis). Three of five carrot samples from the floodplain garden had mercury concentrations that ranged from 0.188 to 0.103-mg Hg·kg⁻¹. The carrots in 2003 were harvested after a flooding event that appears to have affected mercury concentration, based on 2004 results.

In 2004, mercury concentrations of bean, beet, pea, pepper, radish, red onion, and potato fresh tissue samples from both gardens were below the MDL. Mercury concentrations in samples of carrots, lettuce, scallions, spinach, and tomatoes from the control garden and unpeeled carrots from the floodplain garden were generally less than the MDL. Trace levels of mercury that were below the method LOQ in these crops harvested from the floodplain samples could not be quantified by the method used to measure mercury.

Using information from the US EPA Exposure Factors Handbook (1996), mercury screening level values of 0.3 and 0.8 mg·kg⁻¹ were calculated for methyl mercury and inorganic mercury, respectively, for homegrown vegetables. These screening level values for mercury in vegetables were calculated using several conservative assumptions, such as a reference dose (R_fD) for methyl and inorganic mercury of 0.0001 and 0.0003 mg Hg·(kg Body Wt.-day)⁻¹, respectively, a 30-year exposure duration, an exposure frequency of 350 days·y⁻¹, a lifetime of 70 years, a body weight of 70 kg, and 100% mercury bioavailability. The LOQ of 0.1-mg Hg·kg⁻¹ (wet weight

basis) for the method used to measure mercury in the plants was about one-third of the methyl mercury screening concentration calculated from the information in the exposure handbook.

This demonstrates that for the two years of the study, trace estimated levels of mercury in the vegetables are not at concentrations sufficient to be a health risk.

Our plans for the garden include:

- Harvest and analyze fall crops planted 28-Aug-04 (radish, carrots, lettuce, spinach, turnips and beets)
- Evaluate the Limit of Quantitation (LOQ) for mercury in plants to insure that it is adequate to meet the study objective
- Collect floodplain and control garden soils in fall 2004 for mercury analysis
- Evaluate 2004 results and plan for 2005