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Research Article

Accumulation of Arsenic Induced by E-Waste in Fresh Water Fish, *Channa Punctatus*

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Abstract

The present study revealed that *Channa punctatus* cultivated in Western regions of U.P. (India) and sold in markets had arsenic above the standard tolerance limit. The dried tissues of Gastro-Intestinal Tract (GIT) were subjected to acid digestion. Completely digested samples were analyzed by using Atomic Absorption Spectrophotometer (AAS). After measuring the heavy metal concentration by the aforesaid process, data was collected. Arsenic content in water was found to be 39.0 ± 0.05 µg/l. In the digested GIT sample of *C. punctatus*, the level was found to be 0.90 ± 0.51, 0.92 ± 0.29 and 0.73 ± 0.32 µg/g respectively. The natural aquatic systems may extensively being contaminated with heavy metals released from components of electrical and electronic equipment such as Batteries, Circuit boards, Plastic casings, Cathode-Ray Tubes, activated glass and lead capacitors, thus classified as E-waste. Therefore, heavy metals content of both water and fishes of this region has reached too high level to be harmful for human health. Heavy metals released from E-waste after reaching aquatic systems are transferred to fishes cultivated in these regions and finally to human beings through food Chain. Thus the fish consumed for good health might be contaminated with harmful heavy metals. Effects of E-waste exposure on fish health will play a key role in the development of protective policies.

Key Words: Arsenic; E-waste; *Channa punctatus*.

Introduction

The quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions all over the world. Electronic Waste (E-waste) is the term used to describe old, end-of-life electronic appliances such as "computers, laptops, TVs, DVD players, mobile phones, mp3 players" etc. which have been disposed of by their original users. Technically, electronic waste is only a subset of WEEE (Waste Electrical and Electronic Equipment). In 2006, the International Association of Electronics Recyclers (IAER) projected that 3 billion electronic and electrical appliances would become WEEE or E-waste by 2010. That would be tantamount to an average E-waste generation rate of 400 million units a year till 2010 [1]. As per United Nations Environment Programmer report, about 20-50 MT (million tons) of E-waste is disposed off globally each year, which accounts for 5% of all municipal solid waste [2].

Last few years India has emerged as one major IT hub and the consumer electronic market has grown in an exponential rate. In 2005, the Central Pollution Control Board (CPCB) estimated India's E-waste at 1.47 lakh tons or 0.573 MT per day [3]. There are 10 States that contribute to 70% of the total E-waste generated in the country. The State of Maharashtra tops the list generating 20,270 tons of E-waste annually. The other States leading in the generation of E-waste are Tamil Nadu, Andhra Pradesh, Uttar Pradesh and West Bengal. Uttar Pradesh is on the fourth position, generating 10381.11 tons of E-waste in India [4]. A report of the United Nations predicted that by 2020, E-waste from old computers would jump by 400 percent on 2007 levels in China and by 500 percent in India. Additionally, E-waste from discarded mobile phones would be about seven times higher than 2007 levels and, in India, 18 times higher by 2020 [5]. It was also estimated that around 50,000 tons of E-waste was generated through import from around the World besides 3, 32,000 tons generated domestically. Many disassembly of E-waste increases the release of hazardous substances to the environment. Toxic substances like arsenic, lead, cadmium and mercury leach into the soil and ultimately pollute the ground water, if E-waste is dumped to the ground.

Material and Methods

Water Sample Collection: Ground water samples of certain regions in Rampur and Moradabad (Western U.P.) near dumping sites of electronic wastes were collected and further analyzed by Atomic Absorption Spectrometry. The samples were collected in prewashed double capped glass bottles. The bottles were prewashed with detergent and followed by nitric acid and doubly di-ionised distilled water [6].

Collection and acclimatization of Experimental Fishes: Fishes with almost same sizes and weight were collected from a local fish market of Moradabad and Rampur and used for the experiment. Fishes were transported to the laboratory in large buckets with proper covering and frequent agitation.

On arrival at the laboratory, the fishes were immediately released into the big tanks containing tap water and then maintained there

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for about 6-7 days in a static condition, so that all other toxicants could be flushed off except the arsenic or any other metal stored in various tissues *viz.* Gastro-Intestinal Tract (GIT).

Fish were fed on Goat liver twice daily. Any debris or unwanted particles were removed from the tank after feeding. The water medium was changed at 24 hrs interval to remove the metabolic pollutants. Air compressor was used for oxygenation of water. The water quality parameters of the acclimation tank were studied at times. Only healthy fishes were used for the experiment and the length and weight of the fishes were noted.

Experimental Procedure: The GIT was removed and oven dried at 105°C for 24 hrs. Weighted amount of dried tissues were digested with mixture of nitric acid and per-chloric acid in 3:1 ratio. Digested samples were made up to 25ml with metal free double distilled water and arsenic measurements were made using AAS [7].

Statistical Analysis: The measurements thus obtained were analyzed by using ANOVA (Analysis of Variance) followed by secondary test SNK (Student Newmann Keul's). The results are expressed as Mean ± SD.

Results

F-value obtained from analysis of variance was calculated as 335.156 at $p<0.05$ significance level with 0.978 strength of association. Results shown in table-1 depict the range, mean and standard deviation of arsenic content in water while table-2 that in GIT of Fish. Results shows significantly high ($p<0.05$) arsenic content in fish tissue.

Table-1: Arsenic content in water (μg/l)

Range	Mean	S.D.
38-41	39.0	0.05

Table-2: Arsenic content in GIT of *Channa punctatus* (μg/g).

	Mean	S.D.
Set-I	0.90	0.51
Set-II	0.73	0.32
Set-III	0.92	0.29

Discussion

Arsenic is one of the most toxic element present as Gallium Arsenide found in LEDs, solar cells, microwaves, semi-conductors, circuit boards, LCD displays and computer chips, which is disposed of by E-waste and thereby contaminating the groundwater. As the electronic parts of these components pile up in landfills, the arsenic present leaches into the soil and the ground water composition. The presence of arsenic in E-waste and its high toxicity tending to bio-accumulate in fresh water fishes. Contamination of the aquatic environment by arsenic has increased during recent years primarily due to anthropogenic sources [8,9].

Contamination of water by arsenicals and consequent toxicity in aquatic organisms has now emerged as a global environmental problem. Arsenic is known to cause adverse effect in aquatic biota and is a major concern to human health [10]. Fish accumulate substantial concentrations of heavy metals in their tissues and thus represents major dietary source of heavy metal to humans. Arsenic level was found to be below the standard tolerance limit but not quite low levels as to be ignored. According to Todd, 1980 the standard tolerance limit for Arsenic is 0.005mg/l. So considerable contamination was obtained in the fish we unknowingly consume daily as our staple food [11,12].

Bioaccumulation factors (BAFs) for total arsenic in fish ranged from 10.3 to 22.1, whereas BAF for inorganic arsenic ranged from 1.33 to 2.82 [13] Due to the lack of formal arsenic concentration norms in fish, it is very difficult to judge the potential human risk related to the consumption of fish. The Joint FAO/WHO Expert Committee (1983) has also set a limit of 0.1μg/g. Comparison of these results with Standard values suggest that the inhabitants in this region are being subjected to elevated arsenic exposure through the consumption of fish *Channa punctatus*.

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