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QUANTIFICATION OF HEAVY METAL RESIDUES IN FECAL MATTER OF BLUE ROCK PIGEON (COLUMBA LIVIA) IN PUNJAB

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ABSTRACT

The present study was done to assess the heavy metal contamination in the excreta of Blue Rock Pigeon from rural areas of Punjab. This study was conceded out in three locations: Location I: Agronomy Farm, Punjab Agricultural University, Ludhiana, Location II: Cold Storage, Jalandhar Bypass and Location III: Cold Storage, Mullanpur. The results revealed that the levels of Arsenic (As), Chromium (Cr) and Cadmium (Cd) were greater than normal levels in excreta of pigeon from all the three locations and for Lead (Pb) it was above the toxic level at Location II and III. Lead (Pb) levels were observed to be more than thetoxic range from both the locations. Concentrations of heavy metals were higher in locations II and III because these locations are close to road and have more industrial units than location I. Therefore, pigeons excreta can be used as bioindicator for heavy metal levels.

Key words: *Columba livia*, heavy metals, contaminants, excreta, arsenic chromium, cadmium lead, location, variations, indicators

One of the most terrible ecological challenges the world is currently dealing with is environmental degradation. Industrialization also plays a significant role in bringing about certain environmental changes. Heavy metal contamination has been identified as a major environmental issue with rising industrialization. Any metallic chemical element that has a relatively high density and is dangerous or toxic at low concentrations is referred to be a heavy metal. Copper, Manganese, Lead, Cadmium, Iron, Mercury, Zinc and Nickel are few examples (Raikwar et al., 2008). Despite the fact that heavy metals are naturally occurring elements that are present throughout the earth's crust, the majority of environmental contamination and their exposure are caused by human activities like mining, smelting operations, and industrial processes like metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations, and the production of plastics, textiles, microelectronics, wood preservation, and paper (Braune and Noble, 2009). Due to their high sensitivity to environmental contaminants, particularly from anthropogenic activities, than any other vertebrate, birds are the most noticeable and significant component of various habitats; therefore, their presence or absence may indicate the ecological conditions of the specific area. Birds are therefore the best to observe environmental change (Kler et al., 2014 and Medona et al., 2015). Birds are exposed to heavy metals by ingested food, drinking water contamination (such as lead pipes), or high ambient metal concentrations close to emission sources. Following absorption, metals move throughout the body, are eliminated in faeces, build up in various body tissues, or are trapped in feathers (Nighat et al., 2013).

Excretion of heavy metals in fecal matter of birds has received attention because according to Wildlife Protection Act 1972, the capturing and killing of birds is legally banned by Govt. of India; therefore any analytical studies which make use of bird's tissues and organs are away from the experts working in this area. Besides, in India studies on heavy metal pollution in bird's excreta are restricted. As a further matter, the heavy metals show the capacity for bioaccumulation and biomagnification in the food chains (Zhuang et al., 2009). Thus, the only source that can be used to estimate the harmful effects of trace metals on these creatures and the environment is bird faeces matter. In order to investigate whether faecal matter may be utilised as a non-invasive way to assess metal concentration in the environment, the present research were created to biomonitor concentration of heavy metals in the faeces of birds that were exposed to an industrial setting.

MATERIALS AND METHODS

Study areas include three locations: Location I: Agronomy Farm, Punjab Agricultural University, Ludhiana, Location II: Cold Storage, Jalandhar

Bypass and Location III: Cold Storage, Mullanpur. The locations were close to the G.T. Road, which implies that the vehicle waste adds various toxins that contribute to air, soil, and water contamination. Due to the Blue Rock Pigeon's great density in some regions, their waste was readily accessible. Spreading plastic sheets underneath the trees at the roosting/nesting sites allowed for the collection of both hardened and fresh excrement. With the aid of the spatula, the excretions were placed in the sterile vials and transported to the lab. The samples were properly labelled with the source, time, and date of collection before being placed in the refrigerator to be used later. Excreta were physically examined to note their texture, colour, consistency, visible constituents, and shape.

The 0.5g dry excreta of feral pigeon (in triplicate) was weighed. To its each sample, 4 ml of conc. HNO_3 and $HClO_3$ was added. Samples were left overnight, and then they were heated until white fumes began to escape. The solution was filtered after makeup of volume with 25 ml of distilled water. By using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICAPAES), the digested samples were examined for their elemental composition, particularly for the presence of several heavy metals, at the Department of Soil Sciences, PAU, Ludhiana. As a carrier gas, 99.999% pure argon gas was used. The Wisconsin Veterinary Diagnostic Laboratory's (WVDL) Toxicology Center's suggested normal range values for avian species were compared to the reported heavy metal concentrations. ICAP-AES measurements were converted to parts per million (ppm=ug/g). The Wisconsin Veterinary Diagnostic Laboratory (WVDL), Toxicology Centre, United States, compared the reported levels to the suggested normal range values of metals for avian species. The data collected was represented as mean and standard error.ANOVA was used in statistical analysis to determine whether there are significant differences in the levels of heavy metals in the samples taken from the chosen locations.

RESULTS AND DISCUSSION

Four elements namely arsenic (As), cadmium (Cd), chromium (Cr) and lead were found in the excreta of feral pigeons (Pb) from three different locations. Out of these, As, Cd, and Pb fall within the group of heavy metals, which are toxic whenever present and are non-essential. Cr is a crucial component that the body needs to execute several metabolic tasks. However, these necessary components are toxic when present in humans and birds at amounts above the threshold level. All the observed heavy metals showed variations among three locations. In most living things, heavy metal concentrations are typically minimal (1 ppm wet weight, or roughly 3 ppm dry weight) (Baker et al., 2017). Table 1 gives the concentrations of various heavy metals in the fecal samples of feral pigeon collected from three locations.

At the agronomy farm, cold store Jalandhar bypass, cold storage Mullanpur, and cold storage Ludhiana, the mean As concentrations in faecal matter were 2.27 ppm, 0.21 ppm, and 0.50 ppm, respectively (Fig. 1). In this study, the concentration of As in the pigeon faeces at the Agronomy farm was over this range. As is an element that is present in all biological tissues, plants, water, and air. Human activity causes significant As emissions into the environment, mostly as a result of pesticide use in agriculture. According to statistical data on arsenic at different locations, there was no discernible variation in the mean concentrations across all locations. Ataxia, asthenia, slowness, jerkiness, falling, hypore activity, fluffed feathers, ptosis, hunched position, loss of righting reflex, immobility, and tetanic seizures are symptoms of acute arsenite poisoning in birds (Hudson et al., 1984). Highly toxic inorganic as seen in some seabirds have endocrine-disrupting effects, result in mortality, have sublethal effects, or interfere with reproduction (Eisler, 1994, Kunito et al., 2008). Lebedeva (1997) discovered that a bird's diet plays a

Table 1. Heavy metals in the fecal samples of feral pigeon

Element	Location I Agronomy farm, PAU, Ludhiana	Location II Cold storage, Jalandhar bypass	Location III Cold storage, Mullanpur	Normal range	Toxic range
Arsenic	2.27± 1.22	0.21± 0.41*	0.50± 0.61*	0.01-0.2	5-10
Cadmium	0.27± 0.005	1.83± 6.70*	1.21± 0.47*	0.02-1.5	70-140
Chromium	8.06± 0.50	8.28± 0.90*	6.07± 2.17*	0.05-0.4	19-170
Lead	8.71± 2.40	14.08± 0.446*	12.39± 4.08*	0.01-1	8-1600

The data is represented as mean ± standard error of five samples of each location; *Significantly different at $p<0.05$ among three locations

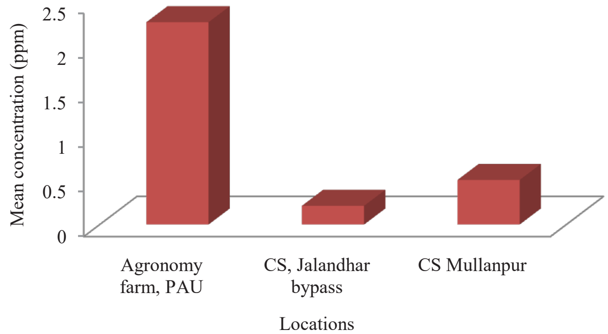

Fig. 1. Concentration arsenic in fecal matter of pigeon

significant effect on the amount of as they would ingest. However, findings from the current study showed that the grain-eating blue rock pigeon has distinct levels of arsenic in its fecal matter.

In the current investigation, it was found that the mean Cd concentrations at Agronomy Farm, PAU, Cold Storage, Jalandhar Bypass, and Cold Storage, Mullanpur were each 0.27 ppm, 1.83 ppm, and 1.21 ppm, respectively which was significantly greater in location II and Location III. (Fig. 2). Due to its use in industrial processes, cadmium is one of the most prevalent non-essential metals in the environment. Cadmium is easily transported and stored as complexes with proteins when it enters the body through the respiratory and digestive systems. These complexes are primarily found in the liver and kidneys, with minor amounts being present in the pancreas, intestines, and bones. The kidney's significant Cd accumulation shows how important this organ is to the detoxification process and to the storage of extraneous materials. According to Lucia et al. (2010), the kidney, followed by the liver, was the primary internal organ for Cd accumulation, whereas muscle and feathers were very minor locations.This toxic metal has been linked to kidney toxicity, intestinal lesions, disruption of calcium metabolism, decreased food intake, and thinned eggshells (Mayack et al.; 1981, Hughes et al., 2000; Burger, 2008). When the Cd levels approached

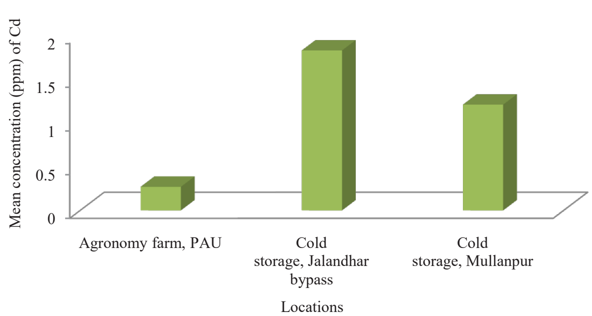

Fig. 2. Concentration of Cadmium in fecal matter of pigeon

20 ppm, numerous species of birds exhibited kidney impairment, according to studies by Battaglia et al. (2005) and Toman et al. (2005). It has been proposed that a threshold concentration of 100 ppm of cadmium in the kidneys marks the point at which cadmium poisoning is likely to occur (Furness, 1996). According to Burger (1995), harmful Cd levels in feathers could be as low as 0.1 ppb (in shearwaters) or as high as 0.2 ppb (terns). Cd levels of 7.25 mg/ l in plasma (2000 times higher than those seen in human plasma) and a high concentration of 13.93 g/ g in the excreta of black vultures (*Coragyps atratus*) were reported by Bravo et al. in 2005.

Over the course of a bird's lifetime, exposure to this trace element, even at low levels, accumulates in the body (Dailey et al., 2008). According to Kim and Koo (2007a), cadmium levels in wild birds' feathers rose in direct proportion to dietary intakes of the metal. Additionally, higher Cd levels in herons and egrets have been linked to their eating areas (Kim and Koo, 2007 b). In the food chain, Cd tends to bioaccumulate (Burger and Gochfeld, 2004). Furness (1996) has reviewed the toxicological effects of Cd in birds.

At Agronomy Farm in PAU, Cold Storage in Jalandhar Bypass, and Cold Storage in Mullanpur, the concentration of Cr was 7.06 ppm, 8.28 ppm, and 6.07 ppm, respectively. The concentration of Cr was highest at the Jalandhar bypass cold storage and lowest at the Mullanpur cold storage (Fig. 3). The statistical information showed that there was no statistically significant difference in the mean concentrations of chromium. Cr has detrimental effects on the mallard's embryonic growth, hatching, and viability, claim Kertesz and Fancsi (2003).

Pb in soils may constitute a significant source of exposure, despite the fact that research on the effects of lead on birds at ranges has primarily concentrated on the consumption and toxicity of lead-shot pellets or pieces (Berglund et al., 2010). The mean Pb concentrations were 8.71 ppm at Agronomy Farm in PAU, 14.08 ppm at the Jalandhar Bypass Cold Storage, and 12.39 ppm at the Mullanpur Cold Storage. The agronomy farm, PAU, had the lowest mean concentration, while cold storage, Jalandhar Bypass, had the highest (Fig. 4). Pb, which is frequently present in connection with hunting activities, harms nestling growth and survival, produces haemolytic anaemia in wild Pb-poisoned birds, adversely affects reproduction by reducing plasma calcium and egg production, and alters

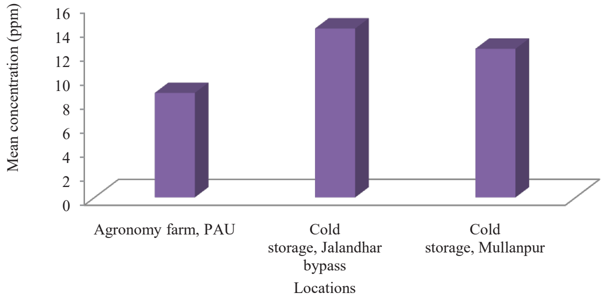

Fig. 3. Concentration of Cr in fecal matter of pigeon

behaviour (Berglund, 2011). Pb is a known element that seeks for calcium formations, rapidly accumulates in bones, hair, feathers, and nails, and is not metabolically controlled, making it potentially crucial for monitoring anthropogenic contamination.

Additionally, red blood cells may create proteins similar to metallothionein that bind to Pb and sequester it in a non-bioavailable state, shielding an organism from the toxicity of Pb (Jayakumar and Muralidharan, 2011). Pb may affect the metabolism of calcium in birds (Baker et al., 2017). Due to Pb's harmful effects on the neurological system, animals develop behavioural deficiencies that may have negative impacts on survival, growth rates, fledging success, learning, and metabolism (Dauwe et al., 2005). The mortality rate was higher in the Pb-exposed nestlings. For Pb, there have been discovered negative correlations between trophic position and metal levels. From the current study, it can be inferred that pigeon excretions exhibit varied degrees of heavy metal contamination in relation to their diet and trophic level-wise feeding and foraging habits. In the immediate area and neighbouring regions, crop-specific chemicals were being employed. To determine the degree of heavy metal pollution in these bird species' food sources and habitat in agroecosystems, organised and systematic investigations must be undertaken on their excreta.

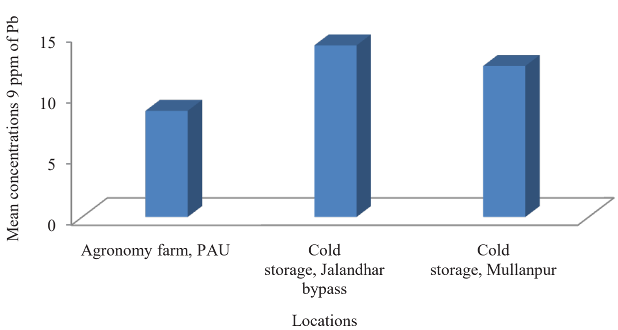

Fig. 4. Concentration of Pb in fecal matter of pigeon

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AUTHOR CONTRIBUTION STATEMENT

SK designed research. SK conducted experiments. SK and PS wrote the manuscript. SK and PS read and approved the manuscript.

CONFLICT OF INTEREST

There is no conflict of interest.

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