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Trace Elements from Soil to Humans

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The quality of human life depends on the chemical composition of food and of the surroundings. There is a homeostatic interrelationship between the non-living media (abiotic compartments) and the living organisms (biotic compartments). The transfer of trace elements through the food chain is a part of their natural cycling. However, several anthropogenic factors already have changed their cycling and especially natural and balanced supply to food and forage.

Chemical solubility of trace elements during weathering, erosion, and transport processes depends on their specific properties. Values of the ratio Cw/Cc (dissolved concentration in river water to concentration of the upper continental crust) indicate which elements are the most stable (Cw/Cc $<$0.001: Nb, Ti, Zr) and the most mobile (Cw/Cc $>$1 to $<$10: Mo, Sb, As, Se, B, Cd, Re, Pd) in the terrestrial environment [1]. These geochemical properties of elements control their behavior in soil and their bioavailability. In addition to geochemical and biogeochemical properties that control the behavior of trace elements, several other factors influence their bioavailability. These are: (i) concentration and quantities, (ii) exposure time and situation, (iii) physical and physiological properties of organisms, (iv) cultivation status of crop plants, (v) age and nutritional status of humans and animals, and (vi) health condition and genetic susceptibility.

The most easily taken up by plants from soil are: Cd, Zn, B, Ni, Sn, Cs, Rb. The most easily absorbed from an alimentary canal of humans and animals are: Cd, Hg, Zn, I, B. There are several metabolic processes of plants that protect against excessive uptake of some trace elements [2]. These are: (i) metal binding by proteins, (ii) detoxification by metallothionein, glutathione and/or amino acids, (iii) interactions between some element, e.g., Cd-Zn, Fe-Co, and (iv) methylation, demethylation. Plants are also able to uptake selectively some elements, to release their excesses as volatile organic metal

compounds (e.g., Hg, Pb, Sn) and to release from some parts such as roots or leaves.

Trace elements that are phytotoxic at concentrations not harmful to human, e.g., B, Cu, Mn, Ni, Zn are of much less concern than elements that are easily concentrated in plants at toxic levels to humans and animals, e.g., Cd, Co, Se, Mo.

According to the EC Commission Regulation [2] maximum levels only for Cd, Pb, and Hg in foodstuffs have to be controlled. Intake of As is also of a real concern. Thus, PTWI (Provisional Tolerable Weekly Intake) values (in μg/kg BW) for adults have been set up for: As, 15; Cd, 7; Hg, 5; and Pb, 25. The Recommended Dietary Allowance (RDA) for other elements also has been estimated for safe and adequate daily intakes for adults (in μg/kg BW) as follows: Cr, 0.6-3; Mn, 26-60; Se 0.9; and Zn 190.

A better understanding of the biogeochemical processes that control trace element cycling and comprehensive dataset on the abundance of trace elements in abiotic and biotic environmental compartments may be a key to better management of trace elements in the environment that is prerequisite to sustainable land use and, presumably, to diminish health risks due to trace inorganic pollutants.

References

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2. Kabata-Pendias A, Mukherjee AB (2007) Trace elements from soils to human, Springer-Verkag (in press)