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Comparative Metal Profiles in Different Organs of House Sparrow (*Passer domesticus*) and Black Kite (*Milvus migrans*) in Sargodha District, Punjab, Pakistan

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Abstract.- The aim of this study was to assess the concentrations of trace metals (Zn, Pb, Cu, Mn, Cd and Co) in different organs (*i.e.,* liver, kidney, muscles, lungs, stomach, bones, and feathers) of house sparrow (*Passer domesticus*) and black kite (*Milvus migrans*), from different areas of Sargodha, Punjab, Pakistan. Zn, Pb, Cu, Mn, Cd and Co were significantly higher in black kite as compared to those measured for house sparrow. Bioaccumulation trends of studied trace metals into different tissue were specific-specific Zn was higher in bones (23.5 mg/kg), Mn in stomach (4.8 mg/kg), Pb in liver (4.3 mg/kg), Cu in bones (0.9 mg/kg), Cd in liver (11.2 mg/kg) and Co in feathers (1.9 mg/kg) of black kite. However, Zn was higher in feathers (14.7 mg/kg), Mn in stomach (2.7 mg/kg), Pb in lungs (4.6 mg/kg), Cu in bones (0.63 mg/kg), Cd in liver (6.14 mg/kg), and Co in muscles (2.5 mg/kg) of house sparrow. The present study would be helpful to understand the concentration of heavy metals in birds regarding biomagnifications and bioaccumulation in bird and its organs.

Key words: Heavy metals, house sparrow, black kite.

INTRODUCTION

Developing countries including Pakistan are facing sever environmental problems including trace metals pollution from different areas of the country (Abdullah *et al*., 2014). Trace metals (*i.e*, Zn, Pb, Co, Mn, Cd, Cu etc.) are widespread environmental contaminants and highly persistent in the environment, which resulted in accumulation of food chain and may cause severe health problems to human and wildlife (Malik and Zeb, 2009). In previous literature, it has been widely reported that agriculture runoff, industrial waste disposal, mineral and mining processing, volcanic eruption, atmospheric transport, and dust exposure may play their role, to contaminate the different environmental compartments (Bernis *et al.,* 1973; Zafar *et al*., 2014; Abdullah *et al*., 2014).

Monitoring of trace metals levels into different environmental compartments is of prime significance because of their bio-accumulative characteristics and several health risks into living organism (Deng *et al*., 2007; Malik and Zeb, 2009). Many studies reported that higher levels of trace metal contaminants may cause variety of health effects of wildlife including neurological disorder, kidney failure, reproductive impairments etc. Therefore, few studies are evident that trace metals affect the reproductive health and resulted into failure of nest building, retarded testes growth, spermatogenesis failure, decreased egg production, lighter eggs, eggshell thinning, increased embryo mortality, reduced hatching success, teratogenesis and lethargy, and behavioral abnormalities in avian fauna (Dmowski, 1997; Erwin and Custer *et al.,* 2000; Malik and Zeb, 2009). Consequently, several environmental agencies both at public and governmental levels are concerned to monitor the trace metals contamination into different environmental media, which many help to control

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their emission and exposure to human and wildlife (Abdullah *et al*., 2014). However, previous studies adopted different sampling strategies (*i.e*. use of biological organism, air, water, soil, vegetables etc.) to assess the levels and adverse health effects of trace metals contaminants into environment. Use of different avian population for the purpose of environmental monitoring is very reliable approach and provides the local levels of trace metals along their bioaccumulation trends and possible source into the food chain, which ultimately helped the authorities to control the environmental degradation (Ullah *et al*., 2014; Nighat *et al*., 2013; Malik *et al*., 2010).

In current study, we investigated the trace metals levels in different parts of the Sargodha district, Pakistan by using two different bird species *viz.,* house sparrow and black kite. Our selection criteria for these two avian species are subjected to the wide range distribution in the study area and convenient sampling collection. The house sparrow is one of the larger sparrows with length of 160-165 mm and 210-255mm wingspan (Gochfield and Burger, 1987). Its major food is the seeds of annual herbs such as grasses (*Graminae*), rushes (*Juncidae*), goosefoot *(Chenopodiu*m "spp"), docks (*Polygonacaea*) and chickweed *(Stellaria* spp.) The black kite (*Milvus migrans*) is a medium-sized bird of prey in the family Accipitridae. As a scavenger, black kites have been recorded in large numbers on waste accumulations generated by human activities, including rubbish dumps, markets, fishing-ports and abattoirs (Honda *et al.*, 1985, 1986).

The objective of the present study was to determine heavy metal concentration in house sparrow and black kite and to assess the status of accumulation of heavy metal in various organs.

MATERIALS AND METHODS

Specimen collection and sample size

Twenty black kites (*Milvus migrans*), including 4 females and 16 males, and twenty house sparrow (*Passer domesticus*), including 8 females and 12 males were collected from Sargodha city and Bhalwal (Town) Punjab, Pakistan.

Protocol

Feathers and nails were washed thoroughly with double distilled water to remove dust particles according to Veerle *et al.* (2004). All the organ and /or body parts were dried at 100°C in oven (Licata *et al.*, 2010). Then grind the samples in the grinder and ground to powder. Trace metals were analyzed in the collected samples by digestion of 0.5 g of sample in conical flask and with 4ml of HNO_3 (conc.). All the samples in conical flask were left-overnight to digest at room temperature. The following day, 2 ml of H_2O_2 were added in the samples and heated on the hot plate, up to 120°C. Then filtered the samples with the help of filter paper, and make its volume up to 50 ml by adding the distilled water. These samples were stored under refrigerator conditions until analysis. Trace metal levels in different organs were determined with the help of Atomic Absorption Spectrophotometer (Model# AA. 6300 Shimadzu 'Japan' AAS flame type) at Department of Chemistry, Sargodha University, Sargodha, Pakistan. Calibration curves were prepared separately for each metal by using different concentrations (*i.e*., 0.5, 1, 2, 5 and 10 ppm) of standard solutions. Average values of three replicates were taken for each determination. The precision of the analytical procedures was expressed as relative standard deviation (RSD) which ranged from 5% to 10% and was calculated from the standard deviation divided by the mean The working solutions were daily prepared by appropriate dilutions of the standard stock solution, using a mixture of 65% (v/v) HNO3, 30% (v/v) H_2O_2 and H_2O (v/v/v = 1:1:3). Chemicals, stock solutions and reagents were obtained from Merck and were of analytical grade. All glassware before use were washed with distilled water, soaked in nitric acid (30%) overnight, rinsed in deionized water (Behropur B25), and air-dried.

Statistical analysis

All the data was compiled by using Ms Excel 2013 and descriptive statistical analysis was performed by using SPSS version 17. Furthermore, statistical differences of trace metals among different organs and different species were tested by using one way ANOVA, LSD test.

Table I.- **Mean concentrations of heavy metals (in mg/kg) in different organs of** *Passer domesticus* **(house sparrow) and** *Milvus migrans* **(black kite).**

Name of species	**Name of organs**	**Mean concentrations of heavy metals (mg/kg) ± SD**					
		Zn	**Mn**	**Pb**	**Cu**	**Cd**	**Co**
House sparrow (*Passer domesticus*)	Bones	1.10±2.18	0.41±0.10	0.26±0.31	0.03±0.11	0.18±0.38	0.52±0.040
	Feathers	14.78±2.22	0.5±0.08	2.67±0.29	0.14±0.016	1.81±0.43	1.96±0.23
	Heart	3.99±1.02	2.41±0.31	0.73±0.10	0.11±0.02	1.64±0.26	1.82±0.43
	Kidney	6.32±1.10	0.90±0.15	3.28±0.44	0.33±0.05	8.20±1.56	1.37±0.43
	Liver	7.85±0.73	1.45±0.21	3.71±0.40	0.21±0.02	6.14±1.43	1.91±0.47
	Lungs	5.26±1.22	2.07±0.33	4.66±1.17	0.23±0.04	0.90±0.12	1.25±0.29
	Muscle	8.52±1.13	2.22±0.41	2.18±0.51	0.34±0.06	1.84±0.35	2.57±0.39
	Stomach	5.78±0.45	2.78±0.52	2.03±0.58	0.26±0.05	0.88±0.12	1.421±0.26
	P value	p=<2.2e-16	p=<2.2e-16	p=1.244e-06	p=6.717-13	p=<2.2e-16	p=<2.2e-16
Black kite (*Milvus migrans*)	Bones	1.10±2.18	0.57±0.15	0.98± 0.12	0.008±0.10	0.08±0.38	0.62±0.04
	Feathers	18.76±1.53	0.63±0.14	2.40±0.32	0.13±0.03	2.99±0.69	1.93±0.06
	Heart	3.97±1.93	3.58±0.27	0.50±0.09	0.18±0.04	2.65±0.20	0.54±0.06
	Kidney	3.52±0.31	1.53±0.13	3.42±0.34	0.52±0.06	14.34±0.20	0.27±0.03
	Liver	5.65±0.28	2.19±0.13	4.39±0.36	0.29±0.03	11.28±1.65	0.52±0.07
	Lungs	5.07±2.11	3.10±0.20	6.41±1.79	0.30±0.06	1.21±0.175	0.40±0.07
	Muscles	13.26±0.45	2.33±0.66	2.45±0.98	0.61±0.04	3.08±0.39	1.37±0.03
	Stomach	6.06±0.68	4.82±0.48	2.05±1.05	0.48±0.04	0.63±0.16	0.946±0.0408
	P value	p=<2.2e-16	p=<2.2e-16	p=0.001677	p=<2.2e-16	p=>2.2e-16	p=<2.2e-16

RESULTS

Mean concentrations of trace metals in different organs of sparrow and black kite are represented as Table I. Among both species, black kite showed elevated levels of zinc (mg/kg) in feathers (18.7 mg/kg), muscles (13.2 mg/kg) and stomach (6.06 mg/kg) than those of house sparrow. However, Zn burdens in the kidney (6.32 mg/kg), heart (3.9mg/kg) and lungs (5.26 mg/kg) of house sparrow were higher than those of black kite.

Mean concentration (mg/kg) of Mn in kidney, liver, lungs, heart, muscles, feathers and stomach were higher in black kite than those of house sparrow. Mean Pb concentrations in feathers and heart was higher in house sparrow as compared to black kite. However, in black kite; kidney, liver, lungs and muscles were highly contaminated with Pb than to house sparrow.

Cu levels in heart, liver, kidney, lungs, muscles and stomach were higher in black kite than to house sparrow. Cd (mg/kg) in feathers, heart, kidney, liver, lungs and muscle were higher in black kite than those of house sparrow. This showed that Cd values in black kite were higher than those of house sparrow.

Mean concentrations of Co (mg/kg) in feather, heart, liver, kidney, lungs, muscles and stomach were higher in house sparrow than those of black kite.

DISCUSSION

The results of present study showed the difference in mean concentration of metals among different study sites and species. There were significant variations in metal level in different organs of both species but none of the single study area was consistently ranked as the highest or the lowest for all metals. The black kite showed elevated levels of zinc (mg/kg) in feathers, muscles and stomach than those of house sparrow. However, Zn burdens in the kidney, heart and lungs of house sparrow were higher than those of black kite. Zinic originates both from natural and from anthropogenic sources (Ullah *et al*., 2014; Morais *et al*., 2012; Strezov, 2012). The Zn concentrations reported by our study are in agreement with those found in avian feathers by Boncompagni *et al*. (2003) and Nighat *et al*. (2013) for Pakistan, by Dauwe *et al*. (2002) for

Belgium, and by Zhang *et al*. (2007) and Deng *et al*. (2007) for China. However, the concentrations found in our study are far higher than those previously reported for other areas of Pakistan as (Movalli, 2000; Malik and Zeb, 2009; Ullah *et al*., 2014).

In our study, the mean concentration of Mn in kidney, liver, lungs, heart, muscles, feathers and stomach were higher in black kite than those of house sparrow. Mean Pb concentrations in feathers and heart was higher in house sparrow as compared to black kite. However, in black kite; kidney liver, lungs and muscles were highly contaminated with Pb than to house sparrow. The concentrations found in our study were comparable as reported in feathers of species of family Ardeidae from Pakistan and China (Malik and Zeb, 2009; Burger, 1993) but were higher than those reported from agricultural areas of Pakistan (Boncompagni *et al*., 2003; Ullah *et al*., 2014).

In our study, the avian feathers and heart exhibited the highest concentrations among all the studied metals. The concentrations in our samples are in accordance with a study for Belgium (Dauwe *et al*., 2002), which also showed very high Pb-concentrations in the feather of blue tit and great tit. The Pb concentrations reported in other studies from Pakistan (Movalli, 2000; Boncompagni *et al*., 2003; Malik and Zeb, 2009; Ullah *et al*., 2014; Nighat *et al*., 2013) were far lower than those measured in our case. The reason for such high levels in our study may be related to extensive industrial activities and urban-traffic, since the study areas serves as dumping grounds for untreated waste material.

Cu levels (mg/kg) in heart, liver, kidney, lungs, muscles and stomach were higher in black kite than in house sparrow. Cu is an essential element, required in low concentration to meet various physiological needs, but high dose and chronic exposure may pose serious deleterious effects including reproductive, respiratory, gastrointestinal, hematological, hepatic, endocrine, and ocular damage as well as causing cancer (ATSDR, 2004; Chen *et al.*, 1993).

We found high concentrations of Cd (mg/kg) in feathers, heart, kidney, liver, lungs and muscles in black kite than house sparrow at Sargodha. The high levels of these contaminants in our study may be related to the extensive industrial activities in study area. Cd originates from erosion of surface deposits of minerals containing this element (Malik *et al*., 2010), and from anthropogenic sources including the purification of ores from smelters and mines as well as from commercial products such as batteries, paints, coatings on metal devices, and plastic stabilizers (Qadir and Malik, 2011).

The Bhalwal region had the highest mean concentration of Zn, but lowest mean concentrations of Mn and Pb. There were significant difference ($p \leq 0.05$) among both species. *Milvus migrans* showed higher concentrations of trace metals as compared to *Passer domesticus*. Specie-specific variation of trace metal accumulation may be due to distinct diet patterns of studied two species. Most food items of house sparrow are insects and seeds, while black kite feed mostly on small birds and dead animals. Similar observations were reported by Liang and Lius (1958). It is reported that these scavengers accumulates relatively higher trace metal levels as compared to insectivores and herbivorous species (Goutner *et al.*, 2001). The studied metals profiles could also explained due to physiological differences between the two species i.e. metabolic rates of small passerine vary inversely with body weight and directly with activities such as flight and rest (Welty, 1975); being smaller than black kite, house sparrow was expected to have higher metabolic rate (Deng *et al.*, 2007).

Bones have higher concentrations of heavy metals than other organs in both species. In particular, the highest levels of Pb, Zn, Co, and Cu were found in bones and Cd in kidney samples. Higher levels of trace metals in bone may be due to their affinity to accumulate into calcareous tissues, which are also reported elsewhere. Birds living in terrestrial ecosystems contained more heavy metals than aquatic birds. This is related to the high metabolic rate of small birds. This may mean that small species and predators in particular, are more vulnerable than larger one (Lebedeva, 1999). The distribution patterns of heavy metals among the body parts of black kite and house sparrow may be related to the metabolism and detoxification. Birds can eliminate metals through sequestration in the feather and bone. Moreover, there is a type of metallothionin in the kidney and liver, which can bind some metals Hg, Cd, Zn, Se, and Cu (Deng *et al.,* 2007). Concentrations of Zn were higher than other metals in all samples. The statistical comparisons among the heavy metal concentrations reveal that Pb and Zn levels are more significant in bones than in all samples. These species are batter for monitoring the uptake of environmental contaminants into the food web or pyramid of terrestrial ecosystem (Jager *et al.,* 1996).

CONCLUSION

It is concluded from the present study that the birds spp. are bioindicator of heavy metals in the study area.

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