EXTENT OF HEAVY METAL ACCUMULATION IN HOUSE CROWS OF COASTAL ZONE

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Abstract: As birds can selectively act as an excellent bioindicator for determining the burden of heavy metals in the environment hence House Crow (*Corvus splendens*) of Visakhapatnam was selected in order to investigate the levels of the heavy metals namely Manganese (Mn), Nickel (Ni), Cobalt (Co) and Copper (Cu) in several tissues (liver, kidney, breast tissue and femur) and feathers (primaries, secondaries, tail and breast feathers).Eleven adult birds following the month of September 2015 to June 2016 were opportunistically collected from several residential, traffic and coastal areas of Visakhapatnam shortly after their death. The feather and tissue samples were acid digested using 10mL Nitric Acid, 2mL Perchloric Acid and 5 mL Hydrogen peroxide following the standard methodsand were stored in polythene vials for elemental analysis. The assay of the heavy metals was carried out by using Perkin Elmer Atomic Absorption Spectrophotometer AAnalyst400.The concentrations of the heavy metals were found to follow the order of Mn>Ni>Cu>Co. The highest content recorded was that of Mn compared to the other metals and Co values were below detectable limit. According to the results obtained, the elevated concentrations of certain heavy metals in few samples indicated the fact that the birds were in constant exposure to the risk of heavy metals present in their habitat.

Keywords: Bioindicators, house crow, feathers, tissues, Visakhapatnam.

Introduction: Heavy metals areomnipresent elements that have always remained a natural component of our environment. Even with their sparse concentrations, they are continuously liberated into the environment from natural sources like volcanic eruptions, acid rains and weathering of rocks. Anthropogenic or man-made sources that have given birth to entry of the heavy metals into the environment can be listed out as many. This includes industrial effluent discharge,pollution from leaded petrol, agricultural runoff and leaching of metal ions from the soil into water bodies. The presence of these very toxic pollutants poses a great threat for all living organisms, including humans. These metals are potentially harmful to most organisms at some level of exposure and absorption (Nighat et al., 2013). Ecological damage caused by anthropogenic activities has let the researchers and scientists to assess, evaluate, manage and mitigate the rising public concern of Environmental contamination.Animals situated at the top of the food chain can yield information over a vast area because of their habitat and foraging activities, not only on presence ofcertain contaminants but also on the extent to which they are transferred within the food chain (Pérez-López et al.2007).

Hence to determine the burden of these heavy metals on the environment, bird feathers and tissues can be used as an excellent indicator. Different studies have yielded heavy metal accumulation in different body organ of birds (Deng et al. 2007), blood (Scheifler et al. 2006), eggs (Fasola et al. 1998; Burger and Gochfeld 2000) feathers (Fasola et al. 1998; Muralidharan et al., 2004). Elevated levels of heavy metals has given birth to problem in birds like with eggshell thinning, failure in reproduction, and immuno-suppression, tremendous detrimental effects on the development and jeopardised embryo growthwhich led to population decline (Spahn and Sherry 1999; Burger and Gochfeld 2000; Malik and Zeb 2009). Morphometric parameters such as the body mass; tarsus and wing length directly correlate with concentration of Heavy metals present in the bird. Chronic metal exposure has also resulted indetrimental effects on behaviour, disease resistance, and other physiological mechanisms (Malik and Zeb 2009).

In India, meagre studies have been done on heavy metal accumulation in birds (Muralidharan et al. 2004). Visakhapatnam is a fast urbanising city and lies in a coastal belt which is under the constant threat of pollution created by certain anthropogenic activities like industrial discharge, automobile exhaust, resulting in leaching of metal ions in nearby water bodies. The city has major industries like Steel plant and Petrochemical manufacturing units and also it has few small scale industries like electroplating and agrochemical product manufacturing units.Therefore the fact of metal contamination can assumed to be omnipresent.

Hence, in the current study, House Crow (*Corvus splendens*) was selected due to its scavenging activities and its wide range of distribution over a vast geographical area and seasonal availability throughout the year in abundance. Moreover it occupies a high trophic level in the food chain and shares a very common food habitat with human beings because of its feeding behaviour on household waste.

Therefore, this study was done with the objective of investigating the levels of few heavy metals Mn, Ni, Cu and Co in tissues and feathers which would

otherwise provide useful information and ecological changes occurring at lower trophic level and to identify the sources of the heavy metals and to compare their levels with work done earlier by other authors.

Methodology:

Study Area: As certain bioethical concerns refuses the killing of free living organisms for biomonitoring, hence, opportunistic collection of dead crows for determining metal content in tissues were carried out.

Visakhapatnam lies in the coastal zone of Bay of Bengal and is blessed with adequate amount of hills and valleys but slowly which are losing its turf due to the massive pressure of urbanisation. The present study encompassed the opportunistic collection of House Crow (*Corvus splendens*) feathers and tissue. Eleven adult dead birds following the month of September 2015 to June 2016 were collected from several residential, traffic and coastal areas of Visakhapatnam. In the duration of the time, the birds were collected shortly after their death. Four birds were collected near to electric pole which died due to electrocution from open electrical wirings. On performing post mortem, the results yielded the same reasons for mortality of the four birds.

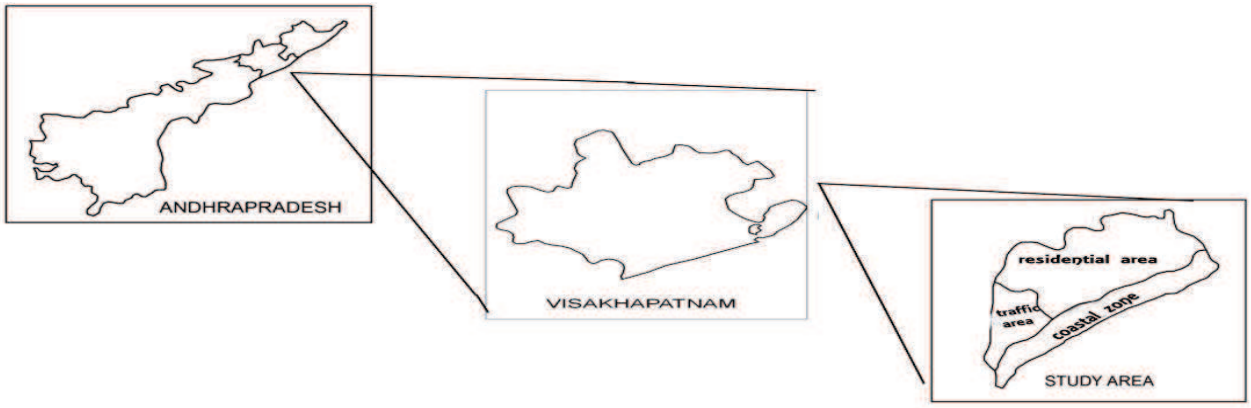

Fig.1: Map of Visakhapatnam showing the different sampling sites.

Sample preparation:

Feathers: Feathers were washed with tap water initially followed bydeionized water, and finally by acetone in order to remove loosely adherent externalcontaminants. The washed feathers were put in metal-free polyethylene vials and dried in hot air oven for 12 h at 80°C. Each sample was cut into small pieces by a scissor and carefully weighed by 1 gram.

Tissues: Livers, Kidneys, Breast tissue and Femur were obtained after post mortem. Following standard methods the tissue samples were dried in hot air oven for 24 h at 60°C. The dried tissue samples were then ground to form powder and each sample was weighed by 1 gram.

Digestion of the samples: For digestion of feathers, the digestion procedure involved the use of 10 mL HNO_3 followed by 2 mL Perchloric and finally 5 mL H_2O_2 in order to get rid of excess organic matter present if any. The digestion procedure was followed as described by Muralidharan et al., 2004. Similar procedure was also followed for digestion of tissue samples with minor changes.

Metal Analysis: The concentration of the metals Mn, Ni, Cu and Co was measured by Atomic Absorption Spectrophotometer (PerkinElmer- AAnalyst400) by using air acetylene gas. Mean concentration for every metaldetermination of the samples were taken in triplicate

Results:

Sample (House Crow)	Mn	Ni	Cu	Co
1	10.56±1.50	0.8±0.01	BDL	0.03 ±1.2
2	5.67±0.02	9.01±0.21	BDL	BDL
3	8.05±3.50	0.28±1.87	0.88± 1.13	0.98 ±0.01
4	17.89±4.50	BDL	BDL	BDL
5	36.80±1.78	11.6±3.4	BDL	BDL
6	47.83±3.21	BDL	BDL	BDL
7	11.65±1.08	0.24±1.02	7.82± 0.21	BDL
8	33.78±0.03	17.2±0.01	BDL	BDL
9	28.5±2.10	BDL	BDL	BDL
10	21.11±2.11	8.1±1.02	3.4± 2.1	BDL
11	10.02±0.03	BDL		BDL
Avg	21.07±1.80	4.2±0.68	1.1±0.1	BDL

Table 1: Metal contamination among eleven House Crow samples (1-11) from Visakhapatnam,

A.P, India which are expressed in µg/g (Mean ± SD).

Among the eleven samples, the results obtained showed that there was variation in the extent of heavy metal accumulation in both feathers and tissues. Concentrations of the heavy metals were found to follow the order of Mn>Ni>Cu>Co. The greatest extent of metal accumulation was observed in Mn 21.07 µg/g followed by Ni with values of 4.2 µg/g. Cu depicted quite low levels of 1.1 µg/g whereas Co was below detectable limit.

Sampling Area	Mn	Cu	Ni	Co
Residential	21.50± 3.41	1.32± 1.21	6.74± 4.76	0.08± 0.32
Traffic	47.21± 0.50	0.76± 0.38	8.97± 3.12	0.16± 0.01
Coastal	52.31± 1.81	1.02± 0.91	1.87± 0.09	0.53± 0.05

Table 2: Pooled data of metal accumulation in the species collected from residential, traffic and coastal, expressed in µg/g (Mean ± SD).

The extent of heavy metal accumulation differed in the areas where sampling was carried out. The concentration of heavy metals for the sampling areas was found to follow the order of Mn>Ni>Cu>Co. High Mn content was yielded from the coastal area 52.31±1.81 µg/g followed by the traffic areas 47.21±0.50 µg/g which were almost related closely. Ni levels in traffic areas were in the range of 8.97±3.12. Cu and Co were much lesser as compared to Ni and Mn.

Tissues and Feather	Cu	Co	Mn	Ni
Femur	0.73± 0.05	0.31± 0.90	9.45± 1.71	12.96± 4.59
Liver	BDL	BDL	17.4± 0.50	BDL
Kidney	BDL	BDL	8.30± 5.32	BDL
Breast Tissue	BDL	BDL	27.33± 1.2	0.08± 0.99
Primary	1.22± 0.05	BDL	12.09± 1.18	BDL
Secondary	BDL	BDL	13.52± 2.21	1.34± 1.98
Tail feather	BDL	BDL	18.50± 1.67	2.19± 0.38
Breast feather	0.54± 0.09	BDL	59.37± 2.78	BDL

Table 3: Pooled data of metal contents among tissues and feathers of House Crow (*Corvus splendens*), expressed in µg/g (Mean ± SD)

The level of metal accumulation yielded different levels in tissues and feathers and followed the order of Mn>Ni>Cu>Co. Among the various organs like liver, kidney, femur and breast tissues, the content of Mn was found to be highest among breast tissues (27.33±1.20 µg/g) and breast feathers (59.37±2.78), lowest in kidneys (8.30±5.32). The content of Ni was found to be highest in femur (12.96±4.59) where breast tissues had negligible limits. The level of Cu was also found to be scanty in Primary feathers whereas the levels of Co were below detectable limit (BDL) in both feathers and tissues.

Discussion: The data was viewed in three sets so as to understand the variation in metal contamination among sample size of eleven and in respect to area wise and tissue wise accumulation of metals. The results showed that the concentrations of the heavy metals were found to follow the order of Mn>Ni>Cu>Co. On the average, the content of Manganese (Mn) was highest among all other metals analysed. The levels of Mn obtained correlated to the work done by other authors. Mn in excreta samples of House Crows of Ludhiana district, Punjab was 45.58±21.78 µg/g and other studies have shown Mn levels in feathers of Cattle Egret as 26.9 µg/g from Pakistan and 36.6 µg /g from Hong Kong (Kaur and Dhanju 2013), 7.1 µg/g from China (Deng et al., 2007) whereas the current study yielded higher levels of Mn accumulation in breast tissues (27.33±1.20µg/g) and breast feathers (59.37±2.78 µg/g). The reason behind the deposition of Mn in these tissues might be due to the bird's continuous flight and exposure to the atmospheric Mn which is released due to heavy traffic activities as an anti-knocking agent (Malik and Zeb 2009). As waste incineration in catchment areas also releases Mn (Malik and Zeb 2009), hence the results correlate with the cause. The major source of Mn at Visakhapatnam can be said to arise from Ocean spray, weathering of rocks, industrial and anthropogenic sources. At elevated doses, Mn produces behavioural effects, decreased growth, decreased haemoglobin synthesis, neckdeformities, bleeding, and anaemia (Burger et al. 2000).

Levels of Ni was present in all three sampling areas and the results reflected 12.96±4.59 ppm of Ni was found in Femur samples which was higher than the amount of Ni depicted in other studies (2.564±1.369 ppm) in House Crow excreta of Ludhiana district, Punjab (Kaur et al.,2014). Similarly, bird feathers studies from Pakistan holds mean Ni levels of 8.1 µg/g (Malik and Zeb 2009). Ni is released in the environment due to electroplating, heat treatment,

electronic equipment, and Ni–Cd Battery industries and tanneries (Malin and Zeb 2009). As the samples were collected from vicinity of such areas of Visakhapatnam, hence it reflected Ni content. Cu levels in Cattle Egrets of Pakistan was 3.9 µg/g (Malik and Zeb 2009)For Great Tits of China it was 2.8 µg/g (Deng et al., 2007), adult Great Cormorants of Japan held values of 6.7 µg/g (Nam et al., 2005) whereas the present study yielded much lower levels of Cu (1.03 µg/g) in House Crows. Copper is essential for growth, development, metabolism and to maintain structure and function of many proteins vital for cell functioning (Burger et al 2000; Malik and Zeb 2009). Release of Cu into the environment is due to mining and smelting activities as well as agricultural waste disposal. Cu accumulates in the soil by means of deposition of dust from localsources, such as spraying of fungicides and sewage sludge. The aquatic systemreceives Cu from agricultural runoff, atmospheric deposition, and direct discharge from industrial processes.Co obtained in the current study was of very negligible levels and below the levels earlier reported.

Conclusion: This current study encompassed the biomonitoring of heavy metals from different areas of Visakhapatnam. The concentrations of few heavy metals in feathers and tissues were reported. The levels reflected the entry of the metals in the food chain through different anthropogenic sources and if not properly studied or monitored, the levels will continue to magnify in the higher trophic levels where human beings are more susceptible to the changes in the environment. Hence, more study needs to be done in order to establish a baseline data of metal toxicities as very scanty studies have been carried out in the Indian context.

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