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Joystu Dutta[1]*, Goutam Roy Choudhary[2] and Abhijit Mitra[3]

[1]Department of Environmental Science, Sarguja University, Ambikapur, Chhattisgarh 497001, India
[2]Chancellor, Techno India University, EM Block, Sector V, Salt Lake City, Kolkata, West Bengal 700091, India
[3]Department of Marine Science, University of Calcutta, Kolkata 700019, India

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***Corresponding author:** Joystu Dutta, Assistant Professor, Department of Environmental Sciences, University Teaching Department, Sarguja University, Ambikapur (C.G)-497001 India, Tel: +91 7049804500; E-Mail: joystu.dutta@gmail.com

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Research Article

Bioaccumulation of Toxic Heavy Metals in the Edible Fishes of Eastern Kolkata Wetlands (EKW), the Designated Ramsar Site of West Bengal, India

Abstract

This paper attempts to conduct a survey in the commonly edible finfish species collected from EKW during three seasons of 2016. Eastern Kolkata Wetland (EKW) is the only designated Ramsar Site in West Bengal The wetland with an area of about 12, 500 hectares act as natural kidneys and is also the natural sewage treatment plant for the ever increasing city of Kolkata. This multiple-use wetland lies on the eastern fringes of the city and includes a garbage dump known as Dhapa Square Mile, a mosaic of vegetable fields, a series of 300-odd fishponds connected by major and secondary canals, paddy fields, wholesale markets, a few roads, and 43 villages with an ever increasing population. The fishponds produce some 13,000 tons of fish annually, whose yield is at 2-4 times higher than average fish ponds, is among the best of any freshwater pisciculture in the country. Some 150 tons of vegetables per day are harvested from small-scale plots irrigated with waste water. It is essential to conduct a survey of the bioaccumulation pattern of toxic heavy metals such as Pb, Cd, Cr, and Hg in the finfish species commonly consumed by people in this region. The survey was carried out during three seasons of 2016. The accumulated toxic heavy metals were found in the order Pb > Cd > Cr > Hg. The seasonal order was Monsoon > Postmonsoon > Premonsoon. The seasonal variation might be the effect of monsoonal runoff from the highly urbanized and industrial city of Kolkata that convey huge quantum of effluents in the water of EKW. Such study has immense importance as fishes are consumed by a large percentage of the people in and around Kolkata. This study would also provide a roadmap for researchers and policymakers to identify and implement effective and sustainable measures to counteract the increasing trends of pollution levels in natural ecosystems

Background

Fishes are the important source of protein with high nutritional value and are consumed by a large percentage of the population in and around Kolkata. According to Basic Animal Husbandry and Fishery Statistics Report [1] the total fish production during 2014-15 in West Bengal in terms of marine and inland fisheries are 178, 851 tonnes and 1, 438, 468 tonnes respectively while total fish production is 1, 617, 319 tonnes. According to Handbook on Fisheries Statistics Report [2], consumption of fish in rural areas of Lakshadweep is over 16 times the national average with Goa at second spot. Kerala and West Bengal rank third and fourth respectively in fish consumption. Many species of fishes are also exported to foreign countries which bring foreign currencies in the basket of Indian economy. However, it has become a potential concern in the present *era* as the fish muscles are often contaminated with chemicals, pesticides, detergents and toxic heavy metals due to increased industrialization, urbanization, agricultural run-off, usage of toxic chemicals to grow food crops and fishes. Heavy metals are conservative in nature and predominantly originate from anthropogenic sources. However, natural sources also contribute considerable heavy metal dissolution in the aquatic phase. Chemical and physical weathering of rocks and soils often releases heavy metals into the sediments and water [3]. Among the anthropogenic sources, industrial discharges [4-6].idol immersion during festive occasions [7] [8] add considerable toxic heavy metals in the water bodies. Metals that are transferred into water may accumulate in the food chain and finally may get transferred in the human. Many of the metal ions such as Pb, Cd, As, Hg, Cr are highly toxic in nature and hence deserve special attention. The present paper is an attempt in this direction to evaluate the seasonal variation of four common toxic heavy metals Pd, Cd, Cr and Hg in three species of finfishes such as *Catla catla*, *Labeo rohita* and *Oreochromis niloticus*.

Citation: Joystu D, Choudhary GR, Abhijit M (2017) Bioaccumulation of Toxic Heavy Metals in the Edible Fishes of Eastern Kolkata Wetlands (EKW), the Designated Ramsar Site of West Bengal, India. Int J Aquac Fish Sci 3(1): 018-021. DOI: 10.17352/2455-8400.000023

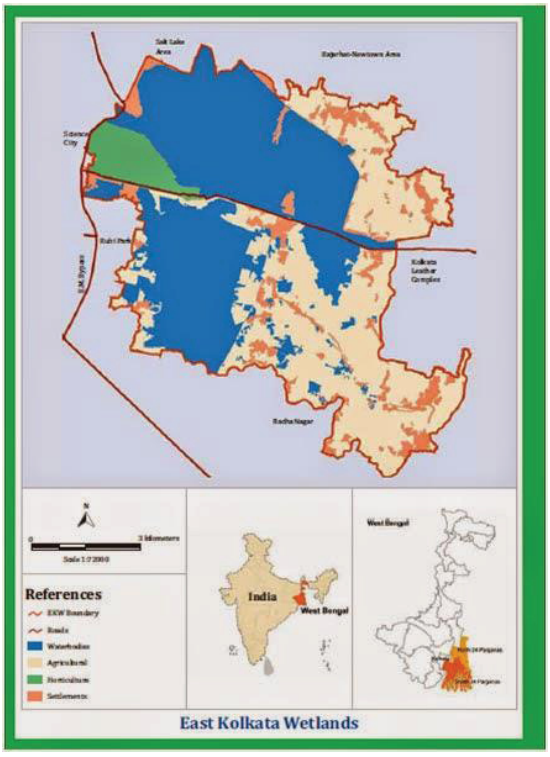
Materials and Methods

Study Site: East Kolkata Wetlands (EKW) is situated at the eastern outskirts of the mega city of Kolkata, India (22º 25' to 22º40' N and 88 º20' to 88º35' E). It is the designated Ramsar Site of West Bengal and is of immense ecological importance. The fish ponds locally known as bheries of the area offers important ecosystem services such as microclimate maintenance, temperature regulation, flood control, recycling of municipal wastes and effluents (generated from urban and semi urban areas), fish production, livelihood, addition of aesthetic beauty to the municipal city of Kolkata etc. EKW is an extremely dynamic as well as ecologically sensitive ecosystem from the point of view of primary production and is a unique reservoir of a galaxy of phytoplankton, which serve as the foundation stone of food chain existing in the system [9] (Figure 1).

Source: EKWMA (Google Earth)

Sample Collection and analysis: Fish specimens were collected from *Natur bheri* (one of the innumerable bheries of East Kolkata Wetlands) in three seasons during 2016. About five to eight fishes of each species were collected and brought in ice freeze condition (temperature -20º c) in the laboratory. Five to eight samples are basically the merging of ten sub-samples and hence n=50-80. The muscle tissues of each species were removed separately and oven dried overnight at 105ºc. After complete drying, the fish muscles were powdered and stored separately by labeling the samples. 1 gm of dried tissues (in three replicates) was mixed in 10ml solution of HNO3and HClO4 in the ratio 5:1. The solution were stirred for few minutes and kept for overnight. The flasks were then placed on a hot plate with tightly corked and allowed to digest at ~250º C until a transparent and clear solution was obtained. The use of microwave-assisted digestion appears to be very relevant for sample dissolution, especially because it is very fast [10-12]. This solution was separately aspirated in Atomic Absorption Spectrophotometer with Hydride module (NOVA 350 Model) and the readings were recorded considering the blank correction.

Heavy metals have tendency to accumulate in the aquatic organisms, preferably fishes, which in turn may enter into human metabolism through consumption causing serious health hazards. The present study was therefore undertaken to observe the level of contamination of selective toxic heavy metals in the fish tissues collected from the only Ramsar Site of West Bengal. The analysis of selected toxic heavy metals in the present study revealed an order of Pb > Cd > Cr > Hg, irrespective of species. The seasonal order of toxic heavy metals are Monsoon> Postmosoon> Premonsoon. (Table 1-4). The unique seasonal variation has been documented because the present geographical locale in the tropical belt has contrasting seasonal features with highest temperature and minimum rainfall during Premonsoon and maximum precipitation (1900 mm average per year) and moderate temperature during monsoon and lowest temperature and minimum precipitation during postmonsoon.



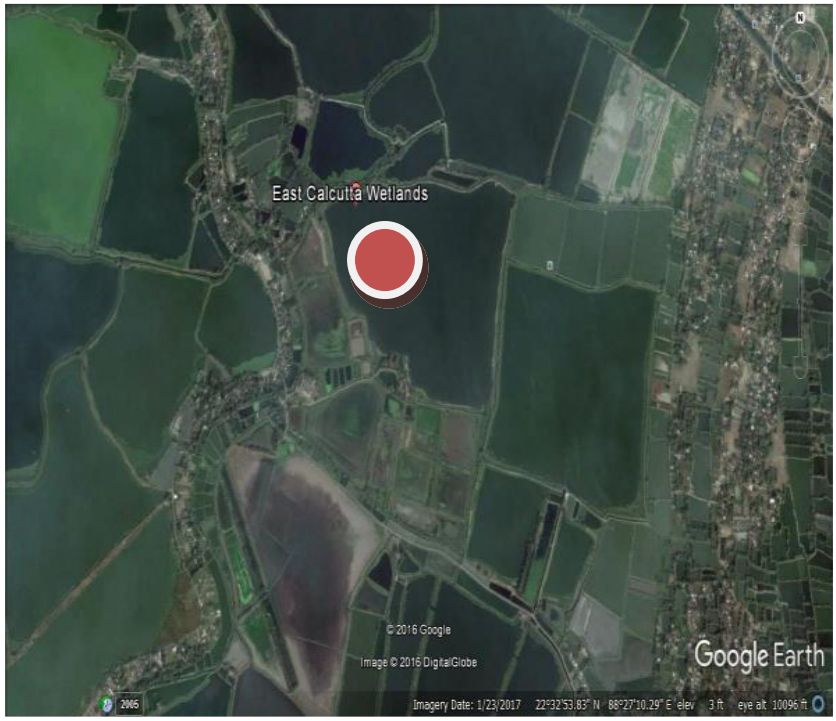


FIGURE 1: HIGH RES MAP OF EKW.
EASTERN KOLKATA WETLANDS; THE DESIGNATED RAMSAR SITE OF KOLKATA, WEST BENGAL INDIA.

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Discussions

Fishes are major part of the human diet due to considerable protein levels, low density lipoprotein and sufficient omega fatty acids which are key ingredients to maintain good health. Therefore, various studies have been undertaken worldwide on the contamination of different fish species by heavy metals [13-19]. Fish accumulate toxic chemicals such as heavy metals directly from water and diet, and contaminant residues may ultimately reach concentrations hundreds or thousands of times above those measured in the water, sediment and food [20-22]. The present study reveals highest concentration of toxic heavy metals in monsoon season, the period characterized by maximum runoff from adjacent landmasses and lowering of pH due to increase of dilution factor. The synergistic effects of these two factors might be the reason for the highest values of toxic heavy metals in the muscles of selective fish species. The results of this study provide valuable information on the heavy metal levels in the selected water bodies of East Kolkata Wetland. The present data of toxic heavy metals such as Lead (Pb), Cadmium (Cd), Chromium (Cr), Mercury (Hg) as revealed during study of seasonal variations in 2016 is much lesser than permissible limits in fish species as suggested by Choi [23]. Choi recommendations are pertinent across the world since the permissible limits as proposed by him are compared to various parameters and in consonance with FAO and WHO recommendations accepted across the world. When considering the toxic heavy metals in fish species, the most important aspect is their toxicity to humans/ suitable for human consumption. Since, the muscles are mostly consumed compared to other internal organs, therefore the present study focuses on the muscle portion of the edible fishes. However, the accelerated values of the heavy metals in the monsoon season in the present study is a matter of concern and requires regular monitoring along with preventive measures during the periods of maximum precipitation.

Table 1: Seasonal variation of Pb (in ppm dry wt.) in selected fish species of EKW

Species	Premonsoon	Monsoon	Postmonsoon	Recommended value (As per Choi, 2011)
Rohu *(Labeo rohita)*	1.16	1.40	1.26	6.00
Tilapia *(Oreochromis niloticus)*	1.34	2.16	1.43	6.00
Catla *(Catla catla)*	0.62	0.94	0.79	6.00

Table 2: Seasonal variation of Cd (in ppm dry wt.) in selected fish species of EKW

Species	Premonsoon	Monsoon	Postmonsoon	Recommended value (As per Choi, 2011)
Rohu *(Labeo rohita)*	0.69	0.92	0.76	2.00
Tilapia *(Oreochromis niloticus)*	0.95	1.79	1.03	2.00
Catla *(Catla catla)*	0.60	0.80	0.71	2.00

Table 3: Seasonal variation of Cr (in ppm dry wt.) in selected fish species of EKW

Species	Premonsoon	Monsoon	Postmonsoon	Recommended value (As per Choi, 2011)
Rohu *(Labeo rohita)*	0.54	0.87	0.61	1.00
Tilapia *(Oreochromis niloticus)*	0.78	1.37	0.82	1.00
Catla *(Catla catla)*	0.33	0.49	0.41	1.00

Table 4: Seasonal variation of Hg (in ppm dry wt.) in selected fish species of EKW

Species	Premonsoon	Monsoon	Postmonsoon	Recommended value (As per Choi, 2011)
Rohu *(Labeo rohita)*	0.31	0.63	0.42	0.5
Tilapia *(Oreochromis niloticus)*	0.57	0.71	0.60	0.5
Catla *(Catla catla)*	0.24	0.55	0.38	0.5

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