Evaluation of heavy metal contamination in paddy plants at the Northern Region of Malaysia using ICPMS and its risk assessment

ABSTRACT

Heavy metals from natural and anthropogenic sources accumulate in soil and plants and as a consequence represent important environmental contamination problems. Nevertheless, food safety issues and adverse health risks make this one of the most serious environmental issues. The aim of the present study was to assess heavy metal contamination in the paddy plants from the northern area of Malaysia using Inductively Coupled Plasma Mass Spectrometry (ICPMS) and its risk assessment. In total, the heavy metals (As, Cd, Cu, Cr, and Pb) of the samples of paddy plants harvested from Kedah areas were extracted using an acid digestion method, while the heavy metals for soil samples using ammonium acetate. The heavy metal concentrations were then analysed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The enrichment (EF) and translocation factors (TF) of heavy metals were calculated, and health risk assessment (HRA) was performed. The EF values for heavy metals from the soil to roots, roots to stems, stems to leaves, and stems to grains followed the order Cu > As > Cr > Cd > Pb, whereas Cr and Pb were characterized by greater TF values from stem to grain than the other elements. The average daily dose (ADD) for both children and adults is below the safe value intake for each of the studied elements. The combined hazard index (HI) of five elements was beyond the acceptable value (HI >1). The carcinogenic risk, as exemplified by lifetime cancer risk (LCR), indicated that single exposure to As or Cr, in both adults and children, was greater than 10−4. The total cancer risk (CRt) resulting from multiple exposure to carcinogenic elements exceeded the acceptable value (CRt >1 ×10−4) in both adults and children. Overall, exposure to heavy metals through rice consumption poses potential non-carcinogenic and carcinogenic health risks to the local residents in the northern area; thus, regular monitoring of pollution in the area is crucial.

Keyword: Average daily dose; Enrichment factor; Hazard index; Lifetime cancer risk; Paddy soil; Translocation factor