Assessment of arsenic exposure from drinking water and dietary components in Arsenic affected regions of West Bengal, India
Implication for sustainable arsenic mitigation managements

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SUMMARY

Deterioration of drinking water quality due to presence of dissolve Arsenic (As) is now a global problem and the problem is most severe in South & South East Asia notably in West Bengal (Eastern India) and adjoining Bangladesh. After the first reporting of elevated levels of dissolved As in the drinking water lot of research has been undertaken regarding well screening, source characterization, and mobilization along with possible mitigation processes. The initiatives have also led to the development of strategies to reduce As exposure from drinking water. Both national and international agencies are now working to provide safe drinking water to the affected rural population, by remediation of the As-contaminated groundwater, changing the sources of drinking water by targeting deeper safe aquifer, or supplying treated surface water. But the problem has remained unchanged.

This study has been carried out to identify the major As ingestion route (drinking water, rice and vegetables) into human body. For this study 24 drinking water samples, 157 rice samples from randomly selected household and 80 vegetable samples from local market and home gardens were collected and measured both tAs and iAs. The As concentration in drinking water varies BDL to 875 µg L⁻¹. Among the 24 surveyed tube wells, 9 tube wells (37.5%) are safe according to WHO drinking water guideline (10 µg L⁻¹). While considering India and Bangladesh national drinking water standard 15 tube wells (62.5%) are safe for As. Although the numbers of safe tube wells are comparatively less but about 74% villagers are drinking As safe water (<10 µg L⁻¹) which indicates that social awareness about As exposure from drinking water has increased among the villagers and people are sharing safe drinking water sources. All the collected household rice samples are of brown color and can be classified into three categories short bold (SB), medium slender (MS) and long slender (LS) according to their grain size and shape. People in rural Bengal mostly prefer SB type of rice due to its lower cost and they think that it takes longer time to digest and thus feel less hungry. Determination of tAs in these rice samples indicates that both the variation and mean As concentration decreases with increasing grain size. One important finding is that among three types of rice people have higher threats to iAs due to consumption of SB type of rice rather than MS and LS type of rice. People who are consuming SB type of rice are divided into three categories younger, middle and older age group participants. Among these three age groups younger and older age
groups are at higher threat to iAs than middle age group participants. The higher risk among younger and older age group participants is due to higher amount of rice consumption together with lower body mass index. According to the edible parts, collected vegetables samples can be divided into three groups leafy, non-leafy and root vegetables. The highest As is present in leafy vegetables compared to non-leafy and root vegetables. If tAs accumulation is compared among individual vegetables of different groups, higher As concentrations are observed in spinach and amaranth leaf for leafy vegetables, amaranth steam for non-leafy vegetables and giant taro, arum tuber and elephant foot for root vegetables. Speciation study indicates that rice contain about 92% of inorganic As whereas vegetables contain 100% of inorganic As.

The comparison of daily intake of inorganic As from drinking water, rice and vegetables indicates that about 17% participants are at potential health threat due to consumption drinking water and rice separately, while none of the participant have this threat due to consumption of vegetables. Although, As in most of the vegetables is present exclusively as inorganic species, consumption of vegetables alone is not a potential health risk to the population, but can increase the value of total daily intake of inorganic As (TDI-iAs) significantly together with rice. The values of TDI-iAs were categorized according to the ranges of As concentration in drinking water viz <10, 10 – 50 and > 50 µg L\(^{-1}\) to examine the contribution of drinking water and dietary components (rice and vegetables) to the TDI-iAs for each participant. When people are drinking water with concentration <10µg L\(^{-1}\), in 35% of the cases TDI-iAs value exceeds the previous WHO recommended PTDI value 2.1 µg day\(^{-1}\) kg\(^{-1}\) BW. At this concentration level in drinking water the contribution of daily intake of inorganic As from rice consumption (DI-iAs-R) predominates over the daily intake of inorganic As from drinking water (DI-iAs-DW) and daily intake of inorganic As from vegetable (DI-iAs-V). When people are drinking water with As concentration >10 to 50 µg L\(^{-1}\), for all the participants TDI-iAs exceeds WHO guideline value and DI-iAs-R and DI-iAs-DW contribute almost equally to TDI-iAs. The relative contribution of DI-iAs-DW to TDI-iAs becomes higher than DI-iAs-R when the As concentration in drinking water exceeds 50 µg L\(^{-1}\). At all As concentration ranges in drinking water, the contribution of DI-iAs-V to TDI-iAs is very small. Furthermore, the determination of urinary As concentration of the participants, who were drinking As safe water indicates that despite drinking of safe water urinary As concentration is very high and positively correlate with DI-iAs-R (\(r = 0.57\)). This indicates that people in rural Bengal, even when are supplied with safe water are at potential risk of As exposure due to consumption of rice.

From this study it is clear that together with remediation of As from drinking water we have to be concerned about other exposure pathways like rice and vegetables. Introduction of the policies for sustainable agricultural practice that minimize the transfer of As from groundwater to soils to human food chain is essential. It should also be mentioned that improvements in nutritional status can eventually reduce the As burden and health treats to the exposed population. It can be concluded that in rural Bengal mitigation of As poisoning needs integrated approaches rather than the traditional fragmented strategies.

**Keywords:** West Bengal, arsenic exposure, drinking water, dietary components, provisional tolerable daily intake
Papers based on this study:


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