Models of Cd Absorption by Italian Parsley

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Introduction
Cadmium (Cd), ranked the 7th most hazardous substance, is a carcinogen; chronic exposure to Cd has detrimental effects on the renal, cardiovascular, developmental, gastrointestinal, neurological, reproductive, and respiratory functions of the body. Human consumption of even minute amounts of Cd can pose a health risk.

Cd enters the environment through mining processes, industrial applications, and the burning of coal and industrial wastes. Due to widespread use of Cd as a pigment in plastics, ceramics, glasses, rubber, and paper, it is increasingly found as an environmental contaminant. It may be found at unsafe levels in soils, rocks, coal, and mineral fertilizers. It has even recently been detected in children’s jewelry imported from China.

The primary human exposure to Cd is through consumption of contaminated food products. Crops grown in Cd contaminated soils may take up Cd through roots, and Cd will accumulate in leaves, fruit, and other edible portions of the plant. Increasing urbanization and industrialization will increase the risk of human exposure through contaminated crop consumption, or consumption of animals that have grazed on Cd contaminated plant material.

The objective of this study was to develop a system for effective investigation of Cd uptake in a commonly cultivated garden plant, Italian Parsley (Petroselinum crispum var. neapolitanum), to be applied to future studies investigating toxic metal contamination in areas associated with urban agricultural production of food.

Specific Research Objectives:
• To develop a model system for evaluating the effect of Cd contamination on plants.
• To investigate the effect of Cd on plant growth and development.
• To determine where Cd is deposited in Parsley by measuring the percent Cd absorption in roots and shoots.
• To assess how soil pH may influence Cd uptake in plants.

Methodology

Model 1: Seven-day-old parsley seedlings were transplanted into self-watering pots (Figure 2) containing peat-based soil mix adjusted to three different pH levels: acidic, neutral and basic. The moisture content was maintained by adding H₂O at the lower chamber of the pots. Plants were grown in a greenhouse maintained at 75 °C and 75% humidity. Cd(NO₃)₂ solutions were added to the soil three times a week. Plants were exposed to 210 ppm (Model 1A) and 630 ppm (Model 1B) of Cd.

Model 2: Parsley seeds were directly planted into Magenta jars (Figure 3). The upper chamber contained peat-based soil mix adjusted to three pH levels: acidic, neutral and basic. A wick was placed through a hole in the upper chamber and extended down the lower chamber. The wick served as a medium that allowed diffusion of solution from the lower chamber to the upper chamber. Seeds were planted in the upper chamber and the plants were grown in a light bank equipped with 40 Watt fluorescent light bulbs. The plants were exposed to 16 hours of light. The light bank was stored in a research lab where the average room temperature was 68 °C.

Soil Preparation: In both models, the peat-based soil mix was made acidic using (NH₄)₂SO₄ and was made basic using CaCO₃.

Determining Cd in plant and soil samples: Plants were harvested after eight weeks. They were washed thoroughly with distilled water to remove soil materials. The shoots were separated from the roots and samples were completely dried and weighed prior to analysis to determine the Cd content. Soils were also dried before Cd determination.

Dried samples were digested in concentrated acids (HNO₃ and HCl) and 30 % H₂O₂; were also dried before Cd determination. Soil pH was measured with a pH meter. The soil was dried at 75 oC and 75% humidity. Cd(NO₃)₂ solutions were added to the soil three times a week. Plants were grown in a greenhouse maintained at 75 °C and 75% humidity. Cd(NO₃)₂ solutions were added to the soil three times a week. Plants were exposed to 210 ppm (Model 1A) and 630 ppm (Model 1B) of Cd.

Results and Discussion

Effect of Cd on plant growth and development: In Model 1 there was no visible difference in appearance among plants grown in Cd contaminated soil and the control, however, in Model 2, the plants exposed to Cd grew larger and greener than the control, Figure 4. The variable responses to Cd exposure between the two model systems indicates a potential difference in bioavailable Cd. The results suggest that more Cd is accessible to the plant roots using Model 2. Future studies will include additional indices to more accurately evaluate plant response to Cd exposure.

Deposition of Cd in roots and shoots: Both Model 1 and Model 2 indicate there is a significantly higher deposition of Cd in plant roots versus plant shoots (Figures 5-6). In Model 1, the data suggest that the % Cd absorption is higher in roots than in the shoots. The % absorption in the shoots was less than 10 %; in the roots the % absorption was greater than 25 %. A similar trend was observed in Model 2 but results were not statistically significant.

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References