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Heavy Metal Contamination in Excreta of Blue Rock Pigeon (*Columba livia*) and Indian Peafowl (*Pavo cristatus*) in Rural Areas of Punjab

Gagandeep Kaur Sohi, Tejdeep Kaur Kler* and Sukhpreet Kaur

Department of Zoology, Punjab Agricultural University, Ludhiana, Punjab, INDIA

**Corresponding author: TK Kler; Email: tejdeepkler@pau.edu*

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ABSTRACT

Bird excreta are considered as bioindicator of heavy metal contamination in agricultural areas. The aim of the study was to evaluate the heavy metal concentrations in the excreta of Blue Rock Pigeon and Indian Peafowl to monitor the environment contamination in rural areas of Punjab. This study was carried out in two villages i.e Rampur Chhana (District Sangrur, location I) and Dargapur (District Patiala, location II). The excreta of Blue Rock Pigeon and Indian Peafowl were collected. After collection they were digested for metal analysis which was done through ICAP-AES. The study showed toxic level of Pb, high level above normal range of As and Ni more in the excreta of Indian Peafowl than in excreta of Blue Rock Pigeon. The concentration of B was in toxic range in excreta of Blue Rock Pigeon. It was inferred that they relied in similar environmental conditions while having exposure to different feeding habitats might have resulted in species specific heavy metal accumulation. Our studies showed that location I had more concentration of heavy metals like Pb, B and As which seems to be due to the presence of industrial units near this location. It has been concluded that more level of heavy metals in the excreta of Indian Peafowl was due to its high trophic level in the food chain. Statistical analysis showed significant difference among both the bird species which signifies the bioaccumulation of metals in the excreta of Indian Peafowl.

Keywords: Blue Rock Pigeon, Indian peafowl, heavy metal, environment contamination

Birds are useful indicators for exposure to pollutants such as metals (Furness, 1993). Birds are considered as bio-indicators (Bost and Lemaho, 1993) particularly because they are sensitive to environmental changes and more prone to intoxications than other animals as they quickly disperse the toxic agent through their body by their respiratory system, metabolic rate and low amount of body fat (Marchesi *et al.,* 2015). Birds are widely distributed in the ecosystem, sensitive to toxins and high on the food chain. Excreta are non-destructive matrices for monitoring heavy metal analysis (Rainio *et al.,* 2013) and provide information on unabsorbed metals and the metals that was absorbed and excreted (Sanchez-Virosta *et al.,* 2015). A large portion of metals are excreted, and feces become especially appropriate to assess the exposure to metals (Berguland *et al.,* 2011). Bird excrements have been suggested as useful non-destructive indicators of metal contamination in birds' diet and environment and excrements are conveniently easy to collect from nests and from their roosting sites (Berglund *et al.,* 2015). So the study was planned to find out heavy metal contamination in environment in rural areas by analyzing the excreta of Blue Rock Pigeon and Indian Peafowl.

MATERIALS AND METHODS

This study was performed to detect the concentration of heavy metals in excreta of Blue Rock Pigeon and Indian Peafowl collected from two sites located in two different districts. Village Rampur Chhanna (Sangrur) was considered as location I and village Dargapur (Patiala) as location II. Both locations include residential area, cultivation area and pond area. The excreta of Blue Rock Pigeon were easily available due to their high abundance in selected areas. Although Indian Peafowl was found in low abundance but the amount of a single fecal pallet of Indian

Peafowl was sufficient to carry out heavy metal analysis. Collection was done from the three nesting sites and three roosting sites of each of the selected species. One sample of 0.5 g from each of the roosting and nesting sites from both locations were analyzed for digestion. Digestion was done with acid mixture of HNO_3 and $HClO_4$. Then it was placed on hot plate for approximately 3 hours and to make final volume 25 ml distilled water was added and the solution was filtered. Digested samples were analyzed for the presence of various heavy metals by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICAP-AES) in Department of Soil Sciences, PAU, Ludhiana (Kaur and Dhanju, 2013). iCAP6300 Duo type of Thermo Electron Corporation Company was used in the laboratory for the analysis. Argon gas was used as carrier gas with 99.999% purity. The reported values of heavy metals were compared with recommended normal range values for avian species provided by Wisconsin Veterinary Diagnostic Laboratory (WVDL), Toxicology centre, United States. The data is represented as Mean±S.E of three samples of each location. Statistical analysis was done by T-test to assess the significant variation between the selected bird species and also between the locations.

RESULTS AND DISCUSSION

The concentration of different heavy metals was detected from the excreta of Blue Rock Pigeon and Indian peafowl. Total of 16metals detected in fecal matter of selected species were Arsenic (As), Boron (B), Cadmium (Cd), Calcium (Ca), Chromium (Cr), Copper (Cu), Iron (Fe), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na), Nickel (Ni), Phosphorous (P), Lead (Pb), Sulphur (S) and Zinc (Zn). The excreta was taken from selected villages and analyzed for exposure in the environment to different metals at different levels. At location I, recorded concentration of as was 0.895±0.301 ppm and 1.317±0.289 ppm in the excreta of Blue Rock Pigeon and Indian Peafowl respectively.

The concentration level of heavy metals in excreta of both selected species exceeded the normal range of As (0.01-0.02 ppm) but ranges below the toxic level. In case of B, the concentration detected in the excreta of Blue Rock Pigeon was 22.233±2.173 ppm and 17.533±1.291 ppm in excreta of Indian Peafowl. The level of B was toxic because the recorded range exceeded its normal range i.e 0.13-0.43 ppm. Cd detected in excreta was 0.4±0.05 ppm and 0.203±0.009 ppm in excreta of Blue Rock Pigeon and Indian Peafowl respectively. The concentration of Cd recorded was within the normal range i.e 0.02-1.5 ppm. Ni was detected from excreta of both selected species below its toxic value which was 10-12 ppm. The detected concentration of Ni was 2.85±1.245 ppm at location I and 3.143±0.497 ppm in excreta of Blue Rock Pigeon and Indian Peafowl. The range of Pb found in the excreta of Blue Rock Pigeon and Indian Peafowl was 5.75±0.747 ppm and 22.476±1.229 ppm respectively at location I. The level of Pb was lying within its normal range i.e 1-12 ppm in excreta of Blue Rock Pigeon and toxic level was found in excreta of Indian Peafowl (Table 1).

Table 1: Showing different metals in excreta of Blue Rock Pigeon and Indian Peafowl at location I

Elements	Blue Rock Pigeon Mean±S.E (ppm)	Indian Peafowl Mean±S.E (ppm)	T values
Arsenic	0.895±0.301	1.317±0.289	0.89223
Boron	22.2333±2.173	17.533±1.291	1.525086
Calcium*	8928.3333±285.910	4604.000±312.117	3.83566
Cadmium*	0.4000±0.050	0.203±0.009	2.48728
Chromium*	16.4000±1.173	6.458±0.724	3.355382
Copper	10.5833±5.355	10.386±0.895	0.034297
Iron*	2548.3333±29.689	787.000±101.106	4.502745
Potassium	9391.6667±429.431	10165.000±1280.452	0.532916
Magnesium*	3230.1667±47.743	2587.000±133.590	2.706822
Manganese*	70.8667±1.683	52.000±4.952	2.388554
Sodium*	514.3333±7.513	606.667±29.362	2.157078
Nickel	2.8500±1.245	3.143±0.497	0.206616
Phosphorus*	3330.8333±27.479	10300.000±927.636	3.411546
Lead*	5.7500±0.747	22.477±1.229	4.012777
Sulphur*	1899.6667±15.390	5743.000±791.708	2.802262
Zinc*	54.8500±2.610	126.967±13.452	2.915616

*Significant variation among both selected species, p≤0.05.

At location II, the concentration level of As recorded was 0.703±0.104 ppm and 1.133±0.136 ppm in excreta of Blue Rock Pigeon and Indian Peafowl respectively. So the concentration of As was higher than its normal range (0.01-0.02 ppm) but below itstoxic range (5-10 ppm). The concentration of B tested in the fecal matter of Blue Rock Pigeon was 14.3±0.929 ppm and 13.867±1.065 ppm in

excreta of Indian Peafowl. The concentration of B was higher than its normal range i.e 0.13-0.43 ppm. So the level of B was toxic in the excreta of Indian Peafowl and Blue Rock Pigeon. The level of Cd detected was 0.333±0.017 ppm and 0.176±0.033 ppm in feacal matter of Blue Rock Pigeon and Indian Peafowl respectively at location II. The concentration of Cd recorded from excreta of both species was within the normal range i.e 0.02-1.5 ppm. The normal range of Ni concentration was 0.06-0.13 ppm and toxic range 10-12 ppm. Our results showed that, level of Ni detected was 2.267±0.390 ppm and 2.813±0.518 ppm in excreta of Blue Rock Pigeon respectively. Pb detected in the fecal excreta of Blue Rock Pigeon and Indian Peafowl was 4.862±0.217ppm and 18.706±1.040 ppm respectively which means its value exceeded the normal range (1-12 ppm) in excreta of Indian Peafowl. So, there was found toxicity in the excreta (Table 2).

Table 2: Showing different metals in excreta of Blue Rock Pigeon and Indian Peafowl collected from location II

Elements	Blue Rock Pigeon	Indian Peafowl	T-value
	Mean±S.E (ppm)	Mean±S.E (ppm)	
Arsenic	0.703±0.104	1.13±0.136	1.52571
Boron	14.3±0.929	13.867±1.065	0.181449
Calcium *	8666.667±320.473	5290.667±784.458	2.526386
Cadmium*	0.333±0.017	0.176667±0.033	2.60126
Chromium*	16.583±1.261	5.55±0.947	3.313424
Copper*	14.700±0.683	10.45333±0.649	2.698707
Iron*	2675.333±31.491	1020±320.633	2.882015
Potassium*	9155.000±521.664	7110±365.251	2.228713
Magnesium*	3189.333±115.495	2454.667±171.260	2.368993
Manganese	72.867±2.341	53.8±8.779	1.671434
Sodium	484.267±46.823	500.3333±47.876	0.226478
Nickel*	2.267±0.390	2.813±0.518	1.960986
Phosphorus*	3430.500±116.727	9141.667±874.530	3.204996
Lead*	4.862±0.217	18.70667±1.040	4.166928
Sulphur*	1943.667±103.849	5571.667±91.712	5.10278
Zinc*	54.883±2.348	125.5667±7.083	3.731961

*Significant difference among the selected species, p≤0.05

In the present study we found that concentration of some metals like Pb, Ni, B, As were higher in the excreta at location I (Fig. 1) than location II (Fig. 2). The toxic level of B and Pb and high level of As and Ni at location I might be due to a small scale industry situated near it. Significant difference between heavy metal contaminations shows variation in the selected locations.

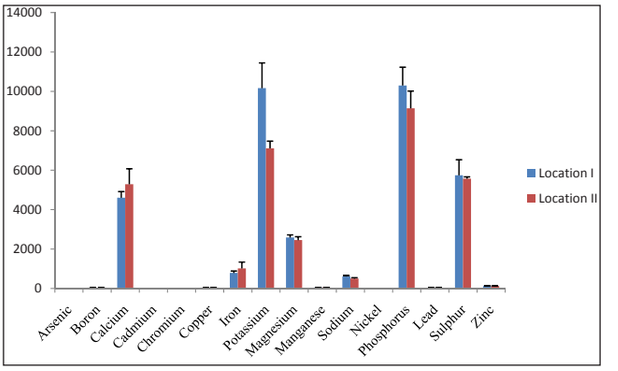

Fig. 1: Graphical representation of heavy metal concentration in excreta of Blue Rock Pigeon at both selected locations

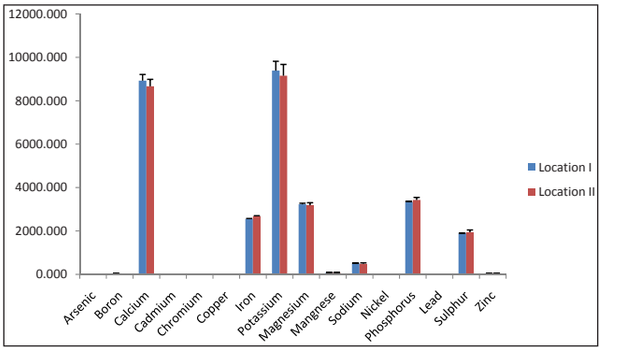

Fig. 2: Graphical representation of heavy metal concentration in excreta of Indian Peafowl at both selected locations

It was concluded that location I and location II had different concentration of metals which might be related to different chemical use in agriculture, dairy farming and other aligned sectors. Boersma (2008) had mentioned that human activities such as oil spills, sewage, hazardous wastes, pesticides, mining or smelting could contribute to increase Hg, As and Cd levels, whereas electrical devices, mining or explosives could increase Pb levels in ecosystems. Many of studies had focused on the case of acute poisonings due to the ingestion of lead-shot pellets (Mateo *et al.,* 2003) and isolated events and the subsequent release of acid sludge (Baos *et al.,* 2006). Lebedeva and Minkina (1998) reported that industrial pollution cause environment contamination of lead, nickel, copper, aluminum and

chromium. Most of heavy metals are released into the environment from use of mineral fertilizers and pesticides, air emissions of plants (Kabata-Pendias, 2004; Messadeh and Al-Safi, 2005), motor vehicles (Timmer *et al*., 2004), forest fires (Aronsson and Ekelund, 2004; Fowler *et al.,* 2004). Outridge and Scheuhammer (1993) had noted high level of Ni in liver and kidney in the birds in polluted environment. Many workers had found high fecal Ni concentrations in the passerines (Berglund and Nyholm, 2011; Dauwe *et al.,* 2004). Lebedeva (1997) reported that accumulation of As could due to type of food taken by birds. Some earlier reports revealed that the concentrations of heavy metals in exposed birds above the threshold level were insufficient to cause direct mortality but may result in behavioral changes, reproductive dysfunction, and increased chances of disease (Dauwe *et al*., 2004). Flycatchers had been known to accumulate excessive amounts of cadmium and lead that may cause pathological changes and physiological dysfunctions of their organs, reduction of clutch size, elevated embryonic and bird mortality, decrease in hemoglobin levels (Chaplygina and Yuzyk, 2016).

In the present study, we have found difference in the concentration of metals in the excreta of Blue Rock Pigeon (Table 1) and Indian Peafowl (Table 2). Significant variation among some heavy metals like Ca, Cd, Cr, Fe, Mg, Mn, Na, P, Pb, S and Zn showed difference between the two species at location I and Ca, Cd, Cr, Cu, Fe, K, Mg, Ni, P, Pb, S and Zn showed difference in excreta of two avian species at location II. Significant difference among the concentration level of heavy metals in excreta of Indian Peafowl and Blue Rock Pigeon might be related to different metabolism or feeding between the two species. Indian Peafowl is having omnivorous feeding habits while Blue Rock Pigeon is granivorous in its dietary composition. Excreta of Indian Peafowl having toxic level of Pb and high level of Ni, As whose possible source could be wide spectrum of its feeding habits and bioaccumulation of metals due to its high trophic level. Duruibe *et al.* (2007) referred as some heavy metals like As, B, Cd and Pb were found toxic to birds and mammals. Different workers have found metal contents in bird excreta due to their food and their environment (Dauwe *et al.,* 2004; Costa *et al.,* 2013). Heavy metal contamination was detected in excreta of five bird species (i.e. House Crow, Common Myna, Blue Rock Pigeon, Ring Dove and Cattle Egret) and it is varied significantly at 5% level of significance among the species. They further mentioned that the toxic elements seemed to be harmful at low concentration when taken over a long period (Kler *et al.,* 2014). Kler *et al.* (2018) have found significant difference in chemical composition of excreta of Blue Rock Pigeon from urban niches of agricultural region at different locations. Kumar and Achyuthan (2007) have found heavy metal concentrations below the threshold levels in the various tissues of marine animals which have been accumulated along the food chain rather than from water sediments. Burger (2002) reported high level of contaminants stored by omnivorous, fish-eating birds and birds of prey. Yigit and Altindag (2006) had mentioned the higher concentration of heavy metals in the food web of Lake Egirdir, which is an important bird nesting area. In our study toxic level of B was found in the excreta of Blue Rock Pigeon and Indian Peafowl which might be due to excessive use of fertilizers or pesticides. Weir and Fisher (1972) have found that boron compounds have moderate acute toxicity. Wrobel (2009) studied effects of boron fertilization of spring cereals depending on application methods and found that boron fertilization improved boron concentration in grains which become part of granivorous birds that feed on it. Metal concentrations in excrement reflect the unabsorbed metal content in food items and excretion of absorbed metals (Morrissey *et al.,* 2005) and food items had been suggested as an important source of metals to insectivorous birds (Berglund *et al.,* 2009; Swiergosz *et al.,* 1998). Different workers had found high Cu level in nestling excrement of Pied Flycatcher and whose possible source was spiders having Cu rich haemocyanin (Eeva *et al.,* 2005; Belskii and Belskaya, 2013).

It can be concluded from present study, the excreta of different birds species show varying levels of heavy metal contamination related to their food and trophic level wise feeding and foraging habits. Crop specific chemicals were being used in its vicinity and adjoining areas. The planned and systematic studies required to be conducted on feathers and excreta of both abundant and less abundant bird species to know the level of heavy metal contamination in their food items and in their habitat in agroecosystem.

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