Cadmium in food crops and impact on human health

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The main anthropogenic sources of Cadmium (Cd) in cultivated soils are phosphorus-fertilizers, atmospheric deposition, animal manures, and to a smaller extent liming agents, sewage sludge and biowaste. Cadmium inputs to soil often exceed outputs in crops and drainage water, resulting in slowly increasing levels of Cd in agricultural soils. In Europe, fertilizers have given significant, although highly variable inputs to cultivated soils, from 0.03 to 38 g/ha/year. The average content in European fertilizers is 138 mg Cd per kg phosphorus. In contrast to other toxic metals, Cd in soil is easily taken up by growing plants through the root system and this is facilitated by the ongoing acidification of the environment. In fact, Cd is relatively soluble or easily solubilizable in soil, with the pH being the principal factor determining the degree of solubility. Other factors leading to increased solubility include low organic matter content, low clay content and low cation exchange capacity. The uptake and accumulation of Cd in growing crops are mainly influenced by Cd-concentration in soil, plant species and cultivar, soil pH and organic matter content of soil. Ingestion via food, especially plant-based foodstuff, is the major route of Cd entering the human body from the environment. Therefore, food crops are among the main sources of Cd exposure of the human population. Average human daily intake of Cd from food has been estimated at around 10-50 mg. This may increase up to several hundred mg per day in highly polluted areas. The intake of Cd through inhalation is generally less than half the amount of the intake via ingestion, while daily intake from drinking water ranges from below 1 mg to over 10 mg. There is a risk of adverse health effects as a result of the total Cd exposure. The highly exposed population groups have an evaluated urinary level of Cd that can be associated with high risk of kidney dysfunction and bone effects. More specifically, the kidney, especially the renal tract, is the critical organ of Cd intoxication in humans. Excretion is slow, and renal accumulation of Cd may result in irreversible impairment in the re-absorption capacity of renal tubules. Nevertheless, only a small proportion (approx. 5-10%) of ingested Cd is absorbed by humans, and large variation exists among individuals. Deficiencies of iron, zinc, and calcium in the human body generally facilitate Cd absorption. Since most crops, with the exception of rice, contain zinc that inhibits the uptake of Cd by animals and humans, there is no relevant indication that normal populations are at risk of Cd exposure via the food chain, at the actual concentration of Cd in the soil of most European countries. Based on model calculations, however, if phosphorus fertilizers containing the relatively high average EU level of Cd were to be intensively used in the future, then the dietary intake of Cd would significantly increase in many EU countries by more than 40% over 100 years. This estimated increase of Cd would lead to a much higher increase in the size of the risk groups in the EU population.