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Assessment of heavy metals in excreta of house crow (*Corvus splendens*) from different Agroecosystems of Ludhiana

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Abstract
The aim of the study was to determine the difference in level of heavy metals in excreta of the House Crow (*Corvus splendens*) from agrifield and residential areas of Ludhiana city. The dry feacal samples were collected from four different crop field and three different residential areas which further comprised of different habitat structures. The lowest concentration of arsenic was recorded in samples of site I (1.38 ± 0.38 ppm) which comprised of orchard area and different trees. Maximum concentration was recorded at site V (4.04 ± 0.20 ppm) which comprised of garden surrounded by residential area. The minimum concentration of boron was recorded at the site VII (6.74 ± 1.03 ppm) which comprised of residential area and maximum concentration was recorded at site II (12.67 ± 1.97 ppm) which comprised of orchard area and vegetable farms having different crops. The minimum concentration of cadmium was recorded on the site I (0.393 ± 0.106 ppm) and maximum concentration was recorded at site V (1.05 ± 0.08 ppm). The minimum concentration of lead was recorded at site VII (2.59 ± 0.57 ppm) which comprised residential area and maximum concentration was recorded at site III (10.17 ± 0.94 ppm) which comprised of eucalyptus trees and different crop fields. The difference in levels of heavy metals in excreta samples from different areas attributed to the availability of different food sources and habitat structure. The reported concentrations of different heavy metals in bird excreta reflects their exposure to metal pollution which is alarming to increased environmental pollution.

Keywords: House Crow, excreta, heavy metal, pollution, agrifield

1. Introduction

The increase in heavy metal pollution has become an important problem in recent years. The increased levels of toxic heavy metals in air, soil and water can threaten the ecosystem's stability. These have always been natural components of our environment present in very low concentrations and are continuously released into environment from some natural sources like volcanic activity, acid rains, weathering of rocks and leaching of metal ions from the soil into water bodies etc. or by human activities like industrial processes, pollution from leaded petrol and some agricultural practices. The metal pollution is harmful to most of the organisms at some level of exposure and absorption [1]. The largest problem associated with the persistence of heavy metals is the potential for bioaccumulation and biomagnification in food chains at different levels.

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 of certain contaminants but also on the extent to which they are transferred within the food chain [2, 3]. In recent years the use of bioindicators for monitoring environmental pollution with heavy and toxic metals has been increased. It is important to keep several criteria like among them common occurrence, easy capturing, well known biology of specie and clearly identified individual territory size when selecting a specie as bioindicator. From this point of view the birds play a valuable role as bioindicators because of their easy availability and higher position in the food chain. Different species of birds such as herons and egrets have been used as a bio-indicator and/or bio-monitor of local environmental contamination because they are high on the food-chain, exposed to a wide range of chemicals, susceptible to bioaccumulation and are geographically widespread [4]. Recently, the House Sparrow has been studied as a bio-indicator of metal pollution due to its abundance, non-migratory lifestyle and close association with

humans in African regions [5]. House Crows are commonly found in residential areas, near agricultural settings and are observed to roost on large trees in agroecosystems. Therefore, the House Crow (*Corvus splendens)* was taken as an indicator of heavy metal pollution in the present studies, due to its scavenging activities 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.

Birds can rid the body of heavy metals through the feces or by depositing them in the uropygial gland, salt gland and feathers [6]. In India, studies on heavy metal contamination in birds are limited. Moreover, the capturing and killing of birds is legally banned by Govt. of India according to Wildlife Protection Act 1972, therefore any analytical studies on the tissues and eggs of these organisms are beyond the reach of scientists working in this area. Thus, excreta of bird are an alternative source, which if analyzed can give an assessment of the harmful impact of environmental contaminants on these organisms.

The aim of this work was to determine the level of different metals in excreta samples of the House Crow collected from different habitat structures including different agrifield and residential areas.

Materials and Methods

Study area

The area selected for present studies was Ludhiana district of Punjab. Ludhiana has one of the worst air pollution problems in India, with particulate matter being over six times the World Health Organization (WHO) recommended standard, making it the 13th most polluted city in the world. The study area comprised of different agrifield and residential areas of Ludhiana for the comparative studies in selected areas. The agrifield area further comprised of crop fields, orchards and vegetable farms of Punjab Agricultural University, Ludhiana. The selected different residential areas in Ludhiana were selected on the basis of presence or absence of parks and gardens in the surroundings.

Sample collection and processing

The dry excreta samples of the House Crow were collected in sterile plastic bags with the help of spatula from the nesting/ roosting sites. The dry excreta samples of the House Crow were pooled and 0.4 g excreta sample from each site taken and 5 ml mixture of perchloric acid and conc. HNO_3 was added. The samples were then digested in Perkin's microwave at 121 °C for 50 minutes. The final volume was made to 25ml by adding distilled water and then the solutions were filtered.

The digested samples were analyzed for the assessment of heavy metals like Arsenic (As), Boron (B), Cadmium (Cd) and Lead (Pb), and other essential metals by ICAP-AES (Inductively Coupled Plasma Atomic Emission Spectroscopy). The readings taken on ICAP-AES were converted into parts per million (ppm = µg/g).

Statistical analysis

The data for heavy metals in samples from different sites was statistically analyzed by one way analysis of variance.

Results and Discussion

The elemental analysis of excreta has shown the presence of a total of 16 elements in all the samples of the House Crow (*Corvus splendens*). Out of which As, B, Cd and Pb are included in the category of heavy metals which are no-essential for body and others like Ca, Cr, Co, Fe, K, Mg, Mn, Na, Ni, P, S and Zn are included in category of essential metals. The concentration of heavy metals and other essential metals varied significantly in excreta samples from site to site (Table 1). The concentrations of heavy metals are usually low (1 ppm wet weight, which approximately represents 3 ppm dry weight) in most living organisms [7]. The type of food eaten by birds plays a predominant role in the amount of metal they would accumulate [8].

Table 1: Level of different metals including heavy metals (ppm) in excreta of House Crow (*Corvus splendens*) from agrifield and residential areas of Ludhiana.

S. No.	Element	Site I	Site II	Site III	Site IV	Site V	Site VI	Site VII
		Orchard crop field area	Vegetable crop field area	Wheat-Paddy crop field area	Garbage dump area	Residential area with garden	Residential area without garden	Residential area with small parks
1	Arsenic	1.38 ± 0.38	2.93 ± 0.49	2.74 ± 0.30	2.94 ± 0.29	4.04 ± 0.20	2.79 ± 0.28	1.85 ± 0.35
2	Boron [a]	7.83 ± 1.55	12.67 ± 1.97	12.19 ± 0.34	11.86 ± 0.93	10.18 ± 0.64	7.46 ± 0.99	6.74 ± 1.03
3	Calcium [a]	560.4 ± 72.69	644.83 ± 170.96	1061.00 ± 27.74	1186.67 ± 102.13	1093.00 ± 12.89	781.00 ± 32.44	1646.67 ± 231.24
4	Cadmium	0.39 ± 0.11	0.62 ± 0.14	0.75 ± 0.05	0.84 ± 0.03	1.05 ± 0.08	0.62 ± 0.05	0.40 ± 0.06
5	Chromium	5.58 ± 1.26	9.92 ± 1.83	10.56 ± 0.17	11.37 ± 0.61	12.45 ± 0.64	8.43 ± 1.02	6.23 ± 1.33
6	Copper	7.70 ± 1.13	11.95 ± 3.47	17.01 ± 1.50	16.06 ± 0.42	16.48 ± 1.02	14.87 ± 0.98	8.73 ± 1.51
7	Iron [a]	3256 ± 683.18	5794 ± 805.05	5963 ± 149.38	6468.3 ± 199.43	6541 ± 143.86	4616 ± 536.82	3640 ± 721.62
8	Potassium [a]	1690.43 ± 441.04	2838.33 ± 564.03	4196.33 ± 82.54	4301.33 ± 88.95	3985.67 ±132.75	2561 ± 6.50	1997 ± 256.95
9	Magnesium [a]	848.66 ± 176.36	1277.33 ± 294.51	1729 ± 49.32	1709 ± 75.106	1278 ± 25.10	780.33 ± 34.27	768.67 ± 70.17
10	Manganese	70.67 ± 13.78	145.29 ± 41.71	175.5 ± 5.88	192.5 ± 7.50	194.42 ± 7.57	129.55 ± 16.10	79.17 ± 16.30
11	Sodium [a]	233.07 ± 5.99	358.4 ± 38.61	344.96 ± 22.59	299.7 ± 40.44	209.06 ± 9.78	114.26 ± 16.23	344.55 ± 54.67
12	Nickel	4.50 ± 0.95	7.66 ± 1.30	8.38 ± 0.08	9.05 ± 0.46	4.22 ± 0.24	2.89 ± 0.39	2.09 ± 0.52
13	Phosphorus [a]	968 ± 249.79	1852.83 ± 532.05	2768.33 ± 429.67	3925.33 ± 186.11	3441 ± 241.81	2524.67 ± 65.54	2577 ± 590.83
14	Lead [a]	5.22 ± 1.27	7.10 ± 1.78	10.17 ± 0.94	9.31 ± 0.27	9.56 ± 0.59	6.13 ± 0.36	2.59 ± 0.57
15	Sulphur	535.83 ± 116.28	962.36 ± 252.90	1279.33 ± 39.89	1397.66 ± 9.33	1191.67 ± 89.29	1085.23 ± 57.51	1126.20 ± 62.21
16	Zinc	79.2 ± 16.68	143.22 ± 40.79	176.56 ± 6.19	184.73 ± 1.44	196.93 ± 16.13	112.77 ± 13.80	42.86 ± 9.12

The data is represented as mean ± standard error of three samples from each site.

[a] Significantly differ in different sites, $P \leq 0.05$.

Concentration of heavy metals

The concentration of arsenic was found to be ranging from 1.38 - 4.04 ppm in selected sites (Fig. 1). The normal level for As is 0.01-0.2 ppm. In the present studies, the arsenic concentration was found above normal recommended range in samples from all the sites. Level of As was found minimum in samples from site I and maximum from site V. This element is found in soil, plants, air and all living tissues. It is released into the environment primarily through agricultural practices like application of pesticides. As is poisonous to multicellular life and was also accused of being a potent endocrine disruptor, with sub-lethal affects leading to disruption of reproduction or death of some birds [9]. Toxicity signs of As showed depression, ataxia, lameness and stunted growth,

body weight loss, less feed consumption, loss of appetite, souring of mouth, dullness and neurological disorders in chickens [10]. The concentration of boron was ranging from 6.74 - 12.67 ppm in excreta samples of the House Crow from selected sites (Fig. 2). The normal recommended range of boron for avian species is 0.13-5 ppm. The concentration of B was recorded above normal range in samples from all sites with highest concentration 12.67 ± 1.97 ppm. The minimum concentration was recorded from samples of site VII and maximum from samples of site II. This may be because of the application of borax that is given frequently to orchard plants so as to increase their height as well as the number of branches per plant [11]. In some areas of California and the Southwestern United States, agricultural drain waters are considered as the major source of boron, boron-based herbicides are produced from borax and boric acid [12]. Boron compounds have moderate acute toxicity and the symptoms include depression, ataxia, congestion, convulsions and weight loss. Boron can cause reduction in hatching success, weight and growth of young birds [6].

The concentration of cadmium was recorded to range from 0.39 - 1.05 ppm in excreta samples from selected sites. The concentration of Cd was recorded between recommended normal range 0.02-1.5 ppm and was recorded minimum from site I and maximum from site V (Fig. 3). Cadmium is the most abundant toxic metal present in the environment and this increase in metal level is due to industrial activities. Cadmium is a teratogen, carcinogen and possible mutagen [13]. The Cd can be absorbed by organisms through the digestive tract and pulmonary system. Once entered in the body of the organism it forms complexes with proteins, and is then easily transported and stored mainly in the liver and kidneys. It has been reported by Dailey *et al.* [14] that with continued exposure even at low levels, this trace element is accumulated throughout the life span of birds. The range of lead concentration was detected in faecal samples of House Crow as 2.59 – 10.17 ppm which indicates strong exposure of this bird species to toxic metal (Fig. 4). Lucia *et al* [15] reported the mean Pb concentrations in kidneys of the Mallard in southwest Atlantic of 17.98 µg g-1. These values were higher than those observed in the present study. Lead is the heaviest non-radioactive element and if ingested, it is poisonous to animals as well as birds. Sources of Pb in the environment are lead pigments in paint, fuel additives, pipes and glazed ceramic food containers etc. The studies on effects of Pb on birds at ranges have mainly focused on intake and toxicity of lead and explained that the soil may be an important pathway of exposure [16]. Birds exposed to Pb are reported to have decreased body weight and reproductive impairment [17]. Sub lethal Pb exposure experienced by free-living birds, possibly resulted in reduced growth rates, decreased clutch sizes, behavioral abnormalities [18].

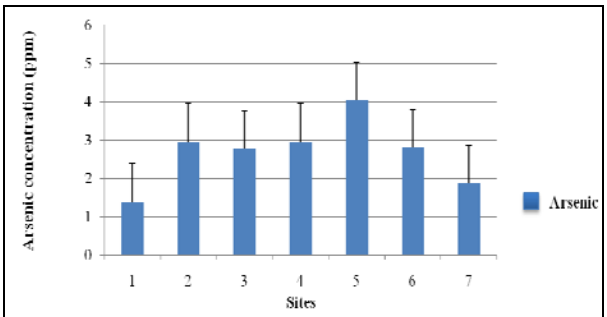

Fig. 1 Concentration of As in excreta of House Crow from different sites

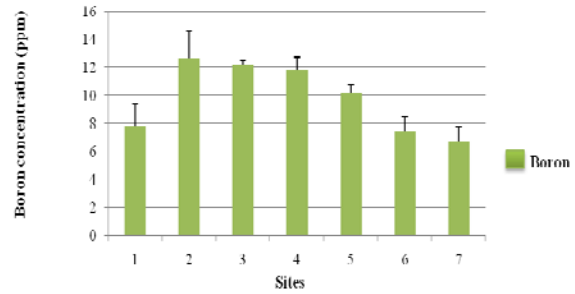

Fig. 2: Concentration of B in excreta of House Crow from different sites

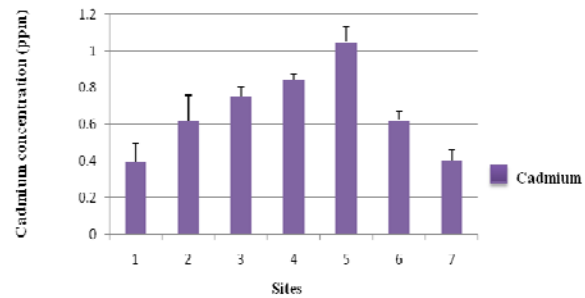

Fig. 3: Concentration of Cd in excreta of House Crow from different sites

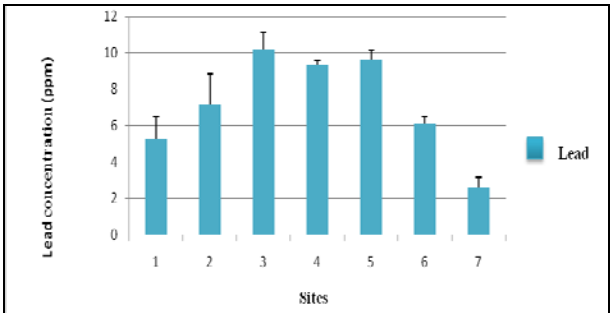

Fig. 4 : Concentration of Pb in excreta of House Crow from different sites

Concentration of essential elements

The range of calcium concentration in faecal samples was reported as 560.4 - 1646.67 ppm from different sites. The minimum range was detected in samples of site I and maximum in samples from site VII. In comparison to other metals the Ca and its other compounds have very low toxicity. But the concentration above required level can also cause calcification of the kidneys, proventriculus, lameness, and chicks unable to hatch out of shell, constipation and abdominal pain. The range of chromium was varying from 5.575 - 12.45 ppm in faecal samples of the House Crow from different site. The lowest concentration was recorded from site I and highest from site V. The chromium is regarded as an essential element but larger amounts and in different forms it can be toxic and carcinogenic. The chromium produces adverse effects on the embryonic development and hatching success of nestling birds [19]. The concentration of copper was ranging from 7.704 to 16.48 ppm at selected sites. However, the studies conducted on heavy metal accumulation in House Crow of coastal zones have reported much lower level of copper i,e. 1.03 ppm [3]. The highest was recorded in site I and lowest in site III. The copper is widely used in industries and agriculture and due to this Cu quantities in the environment have increased. Cu accumulates in the soil by means of deposition of dust from local sources, such as spraying of

fungicides and sewage sludge. The iron concentration range in excreta samples was detected as 3256 - 6541 ppm from different selected sites. The excessive storage of iron in the body of birds may cause many diseases like difficulty in breathing due to lung damage, distended abdomen and paralysis [20]. The concentration of potassium was recorded with a range 1690.43 - 4301.33 ppm in excreta samples from seven different sites. The lowest was recorded in site I and highest was in site IV. Potassium is the third more abundant element of the animal body and additional intake is favourable or birds reared in heat stress environment. The concentration of magnesium was detected in faecal samples from different sites within the range of 848.66 - 1729 ppm. The minimum was recorded in site VII and maximum was in site III. However, the concentration range of manganese was found to be 70.67 - 194.42 ppm. The lowest was recorded from site I and highest was from site V. At elevated doses, Mn produces behavioural effects, decreased growth, decreased haemoglobin synthesis, neckdeformities, bleeding, and anaemia [21]. The sodium concentration ranged from different sites was recorded as 209.06 - 358.4 ppm.

The nickel concentration range was found to be 2.09 - 9.05 ppm in samples from selected sites. The lowest concentration was observed from site VII and highest from site IV. Nickel listed in essential elements plays a role in proper functioning of liver in animals. Above threshold level, Ni is seen to affect the respiratory system of birds, causing asthma, as well as birth defects, vomiting, and damage to DNA [22]. Phosphorus concentration from selected sites was ranging from 968 - 3925.33 ppm. No toxic effect of this metal has been recorded in birds till date. Sulphur concentration range was observed in excreta samples as 535.83 - 1397.66 ppm from different sites. The toxicity effects of this metal are indirect due to acute exposure to H_2S gas with much higher concentrations (>200 ppm) and include pulmonary oedema, respiratory arrest, coma, and death in birds [23] (Durand 2007). However no toxic range has been defined for S in avian species.

The zinc concentration was found within a range of 42.86 - 196.93 ppm from different sites which is comparatively high than the range 10.9-36.21 ppm reported by Alipour *et al* [24] in feathers of the Mallard *Anas platyrhynchos* in Kanibarazan, northwestern Iran. The lowest concentration was observed from site VII and highest was from site V. Element like Zn is an essential metal in animals. Sometimes, the essential elements like Cu and Zn could have toxic effects on the kidneys and impair reproduction at high doses [25]. Besides the effects of toxic elements some metals like K, Mg, Na, P and S are recognized as essential nutrients in animal nutrition and no toxic effect of these metals have been reported in birds till date. The variations observed in metal concentrations in present studies may be because of several factors like age, sex, size of bird and availability of food material in different habitat sites from which excreta was collected. These observations throw light on the fact that significant variations in toxic metal levels are present in the environment where this bird lives.

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