KTH Land and Water Resources Engineering

ARSENIC EXPOSURE RISK FROM RICE AND OTHER DIETARY COMPONENTS IN RURAL BENGAL

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ABSTRACT

This study investigates the risk of arsenic (As) exposure from staple diet to the communities in rural Bengal, even when they have been supplied with As safe drinking water. The results indicate that average accumulation of As in rice grain increases with decrease of grain size [extra-long slender (ELS): 0.04 mg kg^{-1}; long slender (LS): 0.10 mg kg^{-1}; medium slender (MS): 0.16 mg kg^{-1} and short bold (SB): 0.33 mg kg^{-1}], however people living in the rural villages mostly prefer brown colored SB type of rice because of its lower cost. Among the vegetables generally consumed in rural villages, the accumulation of As is highest in the leafy type of vegetables (0.21 mg kg^{-1}), compared to non-leafy (0.07 mg kg^{-1}) and root vegetables (0.10 mg kg^{-1}). Arsenic predominantly accumulates in rice (>90%) and vegetables (almost 100%) in inorganic species [As(III & V)]. The estimates of exposure via dietary and drinking water routes show that when people are consuming water with As concentration <10 μg L^{-1}, the total daily intake of inorganic As (TDI-iAs) exceeds the previous provisional tolerable daily intake (PTDI) value of 2.1 μg day^{-1} kg^{-1} BW, recommended by World Health Organization (WHO) in 35% of the cases due to consumption of rice. Considerably high concentration of As in urine and saliva despite drinking of As safe water (<10 μg L^{-1}) further supports that dietary intake of As, mainly through consumption of rice could be alternative pathway of As exposure among the population. When the level of As concentration in drinking water is above 10 μg L^{-1}, the TDI-iAs exceeds the previous PTDI for all the participants. These results imply that when rice consumption is a significant contributor to the TDI-iAs, supplying water with As concentration at current national drinking water standard for India and Bangladesh (50 μg L^{-1}) would place many people above the safety threshold of PTDI. When As concentration in drinking water exceeds 50 μg L^{-1} As exposure through drinking water largely predominates over the exposure through dietary intake. It is found that the consumption of vegetables in rural Bengal does not pose significant health threat to the population independently. It is also revealed that cooking of rice with high volume of As safe (<10 μg L^{-1}) water can decrease both total and inorganic As content in cooked rice. However, the assessment of As exposure risk indicates that despite such lowering in As concentrations, still consumption of cooked rice is a significant pathway of As exposure to the population in rural Bengal. This study suggests that any effort to mitigate the As exposure of the villagers in Bengal must consider the risk of As exposure from rice consumption together with drinking water.

Key words: Rural Bengal; Arsenic; Rice and other dietary components; Total daily intake; Biomarkers; Risk assessment