SOIL AND CROP CONTAMINATION BY TOXIC TRACE ELEMENTS

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ABSTRACT

The objectives of this study were to determine the heavy metal concentrations in different vegetable growing soils, vegetables, fertilizers and manure samples used in their agricultural activities in Up Country and Low Country-Wet zone; and to establish relationships among vegetable Cd concentrations and soil properties. One of the aims was to evaluate if there is (are) a soil characteristic(s) that describe the availability of Cd in these Sri Lankan soils to vegetables. Crop, soil, and fertilizer/manure samples were collected from Kandapola, Sita-Eliya, Bogahakumbura, Haputale and Rahangala for the Up Country. The crops selected were carrot (*Dacus carota*), leek (*Allium ampeloprasum*), potato (*Solanum tuberosum*), cabbage (*Brassica oleracea*), knol-khol (*Brassica oleracea L.*), and lettuce (*Lactuca sativa*). Wellampitiya (representing Sedawatta, Welewatta and kotuvila) and Bandaragama (representing Bandaragama and Kahathuduwa) selected as the Low Country areas and the collected leafy vegetables were Kangkong (*Ipomea aquatica*), Mukunu-venna (*Alternanthera sessilis*), Sarana (*Trionthema portulacastrum*), Spinach (*Spinacia oleracea*), Kura Thampala (*Amaranthus viridis*), and Gotukola (*Centella asiatica).*

Soil, plant, fertilizer and manure samples were analyzed for total heavy metals (Cd, Cu, Ni, Pb, and Zn). Further, DTPA extractable heavy metals were measured in soil samples as a measure of plant available heavy metals in soils. In Up country, soils with the highest concentrations of heavy metals were found in Haputale, (Cd 3.85 mg/kg, Ni 167.9 mg/kg, Pb 242.88 mg/kg and Zn 486.75 mg/kg) and Rahangala (Cu 114.58mg/kg). In Low country, Sedawatta area recorded the highest heavy metal concentrations in Soils (Cd

3.28 mg/kg, Cu 111.75 mg/kg, Ni 28.3 mg/kg, Pb 113.22 mg/kg, Zn 420.6 mg/kg). Those observed values were higher than the European Community Set Standards in 1986 for the maximum concentrations of heavy metals allowed in agricultural soils treated with sewage sludge. Mean values of Cd and Pb in some leafy vegetables, vegetables and root/tuber crop samples collected from some fields located in both Up country and Low country were higher than the FAO/WHO recommended values for leafy vegetables (0.44 and 9.59 mg/kg for Cd and Pb, respectively). There was a strong positive correlation between the total and exchangeable heavy metals except for Ni in studied soils (r^2 values were for Cu = 0.91, Zn = 0.51, Pb = 0.78, Cd = 0.68 and Ni = 0.05). Further there was a positive relationship with exchangeable heavy metals in soils and plant heavy metal concentrations (r2 values were for Cd = 0.15, Cu = 0.11, Ni = 0.28, Pb = 0.27, and Zn = 0.58) while there was a negative correlation with soil pH and plant Cd concentrations (r^2 = 0.71). Analyzed poultry manure samples had 0.43, 23.9, 6.87, 3.2 and 220.06 mg/kg Cd, Cu, Ni, Pb, and Zn concentrations, respectively and cattle manure always had equal or lower levels of those heavy metals compared to poultry manure (0.43, 8.23, 4.7, 1.1 and 57.47 mg/kg Cd, Cu, Ni, Pb, and Zn concentrations, respectively). Among organic and inorganic manures/fertilizers analyzed, inorganic fertilizer triple super phosphate (TSP) had the highest Cd concentration (23.5mg/kg). Even though the concentrations of heavy metal in those manure and fertilizers (except for Cd concentration in TSP) did not exceed the maximum permissible levels of heavy metals recommended by the Sri Lankan Standard Institute for compost from municipal solid waste and agricultural waste, they can be accumulating in agricultural soils with time especially due to both continuous and

over application of organic manures and inorganic fertilizers over a long period of time as evidenced before in Europe, New Zealand and Australia. These results provide initial evidence that, Sri Lankan leafy vegetables and soils have heavy metal contamination, and emphasize the importance of extensive investigations on the extent of heavy metal contamination in Sri Lankan soils and vegetables, and their sources as well as possible control measures to reduce the associated risk due to food chain transfer of toxic heavy metals.