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Determination and impact of heavy metals in Common Mayna (*Acridotheres tristis*) of District Faisalabad

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Abstract

Heavy metals present in environment cause serious threats to wildlife and humans. Birds are usually affected by the presence of heavy metals in environment. Faisalabad is an industrial centre, due to large number of industries that are responsible for the presence of heavy metals. In highly contaminated areas, toxicity can be pragmatic at any time. The goals of present study were to determine heavy metals in urban and rural areas of Faisalabad District, to assess heavy metals in different organs of common mayna (*Acridotheres tristis*) and to evaluate risk potential due to environmental pollution. The concentrations of Zn, Cd, Co, Cu, Pb and Mn were measured by using Atomic Absorption Spectrophotometer. In general Zn was found highest in concentration in feathers of common mayna in urban areas while Cd was found in trace amounts in heart of rural areas. It seems that heavy metals in urban areas are present in high concentrations due to industrial pollution. Zinc was found in 102.00±0.58 comparable to those found in other urban areas. The present study showed that Faisalabad is highly polluted by Zn and its exposure is causing serious adverse effects. Feathers of birds showed that, they can be used as bio-monitoring tools.

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Introduction

Whenever heavy metals enter in a living organism, it either eliminates or gets deposited. Deposition of heavy metals causes variable types toxicities which have been under consideration for last few decades. There is an emerging trend of bio monitoring due to heavy metal toxicity in environment. Importance of biodiversity and the negative effects of human activities have increased over last several decades (Meine, 2010). Through emission of these heavy metals environmental issue has been a major problem especially in Europe (Azimi *et al*., 2005a; Falq *et al*., 2011). The world is facing a common problem of pollution (a severe change in physico-chemical and biological characteristics of water, soil and air) which may directly or indirectly affects human life and avifaunas of ecosystems (Misra and Dinesh, 1991). In birds, exposure to heavy metals and toxicity has been extensively studied (Eens *et al*., 1999). Birds usually serve as bio indicators for a number of environmental contaminants especially heavy metals (Mochizuki *et al*., 2002). They are widely distributed in environment and are highly profound to toxins.

The common myna has also been observed scattering along highways in South Africa and Australia (Overs, 1997). This behavior suggests that common myna is found spreading in new areas and possess negative impacts in new ecosystem.

Domestic and industrial waste possesses a variety of heavy metals that causes water pollution. The actual source of heavy metal contamination is manufacturing and excavating actions related to agronomy (Singh *et al*., 2007). Exposure to heavy metals have toxic effects on avifaunas, pose greater problem to reproduction, respiration and hormonal system (Kitowski *et al*., 2016). Fecal material can be used as an indicator of heavy metals pollution shown to reflect the toxicities in environment and food items indicate food chain contamination (Dauwe *et al*., 2006). These heavy metals are fatal for living creatures at small deliberations, but copper and zinc can turn out to be fatal at excessive deliberations (Tracey *et al*., 2007). Heavy metals contamination is a great concern at local, regional and global level (Sayadi *et al*., 2009). Amount of heavy metals increase in final consumers including avian species and humans and then they enter in plants and water, through food chains. Non-migratory bird such as common myna feeds on wastes of humans. So they are greatly affected by the exposure of heavy metals and reflects the hazards that results from contamination to organisms (Gochfield 1997).

Heavy metals enter into soil and they pollute plants and water resources through atmospheric testimony (Adams *et al*., 2004). Effluence of heavy metals from human actions postures a perspective risk to different bird species as well as humanoid fitness also through the bioaccumulation of heavy metals in food chain (Sheppard *et al*., 2009). Predatory birds have caught attention in past decades due to greater vulnerability. Common mayna have also severely affected by heavy metals due to modernization of industries among urban and agriculture in rural areas. The present study was conducted with the aim of detecting heavy metals in bird species for future conservation and management plans.

Material and methods

Sample collection and Preparation

Samples were collected from urban and rural areas of Faisalabad District. A total of ninety samples of Common mayna (*Acridotheres tristis*) were collected from urban and rural areas of Faisalabad during February 2018 to May 2018. Samples were brought to laboratory in iceboxes and preserved at -20°C till postmortem. Feathers, legs, bones, lungs, muscles and heart were washed by using distilled water to remove any dust particles followed by Veerele *et al.* (2004). All the organs were dried in an oven at 100°C and then they were grinded in grinder until powder form. Trace metals were analyzed by the digestion of 0.5 g of each sample in the conical flask and then with nitric acid 4ml.

Sample Digestion

After this all the leftover samples were placed in conical flask to digest them at room temperature.

Then on the following day, 2ml of H_2O_2 was further added in the samples and heated on hot plate, until 120°C. The samples were then filtered with the help of filter paper and 50 ml of volume was made by adding distilled water. All the samples were stored under refrigerator till further. All the required solutions were prepared by suitable dilutions of standard stock solutions, by using a mixture of 65% (v/v) HNO_3, 30% (v/v) H_2O_2 and H_2O_2 (v/v/v= 1:1:3).

All the reagents, stock solution and chemicals were of analytical grade. All the glassware was washed by using distilled water and soaked in nitric acid 30% overnight, then rinsed in deionized water (Behropur B25), and then air dried.

Metal analysis

With help of Atomic Absorption Spectrophotometer levels of trace metals such as Cu, Co, Zn, Ni, Mn and Pb were analyzed in different organs at Hi-Tech lab, University of Agriculture, Faisalabad. By using varied concentrations such as 0.5, 1, 2, 5 and 10 ppm of standard solutions, the collaboration curves were made separately. Average values of all replicates were taken for respective determination.

Statistical analysis

Data was subjected to statistical analysis SAS 9.1 factorial ANOVA and means were compared through Duncan Multiple Range test.

Results and discussion

Heavy metals such as Co Cu, Cd Zn and Mn were detected in different body parts of *A. tristis* of rural as well as urban areas of district Faisalabad. Concentration in different body organs was checked. Overall, the concentration of metal contamination measured in the present study was slightly higher in urban areas than those collected from rural areas.

Concentration of Metals in Common Mayna from Rural and Urban regions

In order to observe the environmental difference in metal contamination, it was found that the concentration of all the heavy metals (Cu, Zn, Co, Cd, Mn, Pb) was higher in samples collected from urban areas as compared to those collected from rural areas. However, concentration of Zn, Pb and Cd was found to be significantly different ($p>0.05$) and that of Mn, Cu and Co was found to be non-significant as shown in table 1.

Table 1. Concentration of metals in the common myna collected from two regions in the district Faisalabad. Values are in means of samples ± standard error.

Region	Zn**	Mn*	Pb**	Cu*	Cd**	Co*
Rural	1.59±0.03	0.26±0.03	0.83±0.05	0.34±0.00	0.02±0.00	0.02±0.00
Urban	1.64±0.04	0.28±0.04	0.97±0.04	0.35±0.00	0.03±0.00	0.03±0.00

Significance level *$p < 0.05$; ** $p > 0.05$

Metals in organs of Common Mayna from Rural and Urban area

Zinc (Zn)

Studies by Muralidharan *et al.* (2004) in Nilgiris District reported lower amount of zinc (100.97µg/g) in *A. grayii* while in present study amount of zinc detected in feathers was highest and lowest in muscles of common mayna of both rural and urban areas. Concentration of Zn in different organs from rural area was bones (1.82±0.01), feathers (1.96±0.02), heart (1.39±0.03), muscles (1.30±0.02) and lungs (1.45±0.02). Similarly, in organs from urban area amount of zinc was 1.82±0.06 in bones, 2.03±0.01 in feathers, 1.44±0.01 in heart 1.33±0.03 in muscles and 1.54±0.01 in lungs respectively as shown in table 2. Costa *et al.* (2011) recorded in central Portugal that concentration of Zn was found to be higher 105.24±25.67µg/g than other heavy metals. Several studies showed that feathers of birds are important as bio-monitoring tool for heavy metal contamination (Nam *et al.*, 2004; Nam and Lee, 2006a; Brait and Filho, 2011).

Manganese (Mn)

The amount of Mn was found to be highest in feathers of common mayna just like that of Zn. The amount of

Mn collected from rural area in bones (0.14±0.01), feathers (0.69±0.03), heart (0.20±0.09), muscles (0.08±0.00) and lungs (0.21±0.04). Similarly, in organs from urban area amount of Mn was found to be 0.17±0.07 in bones, 0.76±0.01 in feathers, 0.08±0.01 in heart, 0.07±0.00 in muscles and 0.30±0.05 in lungs respectively as shown in table 2.

Liu *et al*., (2011) found that Mn exposure resulted in oxidative damage of immune system in birds by altering antioxidant defense enzymes, lipid peroxidation and apoptosis.

Lead (Pb)

Absorptions of lead can be harmful to birds even at lower concentrations. Studies conducted by Albayrak and Mor (2011) detected the amount of lead in liver was 0.43±0.49 µg/g and in muscles was 3.53 ± 9.92µg/g while in the present study amount of lead recorded highest in heart and lowest in bones from rural area and lowest in muscles from urban area. Accumulation of lead in different organs of samples collected from rural area was 0.51±0.06 in bones, 1.02±0.06 in feathers, 1.21±0.15 in heart, 0.65±0.03 in muscles and 0.74±0.02 in lungs. However, amount of Pb in different organs of samples collected from urban area was as followed, bones (0.74±0.00), feathers (1.25±0.00), heart (1.44±0.01), muscles (0.61±0.01) and lungs (0.83±0.01). Lead may also be considered as an environmental contaminant because it may cause damage to neurological development of birds. Birds may also inhale Pb and accumulation of lead in birds may be due to ingestion of food items. (Joanna and Michael, 2010).

Table 2. Metal Concentration in the organs of common Myna in Rural and Urban area of District Faisalabad

Sr. No.		Zn		Mn		Pb		Cu		Cd		Co	
	Organ	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1	Bones	1.82±0.01	1.82±0.06	0.14±0.01	0.17±0.07	0.51±0.06	0.74±0.00	0.24±0.00	0.27±0.01	0.02±0.00	0.02±0.00	0.04±0.00	0.06±0.00
2	Feathers	1.96±0.02	2.03±0.01	0.69±0.03	0.76±0.01	1.02±0.06	1.25±0.00	0.36±0.00	0.42±0.00	0.03±0.00	0.03±0.00	0.03±0.00	0.01±0
3	Heart	1.39±0.03	1.44±0.01	0.20±0.09	0.08±0.01	1.21±0.15	1.44±0.01	0.39±0.01	0.34±0.01	0.02±0.00	0.02±0.00	0.02±0.00	0.03±0.00
4	Muscles	1.30±0.02	1.33±0.03	0.08±0.00	0.07±0.00	0.65±0.03	0.61±0.01	0.36±0.01	0.35±0.01	0.01±0.00	0.03±0	0.02±0.00	0.04±0.00
5	Lungs	1.45±0.02	1.54±0.01	0.21±0.04	0.30±0.05	0.74±0.02	0.83±0.01	0.33±0.01	0.36±0.01	0.03±0.00	0.06±0.00	0.01±0.00	0.01±0.00

Copper (Cu)

In the present study, amount of Cu recorded was similar to values determined by Dmowski (1999) in *A. tristis*. The amount of Cu was found highest in heart of samples collected from rural area while in samples from urban area, Cu was highest in feathers. Amount of Cu recorded by Costa *et al.* 2011 in passerine birds of Central Portugal was 7.15±2.22mg/kg. However, in the present study, amount of copper in samples collected from rural area was bones (0.24±0.00), feathers (0.36±0.00), heart (0.39±0.01), muscles (0.36±0.01) and lungs (0.33±0.01).

In samples collected from urban area, amount of Cu was found 0.27±0.01 in bones, 0.42±0.00 in feathers, 0.34±0.01 in heart, 0.35±0.01 in muscles and 0.36±0.01 in lungs. In South Korea concentration of Cu was observed in feathers of grey herons as 45.6±30.2mg/kg. During study of Abdullah *et al.* (2014) amount of Cu recorded in cattle egrets found in range of 42 to 93 µg/g and 28-74 µg/g in Sialkot and Lahore districts. The concentrations of Cu were measured lower comparable to those reported in *M. migrans* of Indian ocean by Anderson *et al.* (2010). Amount of copper detected in pigeons of Brazil and Israel by Janiga *et al.* (1998) was 8-16µg/g in concentration.

Cadmium (Cd)

Cadmium has been reported toxic to birds as it can cause damage to kidneys. Concentrations of cadmium (1.70µg/g) in feathers of *Columba livia* was reported by Solonen *et al.* (1999) while in present study Cd was found in traceable amounts in samples collected both from rural and urban areas. Amount of copper in samples collected from rural area was bones (0.02±0.00), feathers (0.03±0.00), heart (0.02±0.00), muscles (0.01±0.00) and lungs (0.03±0.00). In samples collected from urban area, amount of Cu was found 0.02±0.00 in bones, 0.03±0.00 in feathers, 0.02±0.00 in heart, 0.03±0 in muscles and 0.06±0.00 in lungs.

Cobalt (Co)

Cobalt is an essential trace metal which is found in Earth's crust. Major sources of Cobalt in environment

are industries. Average amount of cobalt reported in various countries especially in agricultural soils is about 20µg/g. In the present study Co was found in traceable amounts in samples collected both from rural and urban areas just like that of cadmium (Cd). Amount of cobalt in samples collected from rural area was bones (0.04±0.00), feathers (0.03±0.00), heart (0.02±0.00), muscles (0.02±0.00) and lungs (0.01±0.00).

In samples collected from urban area, amount of Cu was found 0.06±0.00 in bones, 0.01±0 in feathers, 0.03±0.00 in heart, 0.04±0.00 in muscles and 0.01±0.00 in lungs respectively as shown in table 3.

Table 3. Duncan multiple range test for organs mean value of Concentration with grouping. Means with same letter are not significantly different.

S. No.	Organ	Zn	Mn	Pb	Cu	Cd	Co
1	Bones	1.817^{B}	0.153^{C}	0.62^{D}	0.255^{D}	0.020^{C}	0.054^{A}
2	Feathers	2.003^{A}	0.720^{A}	1.139^{B}	0.390^{A}	0.030^{B}	0.021^{CD}
3	Heart	1.416^{D}	0.145^{C}	1.328^{A}	0.372^{AB}	0.023^{C}	0.030^{CB}
4	Muscles	1.321^{E}	0.079^{C}	0.631^{D}	0.359^{CB}	0.021^{C}	0.033^{B}
5	Lungs	1.503^{C}	0.256^{B}	0.790^{C}	0.344^{C}	0.050^{A}	0.017^{D}

Conclusion

It was concluded that bird feathers are important as bio-monitoring tool for the estimation of heavy metals in an ecosystem. *A. tristis* is the most affected species due to contamination of metals. The decline in species of *A. tristis* is actually due to toxic effects of heavy metals especially Zn, because it is found beyond the permissible limit in species. This study will be helpful in understanding routes of accumulation and detection of metals in the food chain.

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