DOI:10.33451/florafauna.v24i1pp183-186

FLORA AND FAUNA ISSN 2456 - 9364 (Online)

2018 Vol. 24 No. 1 PP 183-186 ISSN 0971 - 6920 (Print)

ESTIMATION OF CADMIUM FROM DRINKING WATER SOURCES AND ITS EFFECT ON CHICK EMBRYO DEVELOPMENT

*PRADNYA KALEKAR[1], SHAMPA CHAKRABORTI[2] AND *SHANKAR LAWARE[3]

[1]Department of Environmental Science,
Fergusson College, PUNE– 411004, INDIA

[2]Department of Microbiology,
H.V. Desai college, PUNE-411002, INDIA

[3*] Arts, Commerce and Science
College (ACS) College, Sonai,
Newasa, AHMEDNAGAR- 414105, INDIA

*Corresponding Author:
E-mail sllfergusson@gmail.com

Received : 18.02.2018; ***Accepted*** : 15.03.2018

ABSTRACT

The aim of the study was to screen Cd contamination from the River Mutha and to investigate its effects on chick embryo development. The study was correlated with the toxicity of fetal development in humans, as chick embryo provides an excellent model system for studying the development of higher vertebrates including humans. The estimated average concentration of Cd in water column of River Mutha was 0.0986 mg/l, exceeded the safe limit of drinking water (0.0003 mg/l). To study the effects of Cd on chick embryo development, analogous concentration observed in River water was introduced in fertilized chicken eggs. Aqueous solutions of Cd ranging from 0.05 to 1.00 mg/l were injected into fertilized chicken eggs at 72 hours of incubation and metal injected eggs were further incubated for 10 days to see the toxic effects if any. Control eggs were treated in the similar way with sterile distilled water. Results showed abnormal development of blood vessels and decrease in the embryo survival rate in the Cd treated eggs.

Figure : 01 References : 16 Tables : 03

KEY WORDS : Cadmium, Chick, embroy, Pollution, River Mutha, Toxicity, Water

Introduction

Cadmium (Cd) is known for its persistence in environment, toxicity and subsequent bioaccumulation at very low level[4]. Major natural sources of Cd are windblown dusts, forest fires and from acidic rain breakdown soil from where it enters into streams, lakes, rivers and groundwater. Anthropogenic sources of Cd in surface water include agricultural runoff, draining sewage, industrial discharge, mining, ammunitions and vehicular deposition along with rainwater and streets runoff[9]. Cd is the most common element principally used in the production of batteries, solder and alloy, fertilizer production, stabilizers in rubber and plastics, fungicides, electroplating industry and pigments in paints[15]. Cd is particularly important, as it is the seventh highest priority hazardous substance according to the Agency for Toxic Substances and Disease Registry[1].

The chick embryo model is commonly used to examine the development of early stages in both birds and mammals, as well as embryo toxicity phases of hazardous heavy metals[11]. Investigation of Cd toxicity on chick embryo right from early development in comparison to control can address its effects on the amniotic development[6].

The study was intended to assess the Cd concentration in River Mutha, which is the major source of water for drinking, agriculture and aquaculture of Pune city; consequently to estimate the effect of Cd on the early embryonic development in chick embryo to scrutinize its toxicity.

Materials and Methods

Study area

The study area comprises sampling locations representative of the River Mutha in the Pune urban stretch. Water samples were collected from six sampling stations from main stream of River using composite sampling method. The sampling sites have been divided

ACKNOWLEDGEMENTS : Authors are thankful to Head, Department of Environmental Science and Research Centre, Department of Biotechnology and Principal, Fergusson College, Pune, India for supporting the experimental work.

TABLE-1: Sampling stations and locations of River Mutha

No. of sampling stations	Location of sampling stations	Latitude	Longitude
S1	Warasgaon	18°23'46.82"N	73°36'48.72"E
S2	Panshet	18°22'49.11"N	73°36'22.36"E
S3	Kuran	18°23'16.62"N	73°39'8.21"E
S4	Khadakwasla	18°25'42.85"N	73°45'27.60"E
S5	Vitthalwadi	18°28'58.82"N	73°49'48.49"E
S6	Pune Urban	18°31'35.16"N	73°51'35.41"E

based on biogeography and land use. The sites S1 and S2 represent origin of rivers Ambi and Mose, while sites S3 and S4 drain intermixing zone where water is lifted for drinking purpose. Sites S5 and S6 were chosen to evaluate changes in water quality due to impact of drains of waste water into the river. Table 1 provides the geographical setting and description of sampling sites.

Water sample collection and analysis

All the samples were collected by following standard techniques and methodologies as per EPA protocol[2]. Samples were preserved on site using conc. HNO_3, transported to the laboratory and stored in freezer[3]. All reagents used were of analytical grade. Working standard of Cd was prepared by diluting concentrated stock solution of 1000 mg/l in de-ionized water[12]. Known volume of water samples were filtered and digested using conc. HNO_3 to avoid organic interference. The completely digested samples were diluted and cooled to room temperature, and final volume was adjusted up to 50 ml. All samples were analyzed in triplicate, using an atomic absorption spectrophotometer (VARIAN AA240 FS) [14].

Chick embryo model

Zero hours fertilized eggs were acquired from a local hatchery and incubated at 37°C for 72 hrs, until reaching stages 12 and 19 respectively[16]. Solution of $CdCl_2$ ranging from 0.01, 0.5 and 1 mg/l was introduced into the air chambers of fertilized eggs. All the eggs were immediately kept for further incubation upto 10 days. After completion of incubation period, eggs were observed for embryo survival rate and development of blood vessels[10].

Results and Discussion

Cd level in River Mutha

The overall results of river water analysis for Cd at six locations as mentioned in Table 1 have been summarized in Table 2 and Figure 1. Average level of Cd in river Mutha (0.0986±0.0018 mg/l) has exceeded standard limit (0.0003 mg/l) given by Bureau of Indian Standard (BIS) [13].

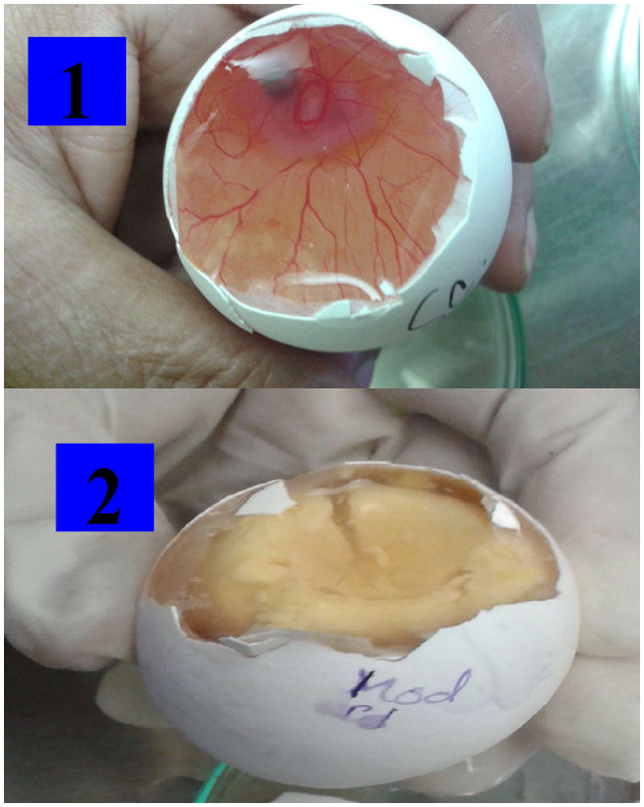

Fig. 1 : Effect of Cadmium (Cd) on development of chick embryo

Out of six sampling stations maximum concentrations were observed at S1 and S2 (0.2003±0.0023 and 0.1987±0.0031 mg/l respectively). Elevated level of Cd near the origin was found may be due to atmospheric deposition, mining and construction activities in the vicinity. Concentration at S3 has been declined up to 0.1011±0.0039 mg/l, due to confluence after S1 and S2. River water gets stagnant at S4 leads to decrease in the Cd level at 0.0799±0.0006 mg/l may be due to increase in sedimentation rate. Source of Cd in river water was mainly from small-scale industries, washing centers, municipal and domestic waste water discharge in the mainstream of river was observed near S5 and S6. However, the high amount of organic waste in river water, may be responsible for immobilization and sedimentation of Cd at locations S5[4]. Therefore, low level of Cd was observed at location S5 (0.0023±0.0003 mg/l) than S6 (0.0090±0.0004 mg/l) [7, 8].

Effect of Cd on chick embryo development

Mortality rate of chick embryos at different concentrations has been given in Table 3. The observed

TABLE- 2: Cadmium (Cd) concentration (mg/l) in River Mutha at different locations

Sampling station	Cd concentration (mg/l)
S1	0.2003±0.0023
S2	0.1987±0.0031
S3	0.1011±0.0039
S4	0.0799±0.0006
S5	0.0023±0.0003
S6	0.0090±0.0004
Average	0.0986±.0018
BIS Standard	**0.0003**

rate of mortality increased from 0.01<0.5<1 mg/l concentration of Cd. Mortality rate for 0.01mg/l after 10 hrs was 25%, for 0.5 mg/l after 10 hrs was 70% and for 1 mg/l after 10 hrs 100% respectively [6].

Normal development of embryo as well as blood vessels has been observed in control on 10th day of incubation, while in the treated eggs abnormal embryos were developed and became dead because of inadequate blood vessel formation (Fig. 1).

Detrimental effect of Cd was observed even at lowest concentration *i.e.* 0.01 mg/l, at early stage of development, while highest dose has been proven lethal for chick embryos[9].

TABLE- 3: Effect of Cadmium (Cd) on the percent survival rate of embryos at early incubation

	Control	0.01 mg/l Cd	0.5 mg/l Cd	1 mg/l Cd
Embryos analyzed (n)	20	20	20	20
Formation of blood vessels	95%	20%	00%	00%
Mortality rate	02%	35%	90%	100%

Early amniotic development of chick embryo substantiates to be a constructive model for effects of Cd on humans. Therefore Cd toxicity at early developmental changes in humans can be significantly studied using chick embryo model. River Mutha is a major source of drinking as well as agricultural water supply of Pune city.

Conclusion

Cd profile estimated in River Mutha is extended beyond maximum permissible limit designed by BIS for drinking purpose. The elevated Cd level in river water therefore may lead to cause cumulative toxicity to human and environment, hence recommended adequate treatment system for removal of Cd before consumption.

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