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Short Communication

Study of fly ash toxicity to fish *Heteropneustes fossilis* (Bloch)

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Abstract

Heavy metals content of fly ash of Hindalco power plant located near Hirakud Reservoir (Sambalpur, Odisha, India) was determined. Manganese metal was found to be in large amount where as cadmium metal with least concentration. The trend shows Mn>Zn>Pb>Cr>Cu>Ni>Co>Cd. When air breathing fish Heteropneustes fossilis was exposed to different concentration of fly ash to determine the LC_{50} value, no death was recorded in fishes exposed below 600g.L^{-1} of concentration for a period of 14 days. However, morphological abnormalities like loss of pigmentation, fins and haemorrhages were observed at 600g.L^{-1}. Beyond this concentration mortality of fish was observed and the LC_{50} value was found to be 1000g.L^{-1} for 96hrs and 800g.L^{-1} for120 hrs. There was hundred percent deaths recorded in 1000g.L^{-1} after 120 hrs where as 132hrs in 800g.L^{-1}.

Keywords: Fly ash, heavy metals, LC_{50}, fish.

Introduction

Fly ash is a residue of coal combustion produced during power generation from thermal power station. There are 13 thermal power plant located in the river basin of Mahanadi of both state of Chhatisgarh and Odisha. Hindalco thermal power plant near Hirakud Reservoir (Sambalpur, Odisha) is one among them. Fly ash which is captured by electrostatic precipitator are mixed with water and transported to ash pond which in turn dries up. This ash directly or indirectly enters the aquatic ecosystem there by affecting flora and fauna there in. Fly ash contains heavy metals[1]. There was a reduction in the phytoplankton and zooplankton diversity in the fly ash impacted side of river Yamuna due to 200MWcapacityI P thermal power station[2]. As fish occupies an important position in aquatic food chain, it is mostly used as a bio indicator of water pollution. Fly ash affects water quality leading to changes in fish behavior[3]. A laboratory toxicity case study indicates that benthic species may be prone to adverse effects from both physical attributes and chemical effects of coal ash[4]. However, fly ash toxicity causing morphological changes and mortality has not been reported. In view of this, present study was carried out in a bottom dweller fish *Heteropneustes fossilis* (Bloch) to assess the toxic effect of fly ash.

Materials and methods

Live specimens of *Heteropneustes fossilis* varying length 14-16 cms and weighing 30-40gms were collected by completely drying the fish pond at Katapali near Sambalpur University. Proper care was taken to avoid stress and injury during capture and transportation to the tank. The fishes were free from any contamination and diseases. They were kept in a cemented pond for a period of one week. Fly ash was collected from the Hindalco thermal power plant located near Hirakud Reservoir. Heavy metal contents of fly ash were analysed with the help of Atomic Absorption Spectrophotometer (SIMADZU-AA-6300) with respective metal ion standard (Merck, Germany)[5].

Six aquaria of 80litre capacity were set for the experiment. Each aquarium containing 80 Litre of 100g.L^{-1}, 200g.L^{-1}, 400 g.L^{-1}, 600g.L^{-1}, 800g.L^{-1}, 1000g.L^{-1} of fly ash concentrations separately were set for the experiment. Ten numbers of fish *Heteropneustes fossilis* were kept in each aquarium to study the $L.C._{50}$ value of fly ash. Fishes were acclimated to the laboratory condition with 22 ± 2^0C. Fishes were fed with a balanced commercial fish food. During the exposure period the P^H was within the range of 7.2-7.4. After the determination of $L.C._{.50}$ value the surviving fishes were exposed for two weeks. Morphological abnormalities observed at the end of exposure period were also recorded with photograph.

Results and discussion

Heavy metal analysis of fly ash was done and is presented in Table-1. The results shows presence of eight heavy metals with highest content of Manganese (371µg.g^{-1}) and Cadmium at its lowest (0.1µg.$g^{-1)}$. The order of metal concentration was in the trend of Mn>Zn>Pb>Cr>Cu>Ni>Cd. Cadmium was found to be least in fly ash sample collected from a coal fired power station in Poland[6]. Presence of heavy metals in fly ash contaminated water is common as metals like Cu, Ni, Fe, Co, Mn, Cr and Zn has been reported from Haduagani Reservoir of Aligarh[7]. Heavy metals enter to fish either directly through their bodies like skin

and gills or through food chain leading to biomagnifications[8]. Manganese which was detected with high concentration is a common stressor of fish physiology[9,10]. As fly ash settles in the sediment and fish *Heteropneustes fossilis* is also bottom dweller, there is more possibility of effect on it.

On exposure to different concentration of fly ash, morphological changes were observed and mortality rate was regularly monitored and is presented in Table-2. Till 72 hours no death was reported in any concentration. At lower concentration (<400g.L^{-1}) neither morphological nor behavioural abnormalities were observed. However, at 600g.L^{-1} concentration after 7 days of treatment morphological abnormalities like loss of pigmentation and excessive secretion of mucous was observed (Figure-2). Excessive secretion of mucous acts as barrier with the toxicant[3]. This is due to the adaptation of fish to the adverse condition. But after 14 days of exposure in the same concentration (600 g.L^{-1}), there was skin necrosis with haemorrhage (Figure-3). There was also loss of fins and fin rays (Figure-3) which ultimately affected the movement of fish there by showing erratic behaviour. Excessive haemorrhage was observed in fish exposed to higher concentration (800g.L^{-1}) for period of two weeks (Figure-4). Fish scale damaged when *Tilapia mossambica* exposed to fly ash pollution[11]. The changes in the skin of *Heteropneustes fossilis* may be due to heavy metals presents in the fly ash.

Mortality was observed above 600g.L^{-1} concentration of fly ash. After 96 hours 20% and 50% death recorded in 800g.L^{-1} and 1000g.L^{-1} concentration of fly ash respectively. This indicates 96 hrs LC_{50} value is 1000g.L^{-1}. The rest 50% fish in the 1000 g.L^{-1} concentration died within 120hrs. In 800g.L^{-1} 50% mortality occurs in 120hrs followed 100% death in 132 hrs. However no death recorded in lower concentration (<600g.L^{-1}) even exposed for a longer period (14 days). As fly ash induces oxidative stress in various organs of fish, the mortality of fishes may be due to enzyme activity in various organ[12].

Figure-1: Photograph of normal fish *Heteropneustes fossilis.*

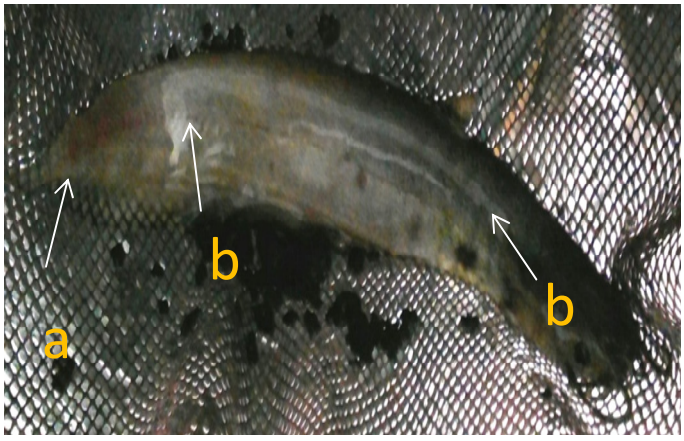

Figure-2: Skin of fish showing a-haemorrage, b-Loss of pigmentation on exposure to 600g.L^{-1} of Fly Ash for a period of 7 days.

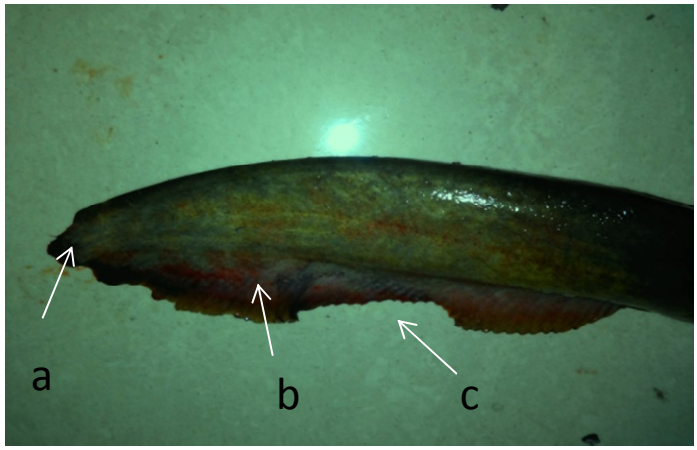

Figure-3: Skin of fish showing a-loss of caudalfin, b-haemorrage, c-loss of anal fin on exposure to 600g.L^{-1} of Fly Ash for a period of 14 days.

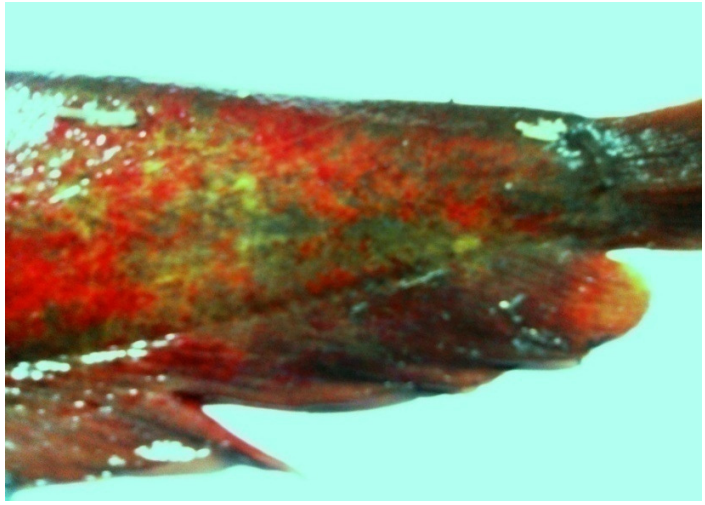

Figure-4: Skin of fish showing haemorrhage on exposure to 800g.L^{-1} for a period of 14 days.

Table-1: Heavy metal content ($\mu g.g^{-1}$) of Fly Ash.

Heavy Metal	Mean ($\mu g.g^{-1}$)	SD
Mn	371	8.5
Zn	170	3.6
Pb	156	2.2
Cr	100	3.2
Cu	87	1.5
Ni	82	1.1
Co	26	1.5
Cd	0.1	0.01

Table-2: Mortality (%) of fish *Heteropneustes fossilis* on exposure to different concentration of Fly Ash.

Fly Ash concentration ($g.L^{-1}$)	24 hrs.	48 hrs.	72 hrs.	96 hrs.	120 hrs.	132 hrs.
100	00	00	00	00	00	00
200	00	00	00	00	00	00
400	00	00	00	00	00	00
600	00	00	00	00	00	00
800	00	00	00	20	50	100
1000	00	00	00	50	100	xxx

Conclusion

Overall results indicate that fly ash is toxic to the fish beyond $800g.L^{-1}$ causing mortality. However, the morphological and behavioural changes observed below sub lethal concentration is of interest as such surviving fish would be available for human consumption. Therefore, further research needs to be carried out to understand the exact physiological status of the fish at sub lethal concentration of fly ash.

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