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The Levels of Heavy Metals in Pigeon Feathers in Different Areas of Ajmer City (Rajasthan): Feather as an Indicator

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Abstract: ***The objective of the study is to provide evidence that pigeon feathers are good bioindicator of environmental pollution with Pb as heavy metals and Cu, Cr and Zn as trace element. Samples of Columba livia were collected from urban, sub urban and rural areas in Ajmer city (Rajasthan). The metals analyzed include lead, copper, chromium and zinc by AAS (Atomic Absorption Spectrophotometry). The results divided primary, secondary and tail fathers according to its richness with metals in order : Primary > tail > secondary and the metals zinc >chromium> copper > lead respectively : The study showed that urban areas are the richest area with in Pb, Cu, Cr, Zn and considers feathers as the best monitor of air pollution in the study area.***

Keywords: Feathers, heavy metals, AAS

1. Introduction

Metals are persistent pollutants that can be biomagnified in the food chains, becoming increasingly dangerous to human and wildlife [1]. The natural environment has been gradually contaminated by various forms of pollution. Heavy metals are those metals having densities higher than 5 gml-1, for example, Iron, Copper, Lead, Cadmium, Mercury, Nickel, Zinc and Manganese. Many of these heavy metals can become toxic at concentration higher than the amount required for normal growth. A serious group of pollutants are heavy metals that pose a threat to all living organisms, with lead being especially considered as highly toxic [2] and [3]. Contamination by heavy metals is a major concern worldwide, regional and local level and influences the functional and structural integrity of an ecosystem. Heavy metals enter into the food chain through uptake by plants and ingestion by the animals. The fraction which is assimilated will accumulate in various body organs/tissues or be metabolized, maternally transferred to their eggs and offspring or excreted through faeces, eventually posing a serious health risk to inhabitants of an ecosystem, including humans. If organisms are unable to eliminate a metal, it may reach dangerous concentrations as it is passed to higher tropic levels in the food chain or web. The bioaccumulation of heavy metals, by living organisms is often a good integrative indicator or exposure, and has been extensively used to assess contamination levels of heavy metals in polluted ecosystems. Quantification of trace element levels in different tissues of the organism is an indicator of the bioavailable fraction of the element in the environment [4]. Birds are easy to identify and their classification and systematic are well established. They are particularly well known organisms, with much research carried out on their ecology and behavior and this background knowledge of biology enhances their usefulness as bio monitor. It is very important to keep several criteria when selecting the bird species for bio-monitoring. In biomonitoringstudies, the *C. livia* have been used for approximately 30 years. Moreover, many of the case studies have been reported recently in India highlighting the effects of heavy metals toxicity in birds.

Since the capturing and killing of birds are banned so faecal pellets and feathers are the alternative source to estimate the concentration of heavy metals in birds. Feathers are metabolically inert after formation, so for those avian species with well known moulting schedules, the analyses of specific individual feathers provide unique chemical information. There are several advantages for feathers and as monitoring units. The object of present investigation is to determine and evaluate the effect metals in feather of different areas are inthe district Ajmer Rajasthan and also objective of my investigation is to develop a non-invasive tool for assessment of environmental heavy metal contamination.

2. Materials and Methods

In the present study, molted feathers of pigeons *(C. livia)*were collected from different traffic density area and analyzed for the heavy metals. For lead, copper, zinc and chromium analysis double beam atomic absorption spectrophotometer (AAS) was used. The results are represented as μg/g (ppm) dry weight.

3. Results and Discussion

The concentration of lead was analyzed in the primary, secondary and tail feathers of pigeon. Samples were collected from different sampling station are presented in table 1. All the results were performed in dry weight.

Table 1: Comparative Study of Lead

S.No.	Sample Point						Reference Site
Experimental Feathers (µg/g dry wt)	Adarsh Nagar	Makhupura	Nasirabad by Pass	Kekri	Kishangarh	Rupangarh	Khiria village
Primary feathers	9.08±0.04 c	8.83±0.21 c	7.26±0.43 c	4.68±0.87 a	5.65±0.27 c	1.51±0.23 ns	1.10±0.05
Secondary feathers	5.33±0.29 c	1.95±0.54 ns	4.83±0.31 b	2.01±0.55 ns	1.70±0.32 ns	1.51±0.23 ns	1.16±0.05
Tail feathers	8.63±0.33 c	8.98±0.41 c	7.43±0.29 c	5.28±0.19 c	5.93±0.37 c	1.66±0.16 ns	1.36±0.17

a-P(<0.05) almost significant
b-P(< 0.01) significant
c-P (<0.001) highly significant
ND- not detectable

Lead concentration in feathers of pigeonauthors have been observed that the Pb concentration was highly significantly (P<0.001) i.e. 9.08 ± 0.04 ppm d/w) at Adarsh nagar and least insignificantly (1.10 ± 0.05) ppm d/w was recorded in Khiria Village in primary feathers. The values in descending order were Adarsh Nagar >Makhupura>Nasirabad Bus stand>Kekri>Kishangarh>Rupangarh> Khiria village (reference site).

In case of secondary feathers Pb concentration was highly significant (P<0.001) at Adarsh Nagar i.e. 5.33±0.29 ppm d/w. Minimum concentration was found insignificantly atKhiria village 1.16±0.05 ppm d/w. The values in descending order was at Adarsh Nagar> Nasirabad> Kekri> Makhupura>Kishangarh>Rupangarh> khiria village (reference site).

In tail feathers, lead concentration was maximum 8.98± 0.41 ppm d/wand highly significant (P < 0.001), at Makhupura.Whereas minimum and insignificant, 1.16 ± 0.54 ppm d/w in Khiria Village . Lead concentration was found in the following descending order; Makhupura> adarshNagar>Nasirabad>Kishangarh> Kekri >Rupangarh> Khiria village (reference site). These values show that most of the high concentration of lead was found in primary feathers.

Table 2: Comparative Study of Copper

S.No.	tnioP elpmaS					Reference Site	
Feather	Adarsh Nagar	Makhupura	Nasirabad by Pass	Kekri	Kishan garh	Rupangarh	Khiria village
Primary feathers	4.58±1.08 a	9.88±2.40 ns	8.31±0.17 b	11.98±1.33 b	8.88±1.78 ns	10.00±0.05 b	2.71±0.19
Secondary feathers	2.61±0.16 ns	6.46±0.08 a	7.63±0.26 b	8.14±1.13 a	6.46±0.74 ns	8.48±0.21 b	2.26±0.11
Tail feathers	5.04±0.46 b	9.61±0.21 b	7.66±0.28 a	12.12±0.02 b	11.50±0.51 b	8.71±0.74 a	2.82±0.16

a-P(<0.05) almost significant
b-P(< 0.01)- significant
c-P (<0.001)- highly significant
ND- not detectable

As summarized in table 2 Copper concentration in feathers of pigeon the highest copper concentration was found in Kekri i.e. 11.98 ± 1.33 ppm d/w in tail feathers and least was found at Khiria Village (reference site) i.e. 2.71 ± 0.19 ppm d/w. The concentrations of Pb in descending order were as follow: Kekri> Makhupura>Kishangarh> Nasirabad>Adarsh nagar> Rupangarh> Khiria village (reference site).

In secondary feathers Cu concentration was significant (P <0.01) at Rupangarh. We found maximum copper content in Rupangarh i.e. 8.14 ± 0.21 ppm d/w and minimum was in Khiria Village i.e. 2.26 ± 0.4 ppm d/w. These values were found in descending order as Rupangarh> Kekri> Nasirabad> KishanGarh>Makhupura>Adarsh Nagar> Khiria village (reference site).

In tail feathers Cu concentration was observed maximum 12.12 ± 0.20 ppm d/w and significant (P < 0.01) at Kekri and minimum 2.82 ± 0.16 ppm d/w and insignificant at Khiria village. Cu concentration was found according to areas as follows: Kekri>Kishangarh> Makhupura> Rupangarh>Nasirabad>Adarsh Nagar > Khiria Village (reference site).

Table 3:.Comparative Study of Zinc

S.No.	sample point						Reference Site
Feather	Adarsh Nagar	Makhupurar	Nasirabad by Pass	Kekri	Kishan garh	Rupan garh	Khiria village
Primary feathers	91.80±5.08 c	91.31±1.29 c	111..50±10.51 c	156..14±12.8 c	86.50±8.08 c	124.65±28.3 c	4.24±0.73
Secondary feathers	52.50±2.56 c	65.17±3.16 c	64.49±3.11 c	67.61±12.48 b	56.75±15.38 a	54.08±1.88 c	4.23±0.53
Tail feathers	49.52±0.57c	91.67±0.41c	80.33±9.35 c	96.50±0.28 c	66.25±2.32 c	56.44±3.1 c	4.43±0.78

a-P(<0.05) almost significant
b-P(< 0.01)- significant
c-P (<0.001)- highly significant
ND- not detectable

According to table 3 zinc concentration in feathers of Pigeon in primary feathers Zn concentration was maximum 156.14 ± 12.80 ppm d/w and highly significant (P < 0.001) at Kekriand minimum 4.24 ± 0.73 ppm d/w and insignificant in Khiria Village (reference site). Whereas descending order was as follows: Kekri > Rupangarh >Nashirabad> Adarsh Nagar>Makhupura>Kishangarh>Khiria Village (reference site).

In secondary feathers, Zn concentration was maximum i.e. 67.61± 12.48 ppm d/w and highly significant (P < 0.001) at Kekri and minimum, 4.23 ±0.53 ppm d/w and insignificantly, observed in Khiria Village.In different areas descending order of Zn concentration was as follows: Kekri> Makhupura >Nasirabad>Kishangarh> Rupangarh> Adarshnagar>Khiria Village (reference site).

In tail feathers Zn concentration was observed maximum, 96.50 ±0 .28 ppm d/w and highly significant (P < 0.001) and minimum 4.43 ± 0.78 ppm d/w and insignificant in Kheria village (reference site). In different areas it was in descending order as follow: Kekri>Makhupura >Nasirabad> Kishangarh>Rupangarh>Adarsh Nagar >Khiria Village (reference site).

Table 4: Comparative Study of Chromium

S.No.	Sample point						Reference Site
Feather	Adarsh Nagar	Makhupura	Nasirabad by Pass	Kekri	Kishan garh	Rupan garh	Khiria village
Primary feathers	7.45±0.23 c	12.55±0.20 c	13.73±1.13 c	14.26±0.14 c	12.57±2.59 a	11.85±0.08 c	1.65±0.24
Secondary feathers	3.73±0.38 b	9.55±0.39 c	13.64±043 c	12.05±0.25 c	9.58±1.58 b	10.70±0.55 c	1.13±0.13
Tail feathers	4.86±0.11 b	12.35±0.48 c	12.60±0.55 c	14..12±0.52 c	12.23±0.14 c	11.22±0.85 c	1.89±0.11 s

a-P(<0.05) almost significant
b-P(< 0.01)- significant
c-P (<0.001)- highly significant
ND- not detectable

We are observed chromium concentration in feathers of pigeon in table No.4. The concentration of chromium inPrimary feathers was maximum 14.26 ± 0.14 ppm d/w and highly significant (P > 0.001) at Kekriand minimum 14.26 ± 0.14 ppm d/w and insignificant in Khiria Village (reference site). The values were found in descending order as follow: Kekri>Nasirabad>Kishangarh>Makhupura>Rupangarh>Ada rsh Nagar>Khiria Village.

In case of secondary feathers Cr concentration was maximum13.64 ± 0.43 ppm d/w and highly significant (P < 0.001) at Nashirabadand minimum 1.13 ± 0.13 ppm d/wand insignificant was observed in Khiria Village. These values were found in descending order as Nashirabad>Kekri> Rupangarh>Kishangarh>Makhupura>Adarshnagar> Khiria Village (reference site).

In tail feathers Cr concentration was maximum14.12 ± 0.52 ppm d/w and significant (P<0.001) at Kekri and minimum 1.89±0.11 ppm d/w and insignificant observed inKhiria Village (reference site) Chromium concentration was found in descending order as follow: Kekri>Nashirabad> Makhupura>Kishangarh>Rupangarh>Adarsh nagar > Khiria Village.

In the present investigation feral pigeons (*C. livia)*were chosen as an experimental animals and whole feathers of pigeons were chosen as indicators. Matcheva et al., (2006) determined concentrations of biogenic and toxic elements (Na, K, Mg, Ca, P, S, Fe, Cu, Zn, Co, Mn, Se, Ni, Sr, Al, Cd, Pb, As) for the first time in feathers of gentoo penguin (Pygoscelis papua) and chinstrap penguin (Pygoscelis antarctica) from Antarctica. A comparison of element levels was performed among these species in years 2002-2003. Penguins molt annually and this fact allows defining precisely the concentrations of accumulated toxic elements and heavy metals in plumage every year. A continual environmental bio-monitoring could establish a possible trend to contamination of the Antarctica sea zones. The pigeon feather is an excellent subject for monitoring because pigeon have long life span, permanent ecological niche and dominate the avifauna in Antarctica.

The results of present study show that the levels of metal in feathers increased with the traffic density as highest concentration of metal in feathers was observed in those samples collected from Adarsh Nagar (High traffic density area) and as we go in low traffic density area the level of metal decreases gradually and the lowest metal level was found in rural areas.

Present study undertaken on pigeon feathers found in various very high densities of automobiles, particularly in the urban while sub urban and rural areas were free from the metal contaminants. The high traffic density areas Adarsh Nagar>Makhupura>Nasirabad Bus stand >Kekri> Kishangarh>Rupangarh>Khiria village (reference site) village of Ajmer city. In Ajmer city many smaller industries spread overall metal pollution.

Lead is cheap and there is a long tradition of its useand its toxic effectshave also been recognized for centuries. Lead, derived from natural geochemical processes, industrial and urban pollution, and agricultural runoff, enters the air, soil and water and eventually moves up the food chain. Lead is widely used in storage battery, hot dip galvanizing, ceramic glazing, petroleum refining, printing paper and pulp, electrochemical, chemical and paint industries [5, 6] and [7]. However, it is potentially toxic and has the tendency to accumulate in blood, soft tissues, and mineralizing tissues like bones and causes serious health hazards such as anemia, damage to kidney, lung, brain and central nervous system.

Janssens [8] reported that Lead concentrations were high in outermost tail feathers of adult great tits (Parus major) inhabiting the vicinity of a metallurgic factory near the city of Antwerpen, Belgium. In the same study, Pb concentrations decreased at a site considered as an 'unpolluted' control one because it was located 20 km away from the factory, remote from industrialization and urbanization.

Similar results were reported in the study carried out by Donga-Ha-Nam et al., in 2004 [9]. They demonstrated that , the lead level in the feathers increased when the atmospheric lead level increased, as a result they found that the lead level

in the feathers from urban and industrial area were two to four time greater than those in the rural area.

Zinc is an essential element for mammals. The wide industrial applications of zinc stem from its chemical and metallurgical properties. The largest use of zinc is in galvanizing iron and steel products. Zinc is substituted by copper and plastic products in residential plumbing systems. Zinc oxide is employed as catalysts in the vulcanization natural and cultural products and cosmetics. Zinc dust form of metal is used in the printing and dyeing of textiles. Zinc is considered to be relatively non toxic, especially if taken orally. However, excess amount can cause system dysfunction [10] and [11].

Out of the sites of present study only Kekri, indicates high concentration of zinc. Zinc is one of the trace elements that are present in all living structures, both in plants and animals. The essential trace element, zinc is an important component of bio membranes and an essential cofactor in a variety of enzymes [12] Zn has antioxidant like properties, thus, it can stabilize macromolecules against radical induced oxidation in vitro as well as limit excess radical production [13]. Zinc occurs naturally in air, water and soil, but zinc concentrations are rising unnaturally, due to addition of zinc through human activities. Most zinc is added in urban environment during industrial activities, such as mining coal and waste combustion and steel processing. In this site Zinc is used in dye, leather workshops and it is used in steel processing. Effluents from textile industry sewage generally contain synthetic chemicals, dyes, and heavy metal which are disposed in Kekri.

Chromium amount added to the environment by anthropogenic activities is far greater than the natural process [14]. The principal chromium emissions into surface water are from metal finishing process such as electroplating, pickling, and bright dipping. Chromium in phosphates used as fertilizers may be important source of chromium in soil, water and some foods [15]. The amount of trace element of hair can reflect the nutrition state of the person or the environment where that person resides or works. Most of all, hair analyses make it possible to explain environmental pollution by inorganic substances [16].

In the present study chromium was found in all samples sites. However, Kishangarh had highest concentration of chromium in the primary feathers of pigeon.

The main human activities that increase the concentration of chromium (III) are steel, leather and textile manufacturing. The main human activities that increase chromium (VI) concentration are chemical, leather and textile manufacturing, electroplating and other Chromium (VI) applications in the industry. These applications mainly increase concentration of chromium in water. Through coal combustion chromium ends up in air and through waste disposal ends up in soil.

Most of these samples were collected from close metalled road. This road is frequented by both diesel and petrol using vehicles and exhaust has no escape route and particulate matter ultimately settles down on the ground and the vegetation. The vegetation is fed upon by the herbivores, whereas the particulate matter that has settled down on the soil is ultimately drained to nearest water body which may serve as drinking water source for the herbivores and mammals apart from inhalation of polluted air. Thus high concentration of lead should be expected.

Murlidharanet. al. [17] observed that the tail feather could be considered as appropriate indicators of heavy metal contamination.

Study done by Davies et. al. [18] on the copper in the environment comes mainly from corrosion of wastes in sewage treatment stations which use of compounds as algaecides and water runoff.

Dmowski [19] reported that the copper value ranged from below detection limit in Common Myna to 235.43 ppm in the tail feather of pond across and was also higher than the values (4 to 117.4 ppm in polish Magpies.

Carvalho [20]. reported that zinc is widely used to industry, mainly in electroplating, in metal and salt form such as chloride, sulfate, cyanide etc. This metal can enter in the environment through natural processes (leaching of rocks and soils) and anthropogenic, among which stands out the production of iron and steel and domestic sewage.

Present study shows that among all feathers higher concentration of metal was observed in primary feathers. This may be supported by the evidences like it takes more days to grow and hence more concentration of metal may accumulate in the feathers through blood circulation and it has been proved by many workers that heavy metals mostly accumulate in the feathers during its growth. The reason of higher level of heavy metal in primary and tail feathers may be due to external deposition of metals because they are more in contact with the atmosphere. It may also be explained that when the wing is folded, innermost primaries and may thus be protected from external contamination. Outermost primaries may also be more preened than the innermost primaries.

In monitoring of metal levels of the environment, the feather method used here has some advantages over the commonly used most techniques [21]. The period of time of exposure of each sample can be accurately estimated the limits of a few weeks as compared with years. Each feather sample represented an area of a few square kilometers rather than a single point susceptible to many local disturbances. In addition, feathers give clues to the distribution of metals in various food chains.

The study has firmly established the value of feathers analysis as bio-indicators of heavy metal contamination. At least this study holds out a promise where feather can be used as bio-indicators, since it does not involve either disturbing or killing of an animal to study the exposure.

From present results, it can be concluded that the metals in feathers of the pigeons in Ajmer city (Rajasthan), may indicate that the soil, water, and dust of this city are contaminated with metals in variable levels.

References

[1] Chao P, Gunangmei Z, Zhengrang and Chengyyi (2003) Bull. Environ. Contan. Toxicol: 71, 142.
[2] Swaileh, K. M. and R. Sansur, 2006. Monitoring urban heavy metal pollution using the house sparrow (Passer domesticus). J. Environ. Monit., 8: 209-213
[3] Roux, K. E. and P. P. Marra (2007). The presence and impact of environmental lead in passerine birds along and urban to rural land use gradient. Arch. Environ. Contam. Toxicol., 53: 261-268
[4] Esteban, M. and A. Castano, 2009. Non-invasive matrices in human biomonitoring: A review Environ. Int., 35: 438-449
[5] Colby G R and Kimberly L. O. (1998) Preliminary studies for removal of lead from surrogate and real soils using a water soluble chelator. Absorption and batch extraction, Environ. Sci. Technol. 32: 987-993.
[6] Renner R (1995) When a lead a health risk? Environ. Sci. Technol. 29:256-261A.
[7] Sen A K and Bhattacharyya M (1993) Studies on uptake and toxic effects of lead on Salvinia natans. Indian J. Environ. Hlth. 35:308-320.
[8] Janssens E, Dauwe T, Bervoets L and Eens M(2001) Heavy metals and selenium in feathers of great tits (Parus major) along a pollution gradient. Envion. Toxicol. Chem. 20:2815-20.
[9] Donga - Hanam, (2004) Monitoring for lead pollution using feathers of feral pigeons (Columba livia) from Korea. Environmental monitoring and Assessment 95:13-22.
[10] Institute of Environmental Conservation and Research INECAR (2000) Position paper against Mining in RapuRapu, Published by INECAR Atenco de Naga University, Philippines.
[11] Nolan K (2003) Copper toxicity Syndrome. J. Orthomol Psychiatry. 12 (4) : 270-282.
[12] Soylak M and Kidnap M (2001) Serum copper and zinc concentration of patients with rheumatoid arthritis from Kayseri-Turkey. Fresenius. Environ Bull. 10: 409-410.
[13] Henning B, Meerarani P, Toborek M, and Mc-Clain C (1999) Antioxidant-like properties of zinc in activated endothelial cell. J. Am. Coll Nutr. 18: 152-158.
[14] Eisner R., (1986)Chromium hazard to fish, wildlife and invertebrate. Contaminated hazard review report no.6 Biological report 85(1.6)
[15] Norseth T.,The carcinogenicity of chromium.Environmental health Prospects 1981August ,40:121-30.
[16] wibowoAAE,HerberRFM, Das HA andZielhuis(1986) Level of metals in hairs of young children as an indicator of environmental pollution. Environmental research volume 40: issue 2, 1986 :346 356.
[17] Murlidharan S, Jayakumar R and Vishnu G (2004) Heavy metals in feathers of six species of Birds in the district Nilgiris, India. Bull.Environ. Contam. Toxiol. 73(2):285-91.
[18] Davies O.A., Allison ME and UyiHS (2006) Bioaccunulation of heavy metals in water, sedments and Periwinkle (TympanotonusFuscatus var radula) from the Elechi Creek, Niger Delta. African Journal of Biotechnology V.S 5(10): 968-973.
[19] Donowski K. (1999) Birds as bio-indicators of heavy metal pollution: review and examples concerning European species. Acta Ornithology 34:1.
[20] Carvalho F(2017) Mining industry and sustainable development:Time for change. Food and energy security vol.6:61-77
[21] Ruhling A (1994) Atmospheric heavy metal deposition in Europe-estimation based on mass analysis. Nordic Council of Ministers (ed.) 9: 1-53.