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<Case Report>

Elemental analysis of the liver, kidney, and intestine tissues from a Hodgson's bat (*Myotis formosus tsuensis*)

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Abstract : Hodgson's bats are critically endangered in South Korea. This study analyzed the concentrations of elements in liver, kidney, and intestine tissues from a Hodgson's bat found dead in the wild. The concentrations of essential elements followed the order Fe > Zn > Cu > Mn > Se in the three tissues. Hg was detected at the highest concentrations among the non-essential elements analyzed in the liver and kidney tissues, while As was the most highly concentrated non-essential element in the intestine. To the best of our knowledge, this is the first study of tissue element concentrations in Hodgson's bats.

Keywords : Hodgson's bat, essential elements, non-essential elements

The Hodgson's bat, also known as the copper-winged bat, is a medium-sized (11–13 g of body weight) vesper bat, and can be distinguished from most other species of bats by its yellowish coloration. The species is currently found in northern South Asia, parts of Southeast Asia and East Asia. There appear to be no major threats to this species as a whole in South Asia, as it is highly adaptable [4]. However, the Korean subspecies, *Myotis formosus tsuensis*, is critically endangered due to unknown causes and has legal protection [9].

Essential trace elements are involved in numerous metabolic and physiological processes in the body. Suboptimal levels of trace elements may affect biological processes, and have been associated with susceptibility to many diseases. Contamination of soil, water, and the atmosphere leads to the incorporation of toxic elements into the food chain, presenting a health threat to wild animals.

A carcass of a Hodgson's bat was found partially decomposed in August 2012 at Gosudonggul Cave in Danyang, South Korea (coordinates: 36°59'N, 128°23'E) and stored at −80ºC. The body was about 5.6 cm long from head to feet. The cause of death was not identified at post-mortem examination.

The liver, kidney, and intestine from the carcass were freeze-dried and then mineralized in concentrated nitric acid [3]. The sample solutions were then filtered and diluted with water. Mercury concentrations were analyzed with a cold vapor atomic absorption mercury analyzer (CETAC Technologies, USA). The concentrations of other elements were analyzed with an inductively-coupled plasma mass spectrometer (Varian Medical Systems, USA) or an inductively-coupled plasma optical emission spectrometer (Varian Medical Systems). Element concentrations were expressed as mg/kg based on dry weight.

In the three tissues analyzed, the concentrations of essential elements followed the order Fe > Zn > Cu > Mn > Se > Mo > Co (Table 1). This ordering was comparable with previous observations of liver tissues of bats [1, 2, 6, 10] as well as various human tissues [7]. Selenium was most highly concentrated in kidney (compared with other tissues), while all other elements were most highly concentrated in the liver.

The concentrations of essential elements measured in the present study were within the ranges described in previous reports for several bat species [1, 2, 6, 10]. The ratios of Fe, Zn, Cu, and Mn in Hodgson's bat liver were 100, 7.51, 2.07, and 1.33, respectively (Table 1), which is comparable with other bat species [2, 5, 10], of which the mean elemental concentration ratio is 100, 8.21, 1.84, and 1.38. The equivalents for human and 6-month-old rat livers are 100 : 28.8 : 2.49 : 0.57 and 100 : 8.69 : 1.45 : 0.80, respectively [7, 8]. The ratios for bats appear to be more similar to those of rats than to those of humans. Bat and rat livers appear to have a lower level of Zn than seen in humans.

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Table 1. Essential element concentrations in the tissues of a Hodgson's bat found dead in the wild in South Korea (mg/kg dry weight)

	Co	Cu	Fe	Mn	Mo	Se	Zn
Liver	0.075	14.7	710	9.47	1.27	1.96	53.3
Kidney	0.066	7.26	480	6.20	0.572	2.71	40.4
Intestine	0.058	9.21	225	6.18	0.912	2.20	42.3

Table 2. Non-essential element concentrations in the tissues of a Hodgson's bat found dead in the wild in South Korea (mg/kg dry weight)

	As	Cd	Cr	Hg	Pb
Liver	0.159	0.583	0.163	0.833	0.053
Kidney	0.246	0.287	ND	0.610	0.110
Intestine	4.67	0.310	0.433	0.885	0.077

Mercury was detected at the highest concentrations of the five non-essential and potentially toxic elements found in the liver and kidney tissues, while Cd showed the second highest concentrations (Table 2). Based upon a recent study in this laboratory, Hg exhibits the highest concentration among non-essential elements analyzed in the tissues of Eurasian otters in South Korea [5]. These findings suggest that Hg is one of the most biologically available non-essential elements in wild animals in South Korea. Lead was detected at the lowest level among the analyzed non-essential elements in the liver and intestines. These findings are in contrast with a recent review of tissue element concentrations in various wild bats from around the world, in which the concentrations of the five non-essential elements followed the order Pb > Hg > Cr > Cd > As [11]. The difference in tissue concentration orders may be related to the degree of local environmental contamination and to the availability of those elements to bats.

Interestingly, As was the most highly concentrated non-essential element in the intestine. The intestinal As concentration was at least 18.9-fold higher than those of the liver and kidneys. These findings suggest that the bat was exposed to food or water highly contaminated with As shortly before its death. Future studies are warranted to elucidate the source of As and its risk to Hodgson's bats.

To the best of our knowledge, this is the first available study of elemental concentrations in tissues from a Hodgson's bat. The present study may provide baseline information that will facilitate the conservation of this critically endangered species in South Korea.

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References

1. **Allinson G, Mispagel C, Kajiwara N, Anan Y, Hashimoto J, Laurenson L, Allinson M, Tanabe S.** Organochlorine and trace metal residues in adult southern bent-wing bat (*Miniopterus schreibersii bassanii*) in southeastern Australia. Chemosphere 2006, **64,** 1464-1471.
2. **Courtin F, Stone WB, Risatti G, Gilbert K, Van Kruiningen HJ.** Pathologic findings and liver elements in hibernating bats with white-nose syndrome. Vet Pathol 2010, **47**, 214-219.
3. **Diederich J, Michalke B.** Enhanced extract preparation of native manganese and iron species from brain and liver tissue. Anal Bioanal Chem 2011, **399**, 1799-1806.
4. IUCN Red List of Threatened Species. Version 2013.2. *Myotis formousus*: International Union for Conservation of Nature and Natural Resources. Cambridge, 2013.
5. **Kang S, Kang JH, Kim S, Lee SH, Lee S, Yu HJ, Oh SJ, Park JD, Nam KH, Han SY, Lim JD, Ryu DY**. Trace element analysis of three tissues from Eurasian otters (*Lutra lutra*) in South Korea. Ecotoxicology. 2015, **24**, 1064-72.
6. **Méndez L, Alvarez-Castañeda ST.** Comparative analysis of heavy metals in two species of ichthyophagous bats *Myotis vivesi* and *Noctilio leporinus*. Bull Environ Contam Toxicol 2000, **65**, 51-54.
7. **Rahil-Khazen R, Bolann BJ, Myking A, Ulvik RJ.** Multi-element analysis of trace element levels in human autopsy tissues by using inductively coupled atomic emission spectrometry technique (ICP-AES). J Trace Elem Med Biol 2002, **16,** 15-25.
8. **Takahashi S, Takahashi I, Sato H, Kubota Y, Yoshida S, Muramatsu Y.** Determination of major and trace elements in the liver of Wistar rats by inductively coupled plasma-atomic emission spectrometry and mass spectrometry. Lab Anim 2000, **34**, 97-105.
9. **Won C, Smith KG.** History and current status of mammals of the Korean Peninsula. Mamm Rev 1999, **29**, 3-36.
10. **Zocche JJ, Leffa DD, Damiani AP, Carvalho F, Mendonça RA, dos Santos CEI, Boufleur LA, Dias JF, de Andrade VM.** Heavy metals and DNA damage in blood cells of insectivore bats in coal mining areas of Catarinense coal basin, Brazil. Environ Res 2010, **110**, 684-691.
11. **Zukal J, Pikula J, Bandouchova H.** Bats as bioindicators of heavy metal pollution: history and prospect. Mamm Biol 2015, **80**, 220-227.