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Comparison of heavy metal accumulation in body organs of house sparrow (*Passer domesticus*) from urban and rural areas of Faisalabad, Pakistan

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Abstract

The present study was carried out in 2017-18 to assess the levels of various heavy metals in different body organs of house sparrow (passer domesticus). Twenty house-sparrows, ten from rural and ten from urban areas of Faisalabad, were shooted. All the specimens were washed with distilled water. Dissection was carried out and feathers, bones, heart lungs, and muscles were separated. All organs were dried at 100 centigrade in oven. The samples were grinded and 0.5g of each sample was digested in 4ml concentrated nitric acid. Next day 2ml hydrogen peroxide was added to each sample and samples were heated on a hot plate up to 130 centigrade. 50ml distilled water was added to each sample and preserved in refrigerator. Spectrophotometer was used for determining concentrations of various heavy metals viz. Cd, Co, Cu, Mn, Pb and Zn. The heavy metal found in maximum concentration in rural and urban sparrows was Pb. It was 107.83 and 116mgkg-1 in rural and urban sparrows respectively. The metal found in minimum concentration was Co. It was 0.52mgkg-1 in rural sparrows and 0.42mgkg-1 in urban sparrows respectively.

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Introduction

The use of various birds as a bioindicator of heavy metal pollution in urban and rural ecosystems is becoming popular among scientists around the globe. The bird species selected for this purpose are typical to a particular environment, mostly found in abundance in a particular area. Sparrows, egrets, herons, mynas and many other birds have been selected and successfully analyzed for the assessment of heavy metals in various body parts by the scientists of different countries (Sharma and Vashishat, 2017).

In developing countries including Pakistan, the information regarding heavy metal accumulation in bird's bodies is available limitedly. This information is very useful and necessary for policy making regarding the sustainability of a pollution free ecosystem ensuring the safety of lives of all types of flora and fauna including human beings themselves. In the absence of this type of information, the planning for a sustainable, healthy and progressive ecosystem may not be fruitful. So, in the present era, data/information with accurate standards, about the presence of risky levels of heavy metals in the environment (water, food and soil etc) as well as in the bodies of animals and birds, must be collected and analyzed for long term planning regarding ecosystem stability and food security (Hashmi *et al.,* 2013).

We are well aware that the threat of subjection of living organisms to heavy metals is more prevalent in areas having large number of industrial units. Faisalabad, the third most populated city of Pakistan, is one of the same with large number of textile industry installations and is known as Manchester of Pakistan. These textile industry units throw their effluents in canals, lakes/ponds in open areas and large drains passing through the city. According to an estimate, in Faisalabad, 80% of total industrial effluents produced, are thrown in canals while remaining 20% infiltrate into the ground and contaminate underground water reservoir (anonymous, 2014). The water mixed with effluents is a major threat to human beings, wildlife, domestic animals, crops and all types of flora and fauna found there (Farid *et al.,* 2015).

Keeping in view the above stated facts and abundance of house sparrow in Faisalabad, present study was designed with the aim to assess the extent and magnitude of various heavy metals viz. cobalt, zinc, cadmium, lead, manganese and copper in various body organs of house sparrow from rural and urban landscapes.

Materials and methods

Selection of samples

Twenty house sparrow, ten from urban and ten from rural areas were shooted. The birds's bodies were washed with distilled water.

Laboratory procedures

Dissection was carried out. Various organs i.e. heart, muscles, lungs, bones and feathers were separated and dried at 100 Centigrade temperature in oven. The samples were then grinded and 0.5 g of each sample was digested in 4ml concentrated Nitric acid in conical flask. The flask was left in lab for 24 hours. Next day, 2ml H_2O_2 was added and samples were heated on the hot plate up to 130 Centigrade. After it, 50ml distilled water was added to each sample and preserved in refrigerator.

Analysis of samples

The samples were analyzed by using spectrophotometer.

Results

The maximum concentration (2.66mgkg^{-1}) of Cd in rural sparrow was found in feathers and minimum (0.98) in bones (table-1). On other hand, maximum concentration (2.79mgkg^{-1}) of Cd in urban sparrows was found in feathers while minimum (0.51) in muscles and lungs. Maximum concentration (2.52mgkg^{-1}) of Co in rural sparrow was found in muscles while minimum (0.52mgkg^{-1}) in bones and lungs. On the other hand, maximum concentration (1.45mgkg^{-1}) of Co in urban sparrow was found in heart while minimum (0.32mgkg^{-1}) in bones.

Maximum concentration (35.50mgkg^{-1}) of Cu in rural sparrow was found in feathers while minimum

(17mgkg^{-1}) in lungs. On the other hand, maximum concentration (34.83mgkg^{-1}) of Cu in urban sparrow was found in feathers while minimum (13.50mgkg^{-1}) in bones. Maximum concentration (20.50mgkg^{-1}) of Mn in rural sparrow was found in lungs while minimum (3.67mgkg^{-1}) in bones. Maximum concentration (20.17mgkg^{-1}) of Mn in urban sparrow was found in feathers.

Table 1. Comparison of concentrations (mg.kg-1) of different heavy metals in various organs of urban and rural *Passer domesticus* (house sparrow) in Faisalabad region.

Metals	Location	Concentration of heavy metals (mgkg^{-1})				
		Bones	Feathers	Heart	Muscles	Lungs
Cd	Rural	0.98	2.66	1.44	1.50	1.00
	Urban	1.53	2.79	1	0.51	0.51
Co	Rural	0.52	1.18	1.47	2.52	0.52
	Urban	0.32	1.11	1.45	1.28	0.42
Cu	Rural	17.83	35.50	28.00	21.83	17.00
	Urban	13.50	34.83	16.33	21.50	20.50
Mn	Rural	3.67	21.33	19.17	5.50	20.50
	Urban	5.27	20.17	2.65	4.23	19.00
Pb	Rural	36	107.83	44.83	38.83	39
	Urban	43.50	116.00	37.50	39.67	42.00
Zn	Rural	53.83	92.83	41.50	48.50	52.33
	Urban	52.50	82.50	40.67	46.50	55.67

Maximum concentration (20.50mgkg^{-1})) of Mn in rural sparrow was found in lungs while minimum (3.67mgkg^{-1}) in bones. Maximum concentration (20.17mgkg^{-1}) of Mn in urban sparrow was found in feathers while minimum (2.65mgkg^{-1}) in heart.

Maximum concentration (107.83mgkg^{-1}) of Pb in rural sparrow was found in feathers while minimum (36mgkg^{-1}) in bones. On the other hand, maximum concentration (116mgkg^{-1}) of Pb in urban sparrow was found in feathers while minimum (37.50) in heart.

Maximum concentration (92.83mgkg^{-1}) of Zn in rural sparrow was found in feathers while minimum (41.50mgkg^{-1}) in heart. On the other hand, maximum concentration (82.50mgkg^{-1}) of Zn was found in feathers while minimum in heart.

The concentration (1mgkg^{-1}) of Cd was more in rural sparrows as compared to urban sparrows which was 0.51mgkg^{-1} (table-2). Similarly the concentration of Co (0.52mgkg^{-1}) and Mn (20.5mgkg^{-1}) was also more in rural sparrows as compared to urban sparrows. On the other hand, the concentration of Cu, Pb and Zn (20.5, 42 and 55.67mgkg^{-1} respectively) was more in urban sparrows as compared to rural sparrows.

Table 2. Concentration of all heavy metals in whole body of urban and rural house sparrow (*Passer domesticus*) in Faisalabad region.

Metal	Area	Concentration (mg.kg-1)
Cd	Rural	1
	Urban	0.51
Co	Rural	0.52
	Urban	0.42
Cu	Rural	17
	Urban	20.5
Mn	Rural	20.5
	Urban	19
Pb	Rural	39
	Urban	42
Zn	Rural	52.33

Discussion

In our study, both in rural and urban sparrows, the maximum levels of Cd were found to be accumulated in feathers. It is an excellent built-in capability of birds that they expel heavy metals to a large extent into their feathers. Thus remaining body parts are saved from the poisonous effects of heavy metals like Cd (Hill, 2010). Maximum amount of Co was accumulated in muscles of rural sparrow and in heart of urban sparrow. Co is considered less injurious for health as compared to Cd. Thus nature is managing various levels of heavy metals at proper sites in the body where they are least injurious (Gruz, 2017). Maximum concentration of Cu, Mn, Pb and Zn were also accumulated in the feathers of sparrows. It is again the inherent capacity of many kinds of birds that they accumulate more/lethal amounts of various heavy metals in their feathers as compared to internal body organs. Thus they save themselves from many abnormalities such as disorder in reproduction failure of kidneys and liver etc. (Salamat *et al.,* 2014).

Deposition of various heavy metals in birds bodies clearly indicate that the food and/or drinking water used by sparrows were contaminated with these elements (Janaydeh *et al.,* 2018). Also in rural areas, many kinds of birds including sparrows can be seen foraging on garbage, from they pick up grains of various kinds and other food material. Similarly

drinking water in ponds is also contaminated mostly with industrial effluents containing heavy metals of many kinds (Manjula *et al.,* 2015).

In urban areas also, the sparrows are frequently seen foraging on garbage depots, from they eat various grains such as wheat, rice and kitchen refuse which include unused parts of vegetables and fruits (Whelan *et al.,* 2015). The vegetables in the vicinity of cities are frequently irrigated with Sewage water being free of any monitory charges, often containing heavy metals in large amounts (Xiao *et al.,* 2014). These vegetables reach kitchens and from there their unused parts are thrown in the garbage, form where they are transported to garbage depots. Moreover the water channels made some decades ago, to drain out the water from waterlogged soils are frequently filled with industrial effluents containing large amounts of heavy metals. The birds drink water from these large and small drains and get their bodies indulged with heavy metals (Tariq *et al.,* 2006, Hossain *et al.,* 2011, Laxmi, 2015).

In rural ecosystem, the top most reason of heavy metal accumulation in bird's bodies is the application of pesticides. The insecticides and herbicides have long term residual effects on plants and overall ecosystem. The bird food (wheat and rice grains etc) is highly contaminated with residues of pesticides. The birds feeding on such material intake large quantities of heavy metals (Raza *et al.,* 2017). This food causes malfunctioning of reproductive system in birds. Similarly, the egg shells also become thin. Furthermore, the immunity of body declines and body weight becomes reduced. The respiratory system also becomes disturbed and birds feel difficulty in respiration. It also includes development of abnormal embryos, skeletal abnormalities, malfunction of reproductive system and nervous breakdown. Heavy metals also disturb the hormonal secretions. The pesticides causing such problems include organochlorine, and organophosphate (Fry, 1995). Ultimately the bird populations start declining and some species become endangered or threatened. Some may also reach at the verge of extinction (Salwa, 2011).

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