

Human (oral) health risks and dietary exposure assessment of potentially toxic trace elements in foodstuffs (vegetables and crops): A case study of Shangla, North Pakistan

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The current study depicted the potentially toxic trace elements (PTTEs) contamination and associated health (oral) risks in different foodstuffs (vegetables and cereal crops) in district Shangla, north Pakistan. The determined PTEs concentrations except lead (Pb) and chromium (Cr) in vegetables and crops samples were considerably found lower than the stated limited in international guideline for human consumption. Based on one-way analysis of variance (ANOVA) the concentration was significantly ($p < 0.05$) different in various types of vegetables and crops except that for manganese (Mn), copper (Cu), and nickel (Ni). The highest Cr and Pb contents were reported in vegetables samples, followed by cereal crops (*T. aestivum*, *O. sativa* and *Z. mays*). The data obtained on the basis of principal component analysis (PCA) two principal components (PCs) were extracted. The PC1 added 36.12% with greater factor loading (FL) on Ni ($r = 0.79$), Cr ($r = 0.64$), and Cu ($r = 0.69$) indicating mafic and ultramafic geogenic source of contamination. The human health risks indicated the following order for adults and children and in term of day-wise hazard quotient and intake: Pb>Mn>Cu>Cr>Ni and Pb>Mn>Ni>Cu>and Cr, respectively. The cancer risks factor (CRsF) for Ni, Cr, and Pb were found to be higher than the tolerance limit ($< 10^{-4}$) in all vegetables and cereal crops. The findings of this study confirmed the human (oral) health risks (THQ>1.0) through the intake of vegetables and cereal crops among child population of the study area.