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Review

Concentration of heavy metals in seafood (fishes, shrimp, lobster and crabs) and human health assessment in Saint Martin Island, Bangladesh

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ABSTRACT

A contaminated aquatic environment may end up in the food chain and pose risks to tourist health in a tourist destination. To assess the health risk for tourists that visit St. Martine Island, which is a popular domestic and foreign tourist destination in Bangladesh, a study is undertaken to analyse the level of heavy metal contamination from chromium (Cr), manganese (Mn), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd), lead (Pb), mercury (Hg) and iron (Fe) in six of the most consumed fish (*L. fasciatus, R. kanagurta, H. nigrescens, P. cuneatus, P. annularis* and *S. rubrum*) and five crustacean species, which consist of a shrimp (*P. sculptilis*), a lobster (*P. versicolor*) and three crabs (*P. sanguinolentus, T. crenata* and *M. victor*) captured. The samples were analysed for trace metals using atomic absorption spectrometer, and the concentrations of the metals were interpreted using the United State Environmental Protection Agency (USEPA) health risk model. The muscle and carapace/exoskeleton of shrimp, lobster and crabs were analysed and contained various concentrations of Pb, Hg, As, Cr, Cd, Fe, Cu, Zn and Mn. The hierarchy of the heavy metal in marine fish is Fe > Cd > Zn > Pb > Cu > Cr > Mn > Hg. The concentrations of Pb in the species *R. kanagurta, H. nigresceus* and *S. rubrum* were above the food safety guideline by Australia, New Zealand and other legislations in most marine fish and crustaceans. Crabs showed higher mean heavy metal concentrations than shrimp and lobster. Acceptable carcinogen ranges were observed in three fish species (*R. kanagurata, H. nigresceus* and *S. rubrum*) and one crustacean species (*P. sculptilis*) samples.

1. Introduction

The world consumption of seafood, such as marine fish and crustaceans (shrimp, crabs and lobster) and their products has increased with the growing concern of their nutrition and health welfare although they contain protein and is a rich source of essential minerals, vitamins and polyunsaturated fatty acids, such as omega-3 and omega-6 (Guérin et al., 2011; Kris-Etherton et al., 2003). This situation makes the quality of seafood highly important for the public health. We review the health risks that may emanate from various heavy or trace metal contamination of seafood as it is positioned in the food chain (Matta et al., 1999; Türkmen et al., 2009; Tüzen, 2003). However, the trace metal contamination of seafood is gradually becoming a global crisis given that sea water is vulnerable to the growing discharges of pollutants at the bay on almost every coast around the world (Ahmed et al., 2015). The human health risk associated with the consumption of food contaminated by toxic metals have been known for a long time (Cooke et al., 1990; Gupta et al., 2008). Human organs, such as the liver, kidney, central nervous system, mucus tissue, intestinal tract and reproductive system may become severely damaged if sea fish is contaminated by hazardous trace metals and are consumed at a population level (Siddique et al., 2012). Environmentally traced metals are present; characteristically, they are freely dissolved and are readily taken up by fish and other aquatic organisms. Food, water and sediment-traced metal can be accumulated by marine organisms, among them are fish and crustacean (crabs, lobster and shrimp) (Mansour and Sidky, 2002; Yilmaz et al., 2007). Crustaceans, particularly crabs, may be a good indicator for measuring the contamination level in the surface sediment. For example, crustaceans are better than fish in this connection; crustaceans may act as a typical benthic organism, and it may be considered as an absolutely discrepant aquatic species (Ololade et al., 2011). The aquatic environment may be deteriorated with the incessant entry of metals from natural and anthropogenic sources. Their long persistence, bioaccumulation, bio-magnification and toxicity in the

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food chain may cause serious health hazard (Papagiannis et al., 2004). Thus, microorganism, fishes, crustaceans and other aquatic animals may consume trace metal residues from the contaminated habitats, and it may go to human food chain causing health risk (Cooke et al., 1990; Gupta et al., 2008). Moreover, crustaceans (crabs, lobster and shrimp) are mobile, and their tissue concentration of copper, manganese and zinc is regulated (Rainbow, 1988). Thus, fish and crustaceans are used as biomarkers or bio-monitors that accumulate trace metals in different body parts.

In Bangladesh, most of the tannery, textile, electroplating, mining, dyeing, printing, photographic and pharmaceutical industry effluents are discharged directly into rivers. Coastal waters are polluted with the discharge of river water that carries contaminants. In the process, fish, crustaceans and other aquatic biota that live in polluted coastal waters become contaminated. The consumption of sea fish and others from such waters threatens human health in the long run. Commercial fish hosts about five million people at the coast. Fish and crustaceans are the main protein source and the source of earning or livelihood for coastal masses.

To date, no complete study was carried out to determine the contamination level of seafood in St. Martine Island of Bay of Bengal. Thus, determining the concentrations of trace metals in fishes and crustaceans that consider the possible health risk of tourists and local people through seafood consumption is important. In the present study, the level of metals in the marine fish, crabs, lobster and shrimp from the landing and surrounding areas of St. Martin Island were determined. Based on certain trace metals (Cr, Mn, Cu, Zn, As, Cd, Pb, Hg and Fe), content in some marine fish and crustaceans (shrimp, crabs and lobster) were compared against the recommended maximum permissible limit to assess the quality of seafood for tourist and local consumption.

2. Materials and method

2.1. Description of the sampling sites

The St. Martin Island of Bay of Bengal is the only coral island of Bangladesh (Fig. 1); it is most dependent on tourism (Rashid, 2008) and separated from the mainland by a channel that is approximately 9 km wide. It is approximately 8 km and shrinks to approximately 5 km^2 during the high tide west of the northwest coast of Myanmar, at the mouth of the Naf River. Among 8000 residents, voter registry showed 1342 males and 1379 females. The main tourist season is November to February. During this period, less than 200 people visit the island daily. Visitors generally spend 3–4 h on the island and then leave. However, six boats ferry more than 3000 tourists between Teknaf and the island every day and more than 5000 to 7000 tourists during holidays due to festivals and weekends (Rashid, 2008) and tend to stay overnight in the small island.

2.2. Collection and preparation of the samples

Eight mostly consumed fish (*L. fasciatus, R. kanagurta, H. nigrescens, P. cuneatus, P. annularis S. rubrum, T. jarbua* and *L. atkinson*) with their mean weight (105, 280, 22.5, 275, 275, 175, 175 and 30 g, respectively) and five crustacean species (one shrimp (*P. sculptilis*), one lobster (*P. versicolor*) and three crabs (*P. sanguinolentus, T. crenata and M. victor*) with their mean weight of 22.5, 105, 90.0, 45.0 and 22.5 g), were collected from different points of Saint Martin's Island and its local market (Fig. 2). Immediately after the collection, all samples were kept in an airtight insulating box and thereafter transported to the fisheries laboratory, Jagannath University, Dhaka, Bangladesh. The samples were rinsed with deionised water to remove surface adherents at the laboratory. The edible parts of the fish samples were cut into small pieces and homogenised with a stainless steel blender cup. The shell/carapace was kept in the microwave, woven to dry and ground properly by the agnate motor. The powder is strained to achieve better powder. Constant weight is obtained. All samples were freeze-dried for 48 h.

2.3. Microwave assisted digestion procedure

Microwave accelerated reaction system (MARS-5, Australia) was carried out to determine the toxic metals of the pasted sample (fish and crustacean). A portion of 1.0 g pasted samples was transferred directly to the XP-1500 plus ™ digestion vessels that were soaked in 20% HNO_3 for 24 h, washed with distilled water and dried properly. Approximately 6 ml of HNO_3 was added to the sample. The complete vessel module was then placed onto the turntable motor assembly of the plant. The heating system of the three steps was applied: (a) ramping time: 15 min

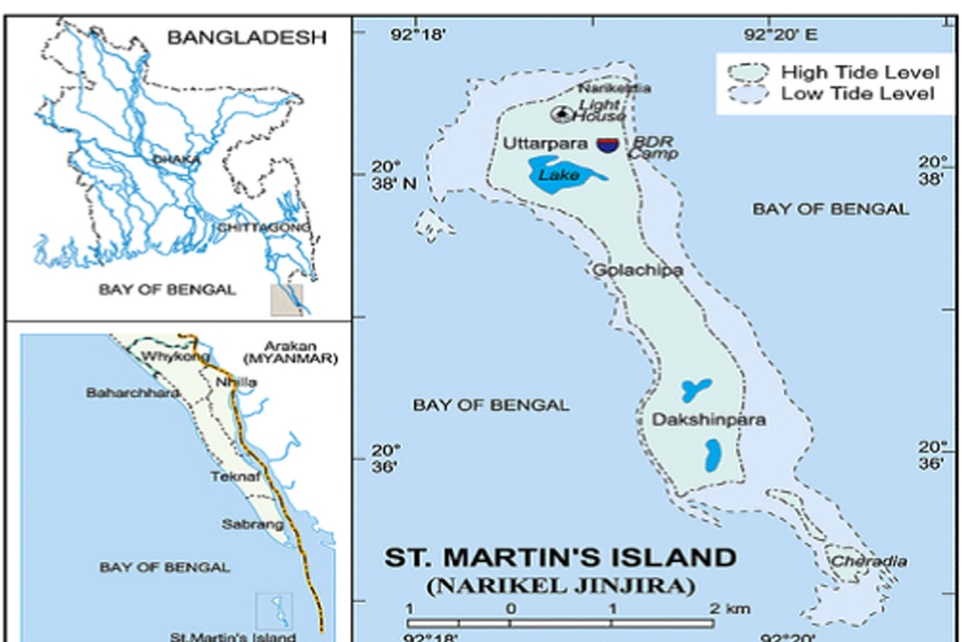

Fig. 1. Map of the sampling areas in the St. Martin's Island.