

A NON-INVASIVE APPROACH TO DETECT HEAVY METAL POLLUTION IN *COLUMBA LIVIA*

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ABSTRACT

Heavy metals are considered as one of the potential threats to environment, with bioaccumulation and bio magnification the key outcomes. Birds have long been known to act as prospective bio-indicators by virtue of their mobility across distant locations. Current scope of study was to establish the efficacy of avian Pigeon feather as bio-indicator of heavy metal accumulation. Another approach was aimed to determine the correlation between the traffic density in locations and concentration of metal viz. Lead and Zinc in the avian feathers, the fact corroborated by significant lowering of pigeon population in urban clusters. Feathers collected from rural areas were found to have significantly less Lead and Zinc concentrations than those from urban environments of Jaipur District. Preliminary findings were indicative of exploring pigeon feathers as bio-prospective ecological monitors.

KEY WORDS : Bio-indicators, *Columba livia*, Heavy metals, Urban clusters

INTRODUCTION

Environment has been constantly under exposure of different environmental contaminants attributed to an unprecedented rise in anthropogenic activities, urbanization and population explosion. Heavy metals are one of the most toxic contaminants which by virtue of their bio-accumulation have endangered the ecosystem at large posing adverse health hazards for biotic resources (Adout *et al.*, 2007; Abdullah *et al.*, 2015). They are non-biodegradable environmental pollutants which accumulate in upper level of food chains in relation to dietary preferences (Boncompagni *et al.*, 2003). To assess the qualitative and quantitative effects of heavy metals, different bio-monitoring strategies

utilizing different bio-indicators have evolved in recent times. Given this fact, specific organisms may exhibit contamination of their ecosystem (Burger and Gochfeld, 2004). Analyzing pollutants in living organisms is more lucrative option as it suffices about indices of bioavailability, bio magnification and bio-transference of contaminants (Oza and Muralidharan, 2018).

Birds have been considered both as potential bio-indicators and bio monitors of heavy metal accumulation spanning across divergent geographical, historical and global boundaries as they occupy a wide range of trophic levels in different food chains (Abdullah *et al.*, 2015). Quantitative assessment of heavy metal in birds can be carried out in organs (liver, kidney), tissues

(muscle, bone, fat) eggs and feathers (Burger, 1993). Advantageous feature of using feathers is based on the fact that is a non-invasive (Markowski *et al.*, 2013) ease of collection with repeated samplings without affecting bird's health (Adout *et al.*, 2007). Incidences of heavy metal adsorption exogenously on feathers are reportedly evident. It has also been pointed out that species like waterfowl and seabirds are known to secrete metals through salt gland and moisten them on their feathers (Dmowski, 1999). Considering eco-toxicological manifestation of heavy metal accumulation, the present study was planned to the study of efficacy of avian feathers as pollution bio-indicator.

In the present study naturally shed feathers of residential birds Blue rock pigeon (*Columba livia*) were collected from rural and urban settings of Jaipur city. Lead and Zinc metal analysis of feathers were performed without washing and with washing (control) were examined as bio-indicators for trace elements pollution. The focus was on polluted environments affected by different anthropogenic activity of industrial, urban, rural and natural areas.

Experimental

The central urban which is walled city area is surrounded by high buildings with heavy traffic density. Approximately 30,000 vehicles (mainly cars and two wheelers) pass daily emitting heavy automobile exhaust (Adout *et al.*, 2007). The following figure represents sampling strategy (Figure 1). Naturally shed feathers of Blue rock pigeon (*Columba livia*) collected from different traffic density site of Jaipur such as Sanganeri Gate, Ajmeri Gate, JDA Circle, Malviya Nagar, Kanota (Rural area) and Bassi (Rural area). Briefly, sample processing is represented in Figure 2.

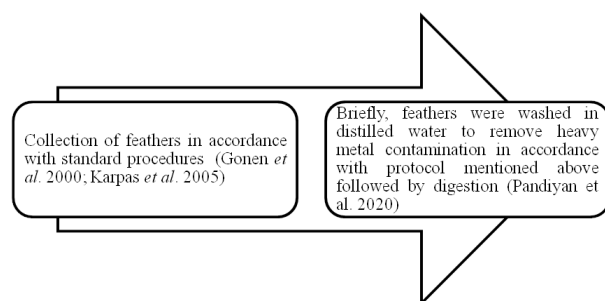


Fig. 1. Sampling strategy to collect and process pigeon feathers

RESULTS

The metal levels in feathers differed among the

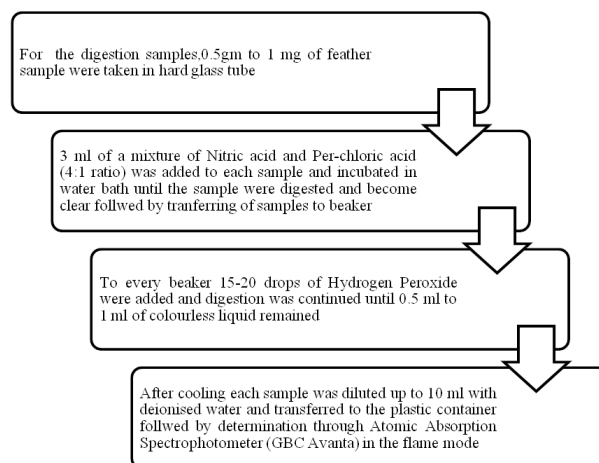


Fig. 2. Estimation of heavy metals in naturally shed feathers of *Columba livia*

traffic density sites. Additionally, pigeon feathers were also collected from non-polluted rural area near Jaipur with known dietary habits were added to serve as a control. Sanganeri gate was found the most polluted area of Jaipur in terms of lead pollution and it was recorded highest as 8.08 (\pm .54) ppm and it was more than double in comparison to rural area i.e. Bassi where it was recorded as 3.5 (\pm 1.2). Zinc was found to be highest at Ajmeri gate (urban area) as 12.3 (\pm 1.6) ppm and was found lowest at Bassi rural area 6.93 (\pm 1.16) (Figure 4). The level of Zinc was found highest in comparison to the Lead level (Figure 3).

Present results clearly indicate that the levels of metal in feather increased with the traffic density as highest concentration of metal in feathers was observed in those collected from Sanganeri gate and Ajmeri gate (High traffic density area) and as we go in low traffic density area the level of metals decrease gradually and lowest metal level was found in rural areas. Studies based at estimating heavy metals in tissues and organs of various species have been reported (Deng *et al.* 2007), feathers (Kim and Koo, 2007), eggs (Burger and Gochfeld, 2004), blood (Scheifer *et al.*, 2006) eggshells (Burger, 1994). Feathers have been considered as non-destructive bio-monitoring tool for estimation of heavy metals (Boncompagni *et al.*, 2003). Similar results were reported in the study carried out by Dong *et al.*, (2004). 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 times greater than those in the rural area.

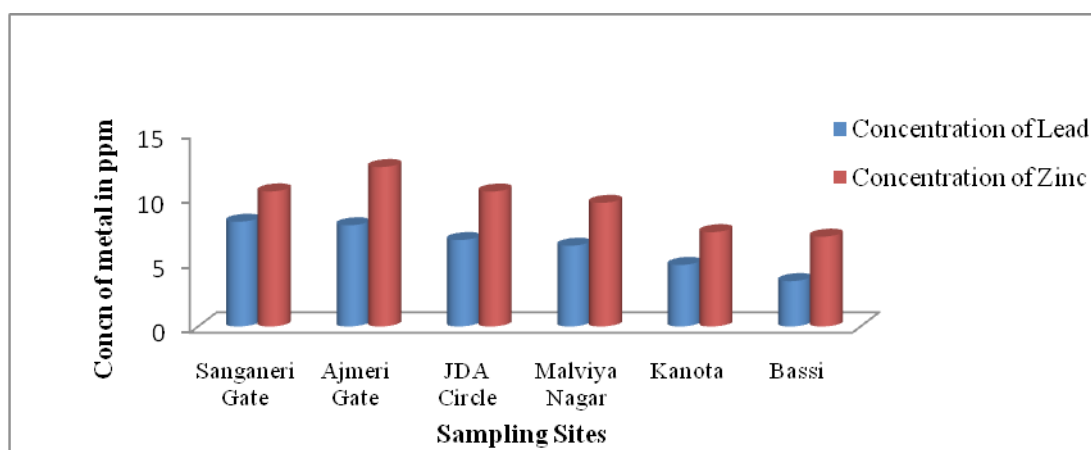


Fig. 3. Comparative levels of Lead and Zinc estimated feathers collected from different localities

Molting is useful bio-mechanism for the removal of toxic metals from their bodies to feathers (Furness *et al.*, 1986). Based on the route of the lead in unwashed feathers, there is not only transfer from metal stored in internal tissues through the bloodstream, but also exogenous deposition onto the feather surface. These results indicate that lead concentrations in the feathers increased when the atmospheric lead level were higher, So that the mean lead concentration in the feather of the pigeons from the Sanganeri Gate (Urban area) $8.08 \pm .54$ ppm were approximately double then those of Bassi rural area 3.5 ± 1.2 ppm. Zinc occurs naturally in air, water and soil, but zinc concentrations are rising unnaturally, due to addition of zinc through human activities. It is also an essential heavy metal that is required for normal feather formation (Sunde, 1972). In the present study the level of Zinc ranges from 12.3 ppm at Ajmeri gate to 6.93 ppm Bassi (rural area).

CONCLUSION

Present investigation was taken up to develop a non-invasive bio-indicator of urban air pollution due to metals in urban birds. The advantage of this method is that the birds are neither killed nor disturbed and exposure of bird can be monitored periodically. In the present study feathers of feral pigeon *Columba livia* were chosen as an indicator. Earlier feathers of pigeons have been used as an excellent candidate for an ecological monitoring of lead contamination. Present study clearly brings out the fact that the City of Jaipur is highly polluted and pigeons are accumulating various concentrations of Lead and Zinc which ultimately might tell on their

health. Presence of these metals in feathers indicates long term exposure to automobile exhaust.

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Conflict of Interest

Authors declare none competing interest

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