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Heavy metal contamination in excreta of house sparrow (*Passer domesticus*) from rural areas of Ludhiana

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Abstract

The purpose of the study was to detect the heavy metal contamination in the excreta of House Sparrow (*Passer domesticus*) from rural areas of Ludhiana. The study was carried out in two villages i.e. Kaind (location I) and Alamgir (location II) falling in district Ludhiana. The results showed that the levels of Arsenic (As), Nickel (Ni), Chromium (Cr), Cadmium (Cd) and Zinc (Zn) were higher than normal range in excreta of House Sparrow from both locations I and II. The concentrations of Lead (Pb) and Boron (B) were observed above toxic range from both the locations. Different types of agrochemicals used in crop fields might be responsible for contamination in the food chain of House Sparrow at various trophic levels.

Keywords: Environment, excreta, heavy metals, House Sparrow, population

1. Introduction

Heavy metals are persistent environmental contaminants and transport of metals into the environment pose a threat to ecosystems, as plants and wildlife are susceptible to long-term exposure, bioaccumulation, and potential toxicity^[9]. Birds of prey are excellent indicators of a healthy ecosystem, as they are top predators occupying multiple trophic levels and various ecological niches^[13]. Bioaccumulation of heavy metals in tissues of birds has received attention because of the lethal and sub-lethal effect of their accumulation, apart from the fact that birds are often located at high levels in the food chain which makes them suitable for use in bioaccumulation studies^[7]. Heavy metals, although naturally occurring, are often mobilized into birds and the environment at faster-than-normal rates due to anthropogenic activities^[12]. One such species is the House Sparrow (*Passer domesticus*) which is closely associated with human settlements ranging from small farms in the countryside to large cities, but is completely absent from areas outside human settlement in Western countries. Heavy metal poisoning in birds most commonly occurs from ingestion of substances containing lead, or less commonly zinc. Lead toxicity in wild birds is commonly seen during migration in the late fall and early spring. In heavy contaminated areas, toxicity may be observed at any time of the year^[4]. Sundaramahalingam *et al*^[13] stated that Pb, Zn, Cd and Hg elements are considered to be effective pollutants, which might cause a threat to the survivability of a House Sparrow. The present work was aimed to investigate the level of heavy metals in excreta of House Sparrow in villages of Ludhiana district, as such studies are lacking from rural areas of Punjab

2. Materials and Methods

The two villages Kaind and Alamgir were selected in district Ludhiana and marked as locations I and II for monitoring of heavy metals in excreta of House Sparrow. Location I was divided into two sites transects 1 and 2. Location II was also divided into two sites transect 3 and 4 respectively. Excreta of House Sparrow were collected from its roosting, foraging and nesting sites during March 2016 to February 2017. The 0.5g dry excreta of House Sparrow was (in triplicates) weighted. To its each sample, 4 ml of conc. HNO₃ and HClO₃ was added. Samples were placed overnight; then these samples were placed on a hot plate till white fumes passed out. 25 ml distilled water was added to make volume and the solution was filtered. The digested samples were analyzed for elemental composition especially, for the presence of various heavy metals by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICAP-AES) in Department of Soil Sciences, PAU, Ludhiana. The readings taken on ICAP-AES were

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converted into parts per million (ppm=ug/g) [6]. The reported values were compared with the recommended normal range values of metals for avian species by Wisconsin Veterinary Diagnostic Laboratory (WVDL), Toxicology centre, United States. The data collected was represented as mean and standard error and it was subjected to t-test to assess whether heavy metals vary significantly among the samples collected from selected locations [8].

3. Results and Discussion

In the study, the elemental composition of dry excreta of House Sparrow has shown the presence of 16 elements As, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, S and Zn. At the location I, the level of B and Pb in excreta of House Sparrow was found in toxic range; As, Cr, Ni, Cd and Zn heavy metals were found higher than normal range but lower than the toxic range. The level of as was found 3.243±0.152 ppm in transect 1 and 2.571±0.427 ppm in transect 2 respectively (Table 1). The normal range for as is 0.01-0.2 ppm. The toxic range for as has been defined between 5-10 ppm. The level of Cd was found 0.368±0.069 ppm in transect 1 and it was observed 0.416±0.088 ppm in transect 2 (Table

1). The level of Cr was to be 7.653±0.217 ppm in transect 1 and 8.853±0.843 ppm in transect 2 respectively (Fig I and II). The normal levels of Cr in birds vary between 0.05-0.1 ppm. The toxic range has been defined for Cr in avian species is 19-170 ppm. The level of Ni in excreta of House Sparrow was found 8.111±0.428 ppm in transect 1 and 7.353±1.138 ppm in transect 2 respectively. The recommended normal range of Ni in avian species is 0.06-0.13 ppm. The toxic range has been defined for Ni in avian species is 10-12 ppm. The level of Zn was found 144.933±7.274 ppm in transect 1 and 240.333±30.396 ppm in transect 2 respectively. The normal level of Zn in birds varies between 22-32 ppm. The toxic range has been defined for Zn in avian species is 300-800 ppm. The level of B was found 127.6±11.429 ppm in transect 1 and 99.4±12.519 ppm in transect 2 respectively. The normal recommended range of B for avian species is 0.13-0.2 ppm. The toxic range of B in birds varies between 0.3-4.3 ppm. The level of Pb was observed to be 20.633±1.548 ppm in transect 1 and 25.156±5.623 ppm in transect 2. The recommended normal range of Pb in avian species is 0.1-1.0 ppm. The toxic range has been defined for Pb in avian species is 8-1600 ppm.

Table 1: Levels of different metals including heavy metals (ppm) in excreta of House Sparrow from residential areas of village Kaind

S. No.	Metals	Transect 1	Transect 2
1	Arsenic	3.243±0.152	2.571±0.427
2	*Boron	127.6±11.429	99.4±12.519
3	Calcium	17145±2912.045	19515±2831.582
4	Cadmium	0.368±0.069	0.416±0.088
5	Chromium	7.653±0.217	8.853±0.843
6	Copper	22.686±1.278	19.146±3.499
7	*Iron	1291.5±525.180	2648±307.15
8	*Potassium	12793.33±1332.699	14088.33±1739.206
9	*Magnesium	4516.667±355.805	3615.667±687.994
10	Manganese	179.4±10.96	139.266±31.152
11	*Sodium	1388±182.385	3558.333±547.916
12	*Nickel	8.111±0.428	7.353±1.138
13	Phosphorus	6378.333±325.785	5446.667±559.375
14	Lead	20.633±1.548	25.156±5.623
15	Sulphur	6215±450.583	4350.333±950.289
16	*Zinc	144.933±7.274	240.333±30.396

The data is represented as mean ± Standard error of three samples of each transects.

*Significant difference among transects P≤0.05.

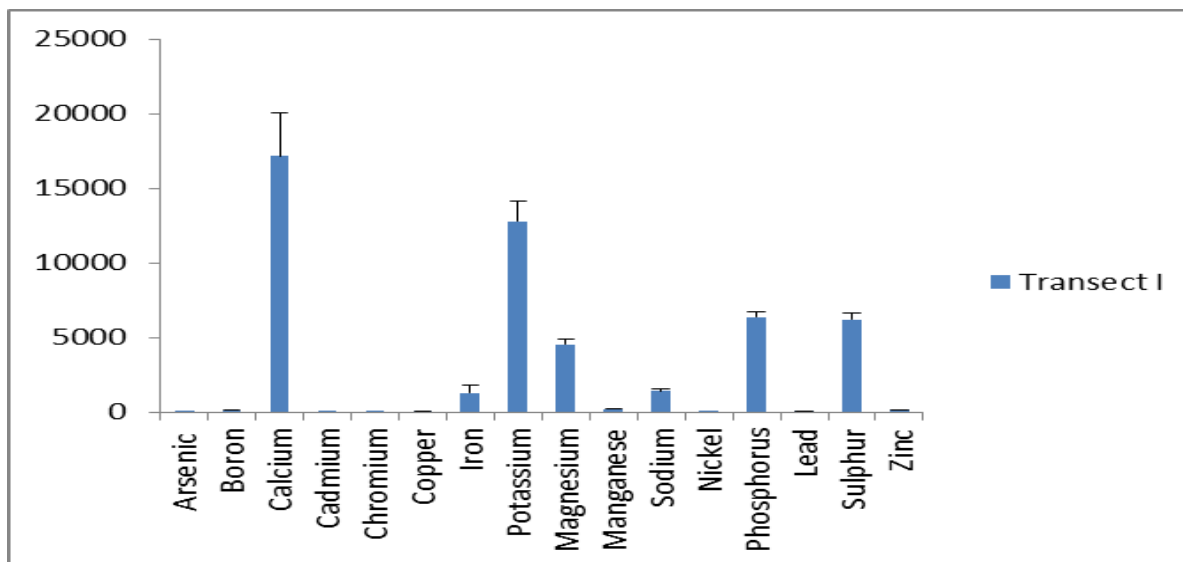


Fig I: Different metals in excreta of House Sparrow

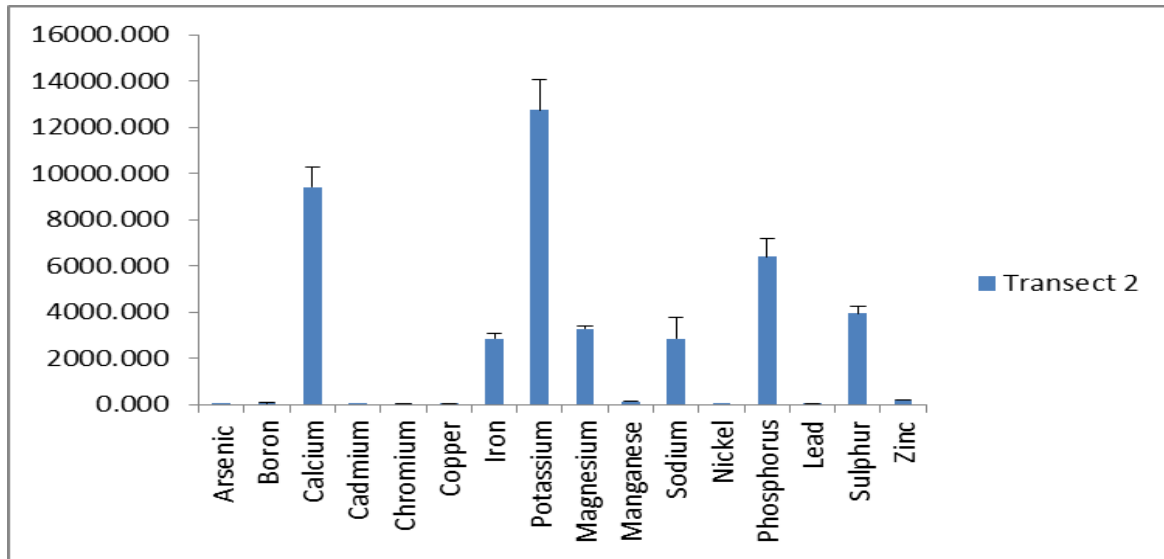


Fig II: Different metals in excreta of House Sparrow

At location II, the level of B and Pb were in toxic range in the excreta of House Sparrow. As, Ni, Cd, Cr and Zn levels were found higher than normal range but lower than the toxic range. The level of as was found 1.816 ± 0.192 ppm in transect 3 and 1.866 ± 0.367 ppm in transect 4 respectively (Table 2). The normal recommended range of as for avian species is between 0.01-0.2 ppm. The toxic range for as has been defined between 5-10 ppm. The level of Cd was found 0.616 ± 0.196 ppm in transect 3 and 0.483 ± 0.116 ppm in transect 4 respectively (Table 2). The normal recommended range of Cd for avian species is 0.02- 1.5 ppm. The toxic range of Cd in birds vary between 70 -140 ppm. The level of Cr was observed 16.1 ± 0.404 ppm in transect 3 and 15.15 ± 1.575 ppm in transect 4 respectively. The normal levels of Cr in birds vary between 0.05-0.1 ppm. The toxic range for birds has been defined for Cr is 19-170 ppm. The level of Ni was found 5 ± 1.027 ppm in transect 3 and 1.716 ± 1.036 ppm in transect 4 (Fig III and IV). The recommended normal range of Ni in avian species is 0.06-0.13 ppm. The toxic range has been defined for Ni in avian species is 10-12 ppm. The level of Zn was found to be 169.616 ± 16.803 ppm in transect 3 and 36800.8 ± 36649.61 ppm in transect 4 respectively (Table 2).

Table 2: Levels of different metals including heavy metals (ppm) in excreta of House Sparrow from residential areas of village Alamgir

S. No.	Metals	Transect 3	Transect 4
1	Arsenic	1.816 ± 0.192	1.866 ± 0.367
2	*Boron	45.716 ± 18.267	27.266 ± 3.527
3	Calcium	9401.667 ± 894.438	7650.667 ± 3041.171
4	Cadmium	0.616 ± 0.196	0.483 ± 0.116
5	Chromium	16.1 ± 0.404	15.15 ± 1.575
6	Copper	22.45 ± 1.791	20.816 ± 3.187
7	*Iron	2847.5 ± 226.293	2277.5 ± 551.781
8	*Potassium	12738.33 ± 1315.055	8658.333 ± 862.266
9	*Magnesium	3282.333 ± 92.550	2691.333 ± 203.930
10	Manganese	131.833 ± 22.300	152.333 ± 53.541
11	*Sodium	2847.167 ± 904.867	1193 ± 230.571
12	*Nickel	5 ± 1.027	1.716 ± 1.036
13	Phosphorus	6403.167 ± 786.302	7170 ± 1057.934
14	Lead	8.683 ± 1.930	9.566 ± 5.166
15	Sulphur	3949.167 ± 278.301	4382.667 ± 605.398
16	*Zinc	169.616 ± 16.803	137.5 ± 24.318

The data is represented as mean \pm Standard error of three samples of each transects.

*Significant difference among transects, $P \leq 0.05$.

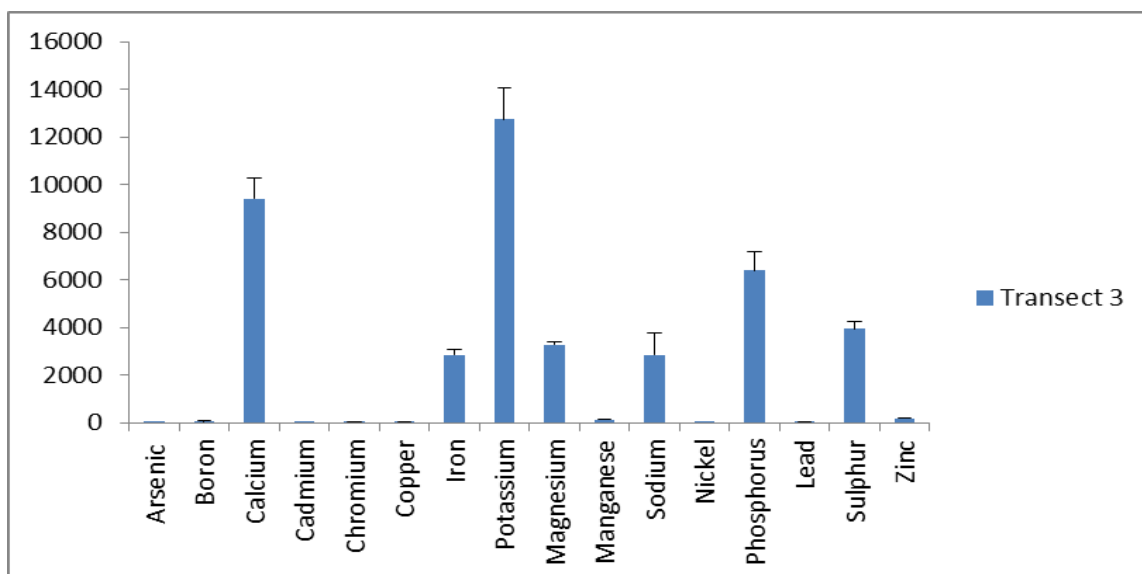


Fig III: Different metals in excreta of House Sparrow

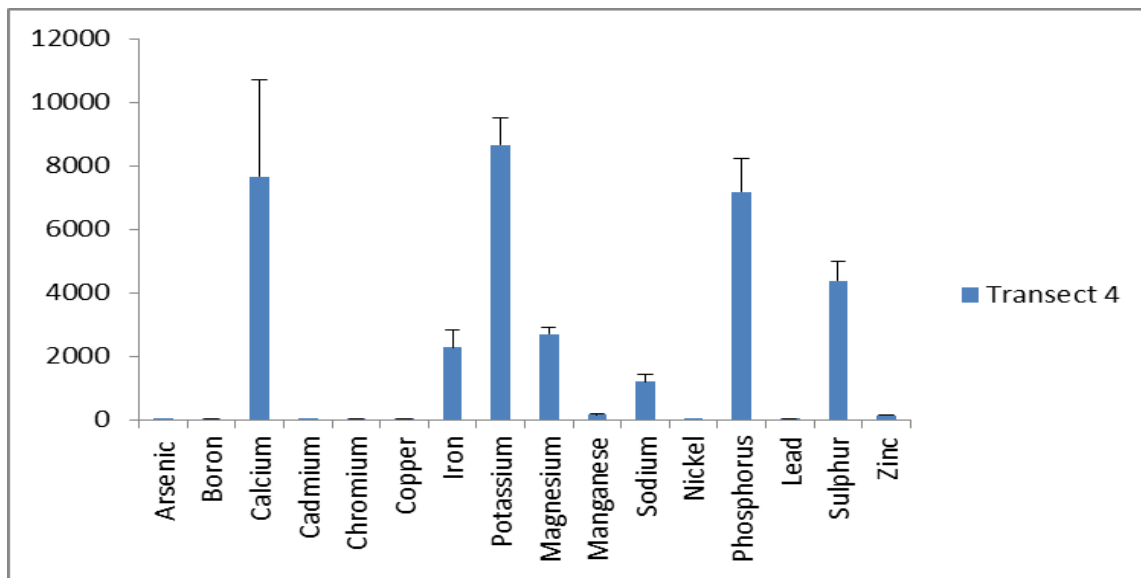


Fig IV: Different metals in excreta of House Sparrow

The normal level of Zn in birds varies between 22-32 ppm. The toxic range has been defined for Zn in avian species is 300-800 ppm. The level of B was found 45.716 ± 18.267 ppm in transect 3 and 27.266 ± 3.527 ppm in transect 4 respectively. The normal recommended range of B for avian species is 0.13-0.2 ppm. The toxic range of B in birds varies between 0.3-4.3 ppm. The level of Pb was observed to be 8.683 ± 1.93 ppm in transect 3 and 9.566 ± 5.166 ppm in transect 4 respectively. The recommended normal range of Pb in avian species is 0.1-1.0 ppm; the toxic range has been defined for Pb in avian species is 8-1600 ppm.

Results had shown that the amount of heavy metals As, Cr, Ni, Cd and Zn were found in higher range; the level of B and Pb were in the toxic range in excreta of House Sparrow at both studied locations. Its possible reason might be the heavy metals contamination in food grains and via the food chain in animals (insects and invertebrates) at these studied locations. Swaileh^[14] reported that the diverse feeding habits of House Sparrow must be taken into consideration for conclusion concerning the metal pollution. Heavy metal contaminations might have had indirect effects on the abundance of House Sparrow^[15, 11]. Different workers had stated that the decrease in the population of invertebrates used as nestling's food must have caused a decline in the population of House Sparrow. Kekkonen *et al*^[7] had stated that intensification of agriculture and changes in human lifestyle had resulted in elevated levels of various chemicals in our environment. Organisms that have become closely associated with human housing seemed to be at greatest risk of being affected. Recently, some researchers explored the potential of monitoring metal pollution using wild species such as House Sparrow (*Passer domesticus*), Pigeons (*Columbia livia*), and great tits (*Parus major*). These species are considered as ideal indicators because they are common and widely distributed and have fast metabolic rates^[10]. Kler *et al*^[8] had found heavy metals in excreta of five bird species from crop fields in Ludhiana district. It was further mentioned that the maximum level of As, Cd, Fe, Mn, Cr and Ni was found in Cattle Egret; the level of Cu, Mg, P and S were observed highest in Blue Rock Pigeon; in excreta of House Crow highest level of B, K, Na were found and further the levels of Ca, Pb, Zn were found highest in Common Myna. Kamath *et al*^[5] had found that young fledglings of House Sparrow had died due to pesticide poisoning as their parents fed them on contaminated grains

and bottom invertebrates collected from their close surroundings. There has been emerging number of studies using small passerines in eco toxicological studies around metal industries. Berglund *et al*^[1] had stated that mining and smelting operations had resulted in increased metal concentrations in the environment with negative effects on the surrounding ecosystem. Baker *et al*^[2] had found that metal concentrations in plume feathers, flight feathers and muscle tissue of House Sparrow and further mentioned the importance of House Sparrow as an indicator organism in terrestrial environments.

4. Conclusion

Presence of heavy metals in excreta of House Sparrow has signified the contamination in its preferred food items like grains and invertebrates in agricultural habitat of Ludhiana district. Heavy metal accumulation might be one of the reasons causing indirect effects on population fluctuations observed for House Sparrow in different parts of India. Further, detailed studies are required to ascertain the sources of these heavy metals and their consequences on avian populations in Punjab.

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