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Cadmium Uptake and Distribution to Edible Organs in African Indigenous Vegetables

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Abstract

Cadmium (Cd) is toxic to humans. The most important source for dietary intake is consumption of plant products, whereby Cd concentrations in leafy vegetables are particularly high. In peri-urban areas, soils are often contaminated with Cd. Thus, recommendations to increase vegetable consumption should consider species-specific uptake and allocation to edible plant organs. Cadmium uptake and distribution within plant was compared in various species to derive recommendations for vegetable production on contaminated soils. Four African indigenous vegetable species (African Nightshade *Solanum scabrum*, amaranth *Amaranthus cruentus*, cowpea *Vigna unguiculata*, spider plant *Cleome gynandra*), and a standard species commonly grown in Asia (Pak Choi *Brassica rapa chinensis*) were grown in nutrient solution at three Cd-concentrations: 0.1 (low), 1.0 (moderate) and 2.5 μM Cd (high contamination). Biomass and mineral nutrient concentrations were measured in roots, leaves, stems and lateral branches.

Growth was little affected by Cd supply with the exception of amaranth and cowpea. In these species, growth of shoot organs was substantially reduced at moderate and high supply. Growth depression was associated with low leaf iron concentrations indicating Cd-induced iron deficiency. In all species Cd concentrations were higher in roots than in shoot organs, which is in accordance with xylem loading being an important barrier for Cd distribution within plants. At moderate and high supply, Cd concentrations in shoot organs strongly differed among species. Concentrations were particularly low in cowpea, and high in amaranth and African Nightshade. Low Cd concentrations in shoot organs of cowpea were associated with low apparent uptake and translocation rates of Cd from roots to shoots. At all rates of Cd supply, Cd density in edible organs was significantly influenced by species. Cadmium density was particularly low in cowpea and Pak Choi. Based on a vegetable dish of 250 g fresh mass, best choice of species reduced Cd intake by 0.1 mg at low supply (amaranth versus African Nightshade), 0.7 mg at moderate (cowpea versus African Nightshade) and 1.7 mg at high Cd supply (cowpea versus amaranth). Best choice of vegetable species can considerably reduce Cd intake by humans.

Keywords: Cd contamination, cd toxicity, dietary intake, leafy vegetables, peri-urban horticulture