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Dietary intake of trace elements from highly consumed cultured fish (*Labeo rohita, Pangasius pangasius* and *Oreochromis mossambicus*) and human health risk implications in Bangladesh

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HIGHLIGHTS

- Sample collected from 30 different agro-ecological zones for the first time in Bangladesh.
- Arsenic in cultured fish was the major contributor to people's health risks.
- Health risks from arsenic in tilapia fish was higher than other fishes.
- Health risks of arsenic from fish alone were low but it was high if other sources are considered.
- Inhabitants are exposed chronically to arsenic with carcinogenic and non-carcinogenic risks.

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ABSTRACT

Concentrations of fourteen trace elements (essential and toxic) in the composite samples (collected from 30 different agro-ecological zones for the first time in Bangladesh) of three highly consumed cultured fish species (*Labeo rohita*, *Pangasius pangasius* and *Oreochromis mossambicus*) were measured by inductively coupled plasma mass spectrometry (ICP–MS). The estimated daily dietary intake (EDI) of all the studied elements was estimated on the basis of a calculation of the amount of fish consumed by Bangladeshi households (mean fish consumption of 49.5 g person^{-1} d^{-1}). The studied fish species pose no risk with respect to the EDI of Cd, Pb, Cr, Ni, Zn, Se, Cu, Mo, Mn, Sb, Ba, V, and Ag. Among the three studied fishes *O. mossambicus* showed higher content of dietary arsenic (1.486 mg kg^{-1}). From the human health point of view, this study showed that the inhabitants in the arsenic-contaminated area, who consume arsenic-contaminated water with fish (especially for *O. mossambicus*), are exposed chronically to arsenic pollution with carcinogenic and non-carcinogenic risks.

1. Introduction

Environmental pollution is now being considered as a major problem in developed, developing and undeveloped countries (Kazi et al., 2009; Gallo and Almirall, 2009; Ozden, 2010). Recent years have witnessed significant attention being paid to the problems of environmental contamination by a wide variety of chemical pollutants including the trace metals (Gallo and Almirall, 2009; Orecchio and Amorello, 2010). Metals from natural and anthropogenic sources continuously enter the aquatic ecosystem where they pose serious threat because of their toxicity, long persistence, bioaccumulation and biomagnification in the food chain (Papagiannis et al., 2004). Trace metals are important from the viewpoint of their toxicity and their essentiality. Trace metals can be classified as potentially toxic (arsenic, cadmium, lead, mercury, and nickel etc.), probably essential (vanadium and cobalt) and essential (copper, zinc, iron, manganese, and selenium) (Munoz-Olivas and Camara, 2001). Toxic elements can be very harmful even at low concentration when ingested over a long time period. The essential and

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probably essential metals can also produce toxic effects when the metal intake is excessively elevated (Celik and Oehlenschlager, 2007). In recent decades, much attention has been paid to the study of essential and toxic trace element content in foodstuffs, as a result of a growing concern about the health benefits and risks of food consumption. In Bangladesh, the evaluation of risks and benefits of the consumption of fish is extremely important because fish supply 60–80% of the animal protein needs of the country, as well as being a key source of essential minerals, vitamins and fatty acids, vital factors in child development and adult health. Furthermore, fishes have been used for many years to indicate the pollution status of water, and are thus regarded as excellent biomarkers of metals in aquatic ecosystems (Muiruri et al., 2013). Moreover, it is important to observe the level of heavy metals in consumed fishes to get some ideas about the safety of fish protein supplied to the consumers and to understand its harmful effects among individuals, population or ecosystem.

Historically, Bangladesh feeds her population with fishes caught mostly from the inland open water fisheries. Bangladesh, as a developing country, is at a high risk of aquatic pollution, especially the inland water bodies which is facing the highest pollution problems due to the contamination of trace metals excessively released from domestic, industrial, mining and agricultural effluents or run-offs. Moreover, the groundwater which is severely contaminated by arsenic and also contain other trace metals (Fig. 1), are being frequently used for the purpose of hatchery operations and culture of highly consumed fish species (BGS and DPHE, 2001). Total arsenic in tilapia is highly correlated (R^2 = 0.80) with total arsenic concentration of pond water (Kar et al., 2011). As a result, the consumed fishes which are fished from the contaminated water bodies would be considered as one of the most severe sources of human health hazards. For this reason, determination of chemical quality of aquatic organisms, particularly the contents of heavy metals in fish is extremely important for human health (Dural et al., 2007). There is no or limited information on the trace metals concentration in composite fish samples which are commonly consumed by the Bangladeshi population. The objective of the study is to determine the level of trace elements in highly consumed fishes in Bangladesh and to evaluate the risks of these trace metals on daily consumption.

Several analytical techniques are available for trace element determination in fish samples (Ikem and Egiebor, 2005; Tuzen and Soylak, 2007). In this study, trace elements (toxic and essential elements) in three different highly consumed cultured fish species (Rui, Pangas and Tilapia) in Bangladesh were determined by ICP–MS after microwave digestion method.

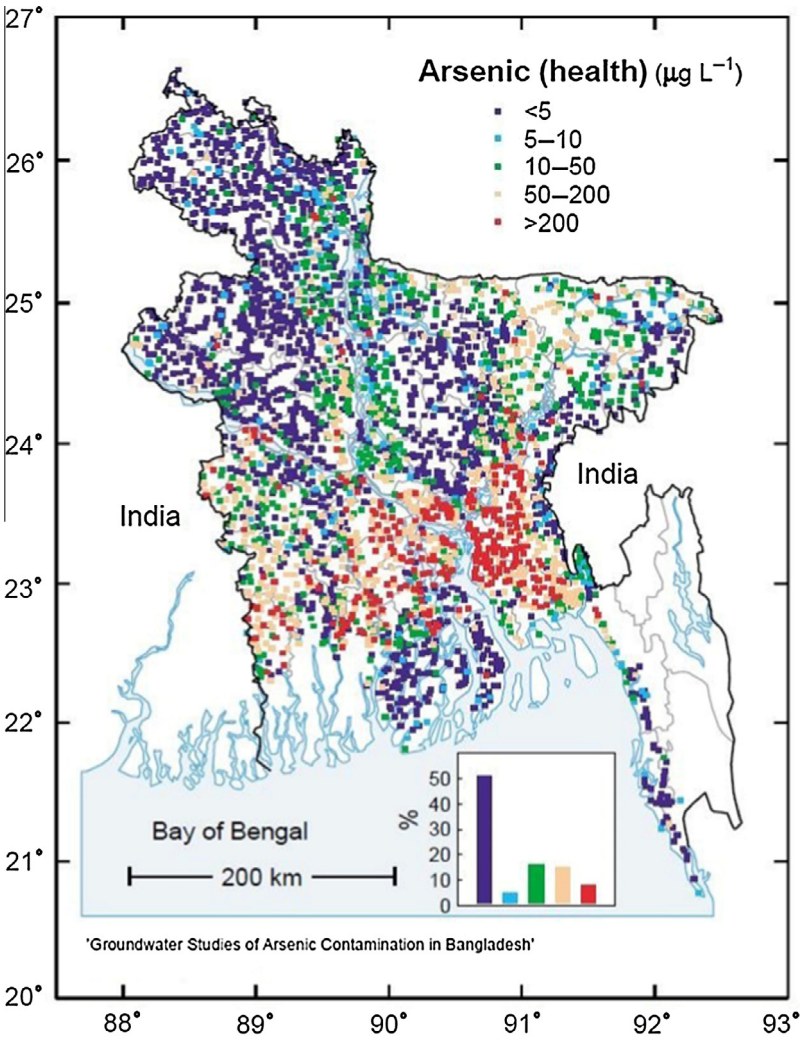

Fig. 1. Map showing the concentration of arsenic in ground waters based on the DPHE/BGS National Hydro-chemical Survey. Class divisions are chosen on the basis of health criteria.