BIOAVAILABILITY AND HEALTH RISK OF METALS IN URBAN DUSTS

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RESEARCH HIGHLIGHTS

- Heavy metals gets into human body mostly through oral ingestion of environmental samples.
- To quantify the risks associated with oral ingestion of urban dust particularly by children, bioavailability fraction is required, as the total metal content may not give the real risk involved.
- Lead (Pb), Arsenic (As) and Cadmium (Cd) were analysed for the bioavailable fraction in urban dust of this study.
- The carcinogenic risks expressed that all the values were within the permissible limits of 1×10^{-6} to 1×10^{-4} with the order $As > Cd > Pb$.
- Children who ingested dust could have no possibility of non-cancer risks because both the HQ and HI values were below the tolerable limits of 1.

The Bioavailable concentration of metals in urban dust were lower. The oral exposure to toxic metals in urban dust is in the order $Pb > As > Cd$. The carcinogenic and non-carcinogenic risks as a result of oral ingestion of dust may not pose significant effects on children, this is because the values are within or below the tolerable limits.

RESEARCH OBJECTIVES

The aims and purpose of this research is for the control of pollution and prevention of risks associated with exposure to urban dust in urban cities, as in the recent decade is the topmost burden on both developed and developing countries of the world. Therefore, the objectives of this work is were to (i) quantify the concentration of heavy metals in dust sample; (ii) assess the exposure levels and contributions of toxic metals in urban dust; (iii) estimate children health risk as a result of exposure to heavy metals in urban dust.

MATERIALS AND METHODS

Prior to the digestion all containers were soaked in a 5% (v/v) HNO_3 for 24 h overnight and ultrapure water from Milli-Q system (Millipore Corporation, USA) was used to rinse the containers about two times. The samples were digested with concentrated suprapure HNO_3 (69% Merck, Germany) and 30% H_2O_2 (R & M Chemicals, UK) using the USEPA Method 3050B and analysed for total concentrations inductively coupled plasma mass spectroscopy (ICP-MS 7500ce Agilent technology).

The bioavailable metals were extracted using the simulation methods to mimic the human digestive system following the physiologically based extraction test adopted by Man et al., (2010) (1). The health risk exposure assessment through the oral route was done using the following equation [1] in accordance to the exposure factors Handbook by the United State Environmental Protection Agency (USEPA) (2).

$$Exp = \frac{Cx \times IngR \times EF \times ED \times CF}{BW \times AT} \quad (1)$$

Where Cx equals to metal concentration in dust sample (mg/kg), IngR is the dust ingestion rate (mg/ay, EF represents the exposure frequency (days/year), CF stands for conversion factor (10^{-6} mg/kg), BW is the body weight (kg), At is the average exposure time (day).

RESULTS

The Values of the bioavailable concentration of metal are in the following order $Pb > As > Cd$. The values of the oral ingestion exposure level contribution to children were very low with the

order $Cd < As < Pb$. The values for the bioavailable cancer risks are $Pb = 1.19E-07$; $As = 5.46E-06$; $Cd = 1.25E-06$, and the total cancer risk (TCR) results for bioavailable content of metal is $6.83E-06$. Whereas, the hazard quotient (HQ) values for the bioavailable metal concentrations were $Pb = 3.73E-03$; $As = 1.29E-02$; $Cd = 2.12E-04$. And the hazard index (HI) value is $1.69E-02$ for bioavailable content. All the values with respect to carcinogenic and non-carcinogenic risk associated with children exposure to urban dust through oral route were within the allowable limits.

FINDINGS

Our findings shows that the bioavailable fractions were seen to be lower. This suggests that not all amount of metals ingested in dust by humans would be solubilized in the gastrointestinal tract (3). Therefore, using bioavailability fraction will give more realistic health risk of metals to human in dust than total metal which could overestimate it. The cancer risk and total cancer risk were found to be within the permissible limits of 1×10^{-6} to 1×10^{-4} , suggesting children who ingests dust have no possibility of incremental lifetime cancer risks (4). Both the hazard quotient and hazard index on oral ingestion of dust by children were found to be > 1 . Meaning no non-carcinogenic risk.

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