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Toxic heavy metals in commercially important food fishes collected from Palk Bay, Southeastern India

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ABSTRACT

Toxic heavy metals are an important group of emerging chemical contaminants in seafood. Heavy metal concentrations in commercially important and most commonly eaten 10 fish species from Thondi fish landing, southeast coast of India, were determined by atomic absorption spectrometry. The concentrations of heavy metals significantly varied within and between the investigated fish species ($P < 0.05$). The results of this study showed best significant correlations among the toxic heavy metals in the fish samples. It was revealed that Cd, Pb, Cu, and Zn metals were present in the fish samples at various levels. The residual levels of toxic heavy metals were less than the permissible levels specified for human consumption by the European Union, Food and Agriculture Organization and World Health Organization guidelines. Therefore, the fish species found in the Thondi fish landing and their fishery products can be considered safe for human consumption and can be exported worldwide.

Fishes are considered as an important food source of macronutrients (carbohydrates, animal protein, fatty acids, vitamins, and polyunsaturated fatty acids) and micronutrients (copper, zinc, iron, and selenium) for human health. Marine chemical contamination can increase the concentrations of toxic heavy metals in aquatic systems and thereby negatively affect the fish health. Such heavy metal pollution can be caused by different natural and anthropogenic sources, including agricultural drainage, industrial effluent discharge, sewage discharge, accidental chemical waste spills, and gasoline from fishing boats (Mishra et al., 2007; Satheeshkumar and Kumar, 2011; Velusamy et al., 2014; Mathivanan and Rajaram, 2014). The accumulation of heavy metals in marine fishes depends on the environmental condition, season, location, distribution, habitat preference, tropic level, feeding habit, age, size, sex, duration of exposure to the metals, and homeostatic regulation activity (Sankar et al., 2006). Accumulations of heavy metals were found in the water and sediment columns, and these metals enter into the food web through the feeding of benthic and pelagic species (Galay Burgos and Rainbow, 2001).

Heavy metals such as iron (Fe), copper (Cu), and zinc (Zn) are important for fish metabolism, while mercury (Hg), lead (Pb), cadmium (Cd), and other metals have unknown functions in their biological system. Metabolic activity plays an important role in the bioaccumulation of trace metals in marine organisms (Velusamy et al., 2014). Sivaperumal et al. (2007) stated that the essential metals can also produce toxic effects at high residual concentrations. Only few metals with proven hazardous nature are to be completely excluded in food for human consumption. Heavy metals such as Cd, Cu, Pb, and Zn are the most common contaminants in fish and fishery products. Consumption of elements such as Pb causes severe health risks such as fatigue, irritability, myalgia, coma, kidney, liver, and brain damage, seizures, encephalopathy, nervous system dysfunction, and development of cancer. Cadmium toxicity caused Itai-Itai disease in Japan and can causes bone disease, anosmia, yellow discoloration of the teeth, and loss of olfaction abilities (Sanders et al., 2009; Sankar and Ashok Kumar, 2014). Various analytical methods have been developed for the determination of heavy metals in fishes. The most widely used techniques are atomic absorption spectrometry (AAS), inductively coupled plasma optical emission spectrometry, inductively coupled plasma-mass spectrometry, X-ray fluorescence, particle-induced X-ray emission, total reflection X-ray fluorescence, neutron activation analysis, atomic fluorescence spectrometry, ion chromatography, and immunoassay (Sivaperumal et al., 2007; Sankar and Ashok Kumar, 2014; Velusamy et al., 2014; El-Moselhy et al., 2014; Kulawik et al., 2016).

Marine fish and fishery products constitute an important diet of human food, and it is therefore not surprising that abundant reports are available on toxic heavy metal contamination in different marine edible fish species (Mitral et al., 2000; Sankar et al., 2006; Sivaperumal et al., 2007; Prabhu Dass Batvari et al., 2008; Uysal et al., 2008; Prabhu Dass Batvari et al., 2012; Akan et al., 2012; Kumar et al., 2012; Murthy et al., 2013; Heidarieh et al., 2013; Javed and Usmani, 2013; Usha and Vikram Reddy, 2013; Elnabris et al., 2013; El-Moselhy et al., 2014; Kulawik et al., 2016; Velusamy et al., 2014). Seafood is the most preferred food worldwide, and it is important to study the bioaccumulation

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of heavy metals in commercially and economically important fish and fishery products. Toxic heavy metal residues can be hazardous to human health, and it often becomes mandatory to screen the chemical contaminants in fish and fishery products from the aquatic environment to understand their potential health effects. Therefore, this study aimed to determine the levels of toxic heavy metal residues (Cd, Pb, Cu, and Zn) in the muscle tissues of 10 marine fish species.

Fish samples used in this study were collected from Thondi, Palk Bay, Southeast Coast of India (latitude: 9° 44′ N and longitude: 79° 00′ E) (Fig. 1). The water quality parameters like pH, atmospheric temperature, surface water temperature, dissolved oxygen, salinity, and levels of phosphate, nitrate, nitrite, total nitrogen, and ammonia were measured using the standard procedures (APHA, 1998; AWWA, 1998; WEF, 1998). Fishes were caught during April–May 2016 using trawl net. The net was trawled approximately 30–50 min in the direction opposite to the water current. After trawling, the fishnet was lifted on to the boat and finfish, shrimps, crabs, and cuttle fish were segregated. They were collected from fishermen and packed into HiMedia polyethylene bags (HiMedia Mumbai, India). Fish samples were stored in a deep freezer (−20 °C) prior to analysis.

The concentration levels of Cd, Pb, Cu, and Zn were analyzed according to the European Standards. One gram of homogenized fish sample was added to a mixed reagent of nitric acid, perchloric acid, and sulfuric acid at a ratio of 5:2:1. Mineralization was performed on a hot plate at 50 °C for 30 min. After the end of digestion, 10 ml of 2 N HCl was added; digested solutions were filtered and made up to 25 ml with double distilled water and stored at room temperature for further analysis (FAO/SIDA, 1983). Cd, Cu, Pb, and Zn were determined by AAS (Shimadzu 7000, Japan) at the wavelengths of 228.80, 324.75, 217.00, and 213.85 nm, respectively. Heavy metal standards were prepared and run to check the precision of the instrument throughout the analysis. The quality assurance and quality control protocol set by the U.S. Environmental Protection Agency for metal analysis was used. The quality assurance testing relied on the blank controls and the yield of the chemical procedure.

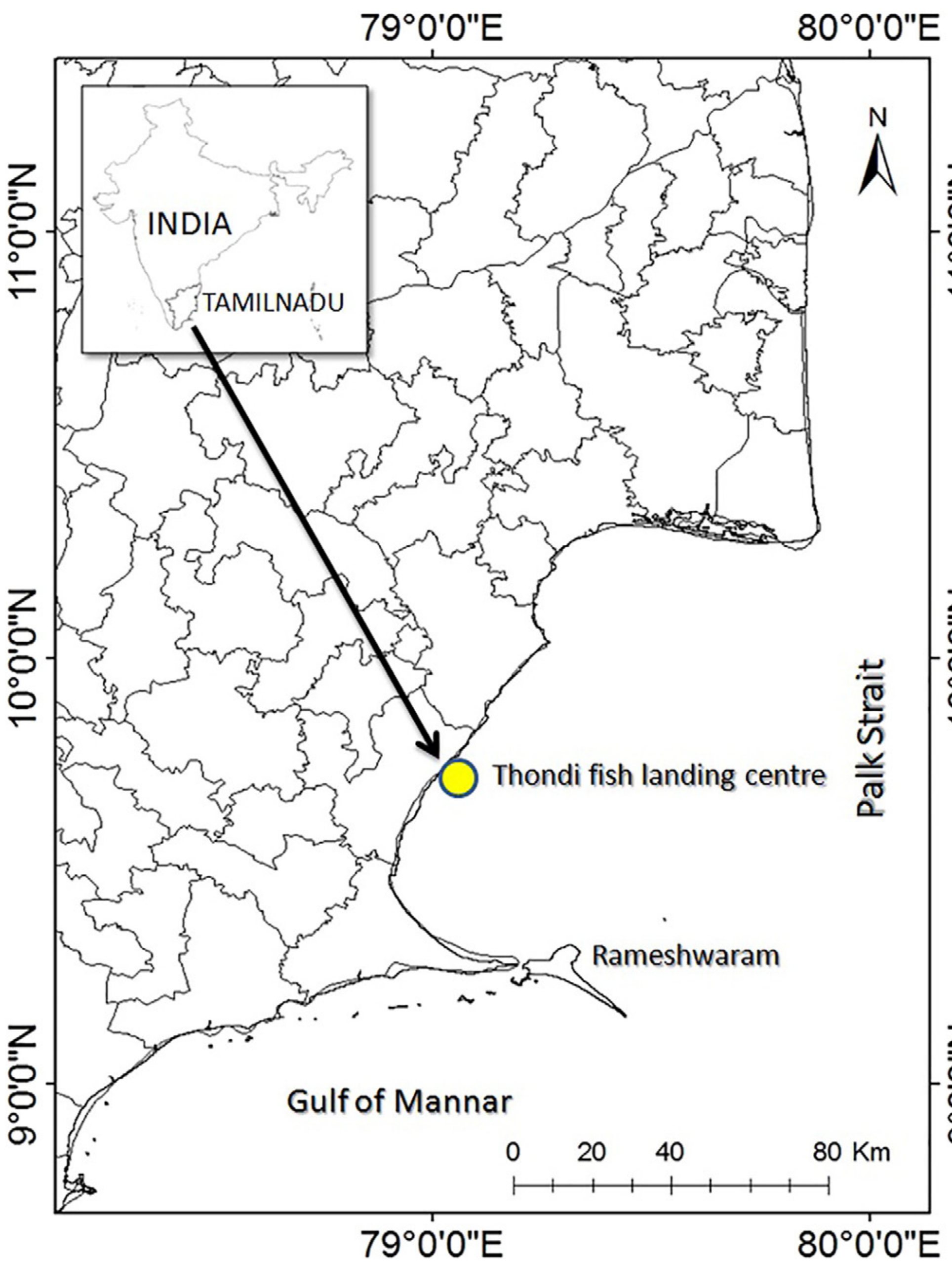

Fig. 1. Study Area of Thondi, Palk Bay, Southeast coast of India.