MULTI-METAL INVESTIGATION IN GROUNDWATER AND SALIVA IN AN AREA OF WEST BENGAL, INDIA

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Introduction

The groundwater of Bengal delta plain comprising of Bangladesh and West Bengal, India is well known to the scientific community for the elevated levels of arsenic (As) in groundwater (>10 $\mu g L^{-1}$). However, groundwater in Bengal delta plain is a complex mixture of various dissolved metals of different concentrations, and as a result, there is unintentional co-exposure of several contaminants to individuals (Frisbie et al., 2002). Therefore, exposure from groundwater source is commonly in the form of multiple metals and considering the single-As exposure does not appropriately represent the health risk of a community.

The primary aim of the present work was to monitor a suite of toxic metals in ground water and examine saliva as a representative biological matrix for assessing multiple metal exposures in a rural population of West Bengal, India.

Methods

Study area and sample collection

The study areas, Debagram and Chhoto-Itna are neighboring villages which are located in the northern part of the Nadia district in West Bengal, India. Fifty groundwater samples from tubewells were collected randomly to have a wider coverage of the area. Fifty saliva samples were collected from the male residents of the area. For this study, male participants were only considered so as to minimize the gender differences. The details of the sample collection have been documented in our previous publication (Bhowmick et al., 2013).

Sample analysis

The cations and trace elements in water samples were analyzed using ICP-AES. As concentration in water samples was measured using hydride generation AAS. For saliva samples, appropriate amount of HNO_3 (2% v/v) and Bruker "Internal Standard" solution (1 $\mu g\ L^{-1}$) was added to 1 mL of the saliva sample. The solution was finally diluted to 3 mL with Milli-Q water and was measured for trace elements using ICP-MS in normal (Pb), helium (As, Cr, Mn, Ni, Zn) and hydrogen mode (Se).

Results

Groundwater portability and health

All the groundwater samples were analyzed for toxic elements (As, Mn, Cr, Mo, Ni, Pb, Ba, Zn, Se, U) and the results indicate that As concentrations in groundwater of our study area are of most important concern and exceeding much above the WHO drinking water guideline value (< 10 $\mu g\ L^{-1}$) in all the wells. Similar to As, Mn concentrations were high in the groundwater, mostly in the shallow aquifers, where the

aquifers are under reducing condition. Although the WHO health based guideline value for Mn is currently being discontinued from the former value of 400 µg L^{-1}, recent studies are increasingly showing that the even low Mn concentration can cause neurological effects, where infants are more prone to such manifestation (Bouchard et al., 2011). The high concentration of Mn in groundwater of our study areas also advocates that the guideline should be re-introduced. Principal Component Analysis (PCA) was done to investigate the interaction among all the elements in saliva and the evaluation shows two distinct grouping: (i) As and Mn, and (ii) Se and Zn (Fig. 1). The clustering of As and Mn was in concordance with the inevitable high exposure from drinking water and locally irrigated foodstuff. Food is the main source of dietary Zn and Se supplement. Unfortunately, the drinking water, crops and ultimately diet in this part of the globe (West Bengal, India and Bangladesh) are deficit in Se and Zn. Thus the scarcity of Se and Zn exposure in the residents is presumably being reflected in the clustering of these elements.

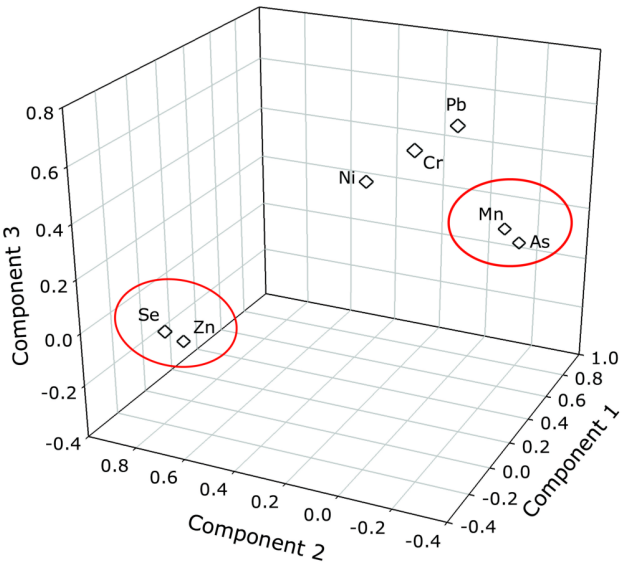

Figure 1. Principal component analyses of the salivary elements.

Conclusion

The present study that was carried out in one of the arsenic-affected areas of Nadia district, West Bengal, India addresses the issue of co-occurrence of other metals with arsenic. Our results implicate saliva as a biological fluid has the potential of reflecting the exposure of toxic metals and can potentially be used for biomonitoring purposes. Therefore, multi-metal exposure in drinking water is an important issue that needs serious attention in future.

References

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