Biological Forum – An International Journal **9**(1): 80-86(2017)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Heavy Metals Accumulation in *Labeo rohita* (Hamilton) of River Kabul, KPK, Pakistan

Khalid Usman*, Hameed Ur Rehman, Sundus Adeel*, Nadar Ali Shah*, Akbar Shah****, Khalid Pervaiz**, Nishat Saeed*** and Mussabeha****

[*]Department of Zoology, Hazara University, Mansehra, Pakistan
[**]Fisheries Research & Training Institute, Lahore, Pakistan
[***]Department of Chemistry, Kohat University of Science and Technology-26000, KPK, Pakistan.
[****]Department of Zoology Pir Mehr Ali Shah Arid agriculture university Rawalpindi.

(Corresponding author: Hameed Ur Rehman)
(Received 05 December, 2016, Accepted 12 January, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The present study was conducted on different sites of River Kabul to determine the concentration of heavy metals on Rohu, *Labeo rohita* (Hamilton). The fish was collected from different sites of the River and heavy metals were detected by Atomic absorption Spectrophotometer. The highest concentrations of Zn (6.00 ppm) was found at Jehangera Upper site, Cu (3.05 ppm) at Dalda Oil Mill Nowshera site, Cr (1.05 ppm) at Jehangera Lower, Mn (2.00 ppm) at Jehangera Lower, Pb (0.02 ppm) at Dalda Oil Mill Nowshera site and Cd (3.0 ppm) at the Jehangera Upper site. The results revealed that Zn, Cr and Cd values were found above the permissible limits while Cu, Mn and Pb values were found within permissible limits shown in table 2. As a result of accumulation of heavy metals in fish bodies, various diseases occurred which ultimately declined their population. It is suggested that if the proper, timely remedial measures are not adopted, the situation will be aggravated and may cause the loss of precious fish diversity in the country. Hence, to overcome this serious problem industries discharge should be cleaned before entering to the River and properly time to time Fish fauna should be checked out.

Keywords: River Kabul, fish, rohu, heavy metals, pollution.

INTRODUCTION

River Kabul originates from the base of Unai pass in the Paghman Mountains in Afghanistan and enters Pakistan at Shalman in Khyber Agency (Alvi, 2007). It then flows between Khyber and Mohmand Agencies flanked by the Kohi-Sufaid Mountain until it reaches Warsak Dam (Fig.1). Below the dam the river is divided into three main channels Shah Alam, Naguman and Adezai and several canals originate from these channels irrigating Peshawar, Charsada and Nowshera districts. After flowing for 34 and 30 Kms, respectively, these channels join together and flow as a single channel downstream for many kilometers before joining River Indus at Kund, Attock. (Yousafzai *et al*., 2007).

Nickel, a major environmental pollutant, is known for its clastogenic, toxic, and carcinogenic potential (Ross, 1995; Hartwig and Schwerdtle, 2002). The carcinogenic potential of nickel compounds depends largely on their solubility. The particulate nickel compounds like Ni_3S_2 or NiO are strong carcinogens, whereas the soluble nickel (II) salts exert weaker effects (Dunnick *et al.*, 1995). This may be due to differences in bioavailability. Water soluble nickel salts are taken up only slowly by cells, while particulate nickel compounds are phagocytosed and, due to the low pH, are gradually dissolved in lysosomes, yielding high concentrations of nickel ions in the nucleus (Costa *et al.*, 1981).

Zinc is a major inorganic pollutant, which has inhibitory and stimulating effects on the growth along with accumulation in plants (Kumar, 1989). Seedling growth and enzyme activities have been found inhibited by zinc in *Phaseolus aureus* cv. R-851 (Veer, 1989). Zinc inhibits transporter-mediated glutamate uptake (Vandenberg *et al.*, 1998) and depending on concentration, can inhibit or potentiate glycine receptors (Han and Wu, 1999). It is also known that zinc is toxic to neurons. Studies in animal models suggest that endogenous zinc mediates neurodegeneration resulting from ischemia (Koh *et al.*, 1996) and seizure (Suh *et al.*, 1996). It has been suggested that increased intracellular zinc may result in mitochondrial impairment and generation of reactive oxygen species (Dineley *et al.*, 2003). In view of the hazardous effects of heavy metal, their removal from the contaminated environment has been a challenge for a long time (Honjoh *et al.*, 1997).

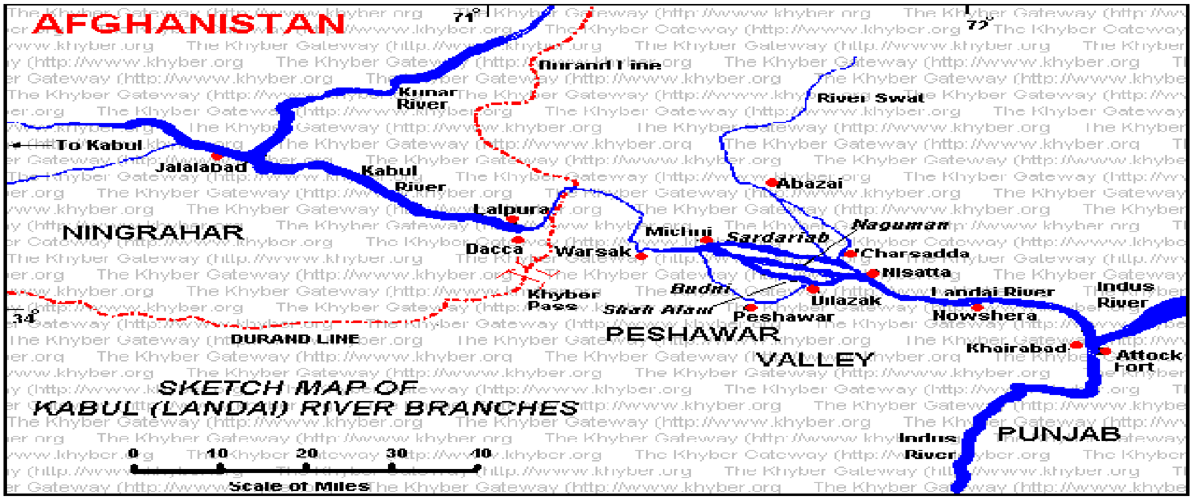

Fig. 1. Map of River Kabul (Alvi, 2007).

The traditional clean up processes of heavy metal contaminated soils and waters are expensive and practical only in small areas (Moffat, 1995), new cost effective technologies that include the use of microorganisms, biomass, and live plants need to be investigated (Gardea-Torresdey *et al.*, 1996; Miller, 1996; Ebbs and Kochian, 1997).

Shakoori *et al.* (2004) have reported 99% and 48% reduction of Zn (II) and Cr (VI) by Vorticella microstoma after 96 h, respectively from the medium. These microorganisms actively contribute to the amelioration of the effluent quality, since the majority of them feed upon dispersed bacteria (Madoni, 2000). Heavy metal uptake processes by biological cells are known under the general term of biosorption. These phenomena include both passive adsorption of heavy metals to the cell walls and metabolically mediated uptake by the cells (Gadd, 1990).

MATERIALS AND METHODS

Nine different sites were selected on River Kabul for the collection of fish samples as described in detail in Table 1. The rohu (*Labeo rohita)* samples were collected from nine different sites of River Kabul. They were caught by hook net, cast net and then brought to PCSIR laboratory for analysis of heavy metals in their muscles.

Table 1: Names of the locations for sampling sites with coordinates.

SR. NO.	Site No.	Area Description	North latitude	East longitude
1	S-1	Warsak (1 Km downstream of Warsak dam)	34°09'59.23"	71°22'05.25"
2	S-2	Khazana Sugar Mill Peshawar	34°06'55.16"	71°36'49.58"
3	S-3	Toti Tannery waste Peshawar	34°07'19.78"	71°36'24.04"
4	S-4	Dalda Oil Mill Nowshera	34°01'02.57"	71°55'51.02"
5	S-5	Cantt Area Nowsehra	34°00'40.24"	71°59'36.75"
6	S-6	Jehangera Upper	33°58'23.24"	72°12'44.27"
7	S-7	Jehangera Lower	33°57'51.81"	72°13'03.70"
8	S-8	Marble Factories Kund	33°55'42.52"	72°13'51.05"
9	S-9	Khairabad Attock	33°54'17.70"	72°14'04.93"

After dissection of fish the flesh was collected and kept in oven and was dried at 100 ^{o}C. The fish samples were then heated with burner and ash was obtained called charring. The ash was kept in muffle furnace at 900^{o}C to get fine white ash powder and then mixed with 6 M HNO_3 and diluted to 150 ml with distilled water. These solutions were then subjected to Atomic absorption spectrophotometer to analyze heavy metals present in fish muscles.

RESULTS AND DISCUSSION

In the present study, the fish samples collected from nine different sites of River Kabul (as mentioned in Table 1) were analyzed for the heavy metals including Zinc, Copper, Cadmium, Lead, Chromium and Manganese. The Permissible Limits of Heavy Metal Concentrations in Fish are shown Table 2 after WHO (1993). Table 3 mentions the concentrations of all metals under consideration at all the sites under consideration. The highest value of Zn was found in the fish at Jehangera Upper (6.00 ppm), while lowest value was found in the fish at Jehangira lower (3.00 ppm) and the rest of the samples have Zn values between these two limits 3.00-6.00 ppm. Lakshmanan *et al*. (2009) determine the zinc value in fish tissues as 0.103–0.809 ppm in southern coast of India. This was lower than the present study. The high value of Zn at was due to the presence of zinc nitrite in the effluent discharge which accumulates in the fish body which affects the growth rate and enters to human body using these fishes. Zinc salts may also used in Dalda Oil Mill Nowshera in preparation of pharmaceuticals due to which the level is high as compared to other sites.

Table 2: Permissible Limits of Heavy Metal Concentrations in Fish.

Sr. No.	Metals	*Permissible Limits (mg/kg)
1	Zinc	0.364
2	Copper	3.000
3	Cadmium	0.500
4	Lead	0.123
5	Chromium	0.100
6	Manganese	5.000

*After WHO (1993)

Table 3: Heavy Metal Concentrations in Fish.

Metals	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9
Zn	4.0	4.0	3.06	4.0	5.0	**6.0**	3.0	4.0	4.05
Cu	0.0	1.0	1.0	**3.05**	1.0	1.0	2.0	2.0	0.05
Cd	0.0	0.01	1.0	2.0	0.01	**3.06**	0.02	0.01	0.02
Pb	0.0	0.0	0.0	**0.02**	0.0	0.0	0.0	0.0	0.0
Cr	0.0	0.0	0.0	0.0	0.0	0.0	**1.05**	1.0	0.0
Mn	0.0	0.0	1.0	0.0	0.0	1.0	**2.0**	0.8	0.0

(Metals with sites at highest concentration are depicted in bold)

The highest value of Cu was found in the fish at Dalda Oil Mill Nowshera (3.05 ppm) while lowest value was found in the fish at Khairabad Attock (0.05 ppm) while the rest of the samples have copper values between these two limits 0.05-3.05 ppm, in the present study,. Zarai *et al*. (2011) reported Cu value in fish tissues which was 1.76–6.29 ppm in southern caspion sea Iran, which was higher than then the present study. The high value of Cu is due to the presence of copper acetate as pesticides, copper chromate as fungicides and copper methane arsenate as an algaecide. Due to the usage of these chemicals the metals accumulate in the fish bodies.

The highest value of Cd was found in the fish at Jehangera Upper (3.06 ppm) while lowest value was found in the fish at Warsak Area (0.00 ppm) while the rest of the samples have Cd values between these two limits 0.00-3.06 ppm. Zarai *et al*. (2011) reported the Cd value in fish tissues as 0.60-1.93 ppm in southern Caspion Sea Iran, which was lower than the present study. The higher value of Cd was due to the presence of cadmium oxide in the industrial effluent discharge into the River which affect water fauna and accumulate in their bodies and the fishes found in these area are a risk factor to use them.

In the present study, the highest value of Pb was found in the fish at Dalda Oil Mill Nowshera (0.02 ppm) while lowest value were found in the fish on all other sites (0.00 ppm). Zarai *et al*. (2011) also reported the value of Pb in fish tissues as 1.51–4.55 ppm in southern Caspion Sea Iran, which was higher than the present study area at River Kabul. The high value of Pb is due to the presence of lead contents present in the water which accumulates in the fish bodies.

During the present research, the highest value of Cr was found in the fish at Jehangera Lower (1.05 ppm) followed by Marble Factories Kund (1.0 ppm) while lowest value were found in the fish on all other sites (0.00 ppm). Lakshmanan *et al*. (2009) report Cr in fish tissues and found that the value of Cr was 0.415–1.562 ppm in Southren coast of India, which was higher than the value, resulted in the present study. The high value of Cr is because in tanning process chromium salt is use when their influent enter to the River and chromium accumulation occur during gills respiration and these fishes having chromium are health hazard.

The Mn highest value was found in the fish at Jehangera Lower (2.0 ppm) while lowest value (0.00 ppm) was found at five sites namely Warsak Area, Khazana Sugar Mill Peshawar, Dalda Oil Mill Nowshera, Cantt Area Nowsehra and Khairabad Attock while the rest of the samples have values between these two limits 0.00-0.02 ppm. Burger and Gochfeld (2005) find Mn in fish tissue which range from 0.16–0.98 ppm in New Jersey, USA, which was higher than the present study value. The high value of Mn was due to the presence of Manganese Oxide and Manganese Sulfide which enter to the River from Industrial discharge and from the rock erosion. These form a part of the fish body and by using human being these fishes are health hazard.

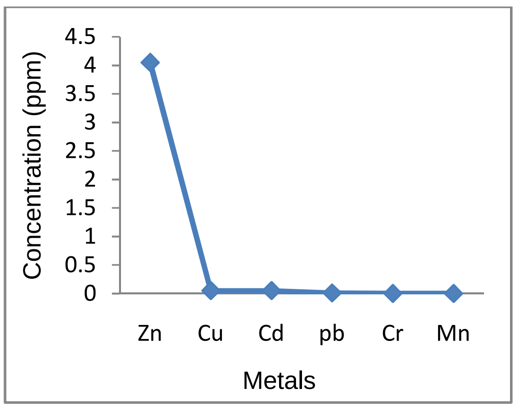

Fig. 2. Heavy metals concentration at site 1.

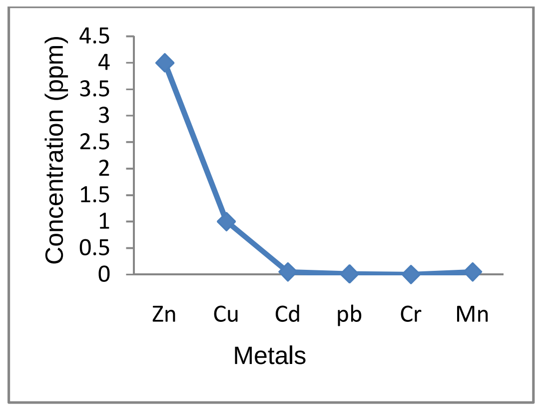

Fig. 3. Heavy metals concentration at site 2**.**

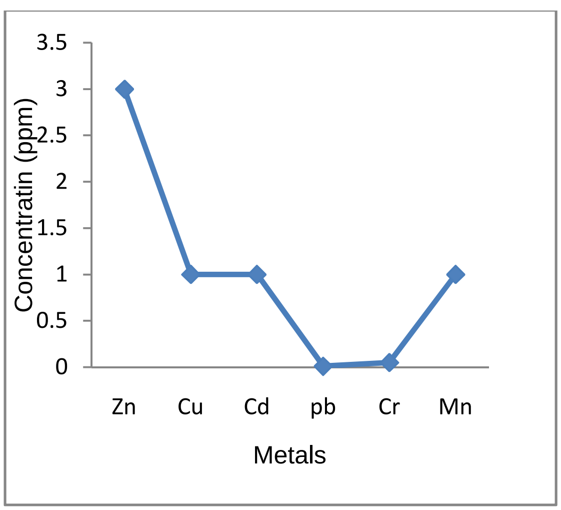

Fig. 4. Heavy metals concentration at site 3.

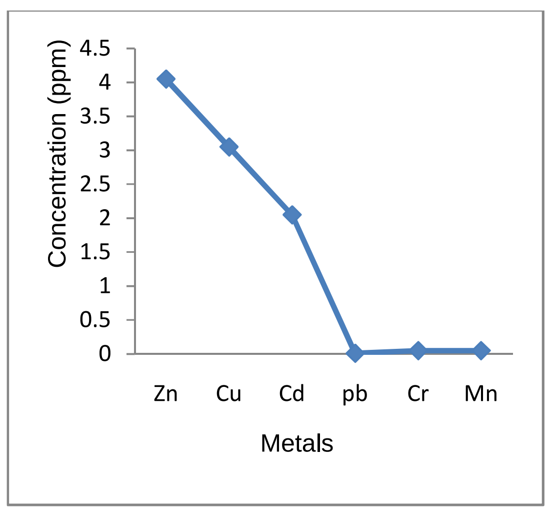

Fig. 5. Heavy metals concentration at site 4.

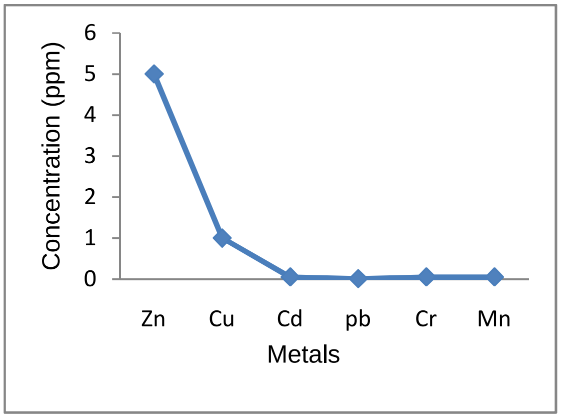

Fig. 6. Heavy metals concentration at site 5.

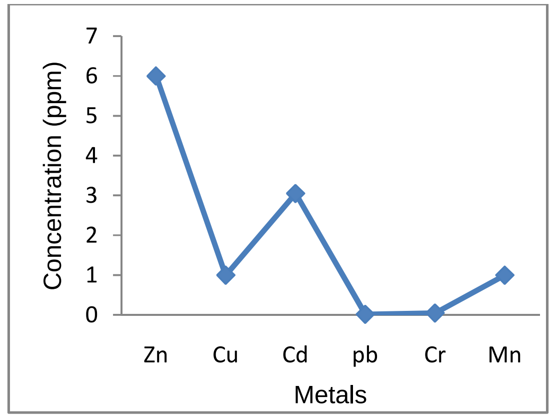

Fig. 7. Heavy metals concentration at site 6.

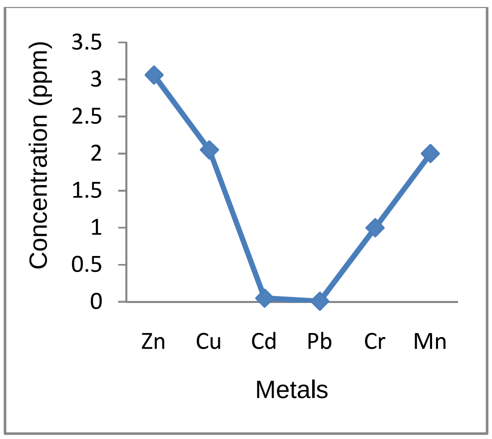

Fig. 8. Heavy metals concentration at site 7.

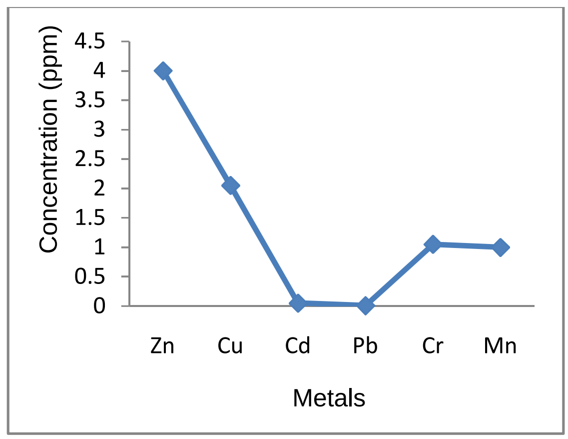

Fig. 9. Heavy metals concentration at site 8

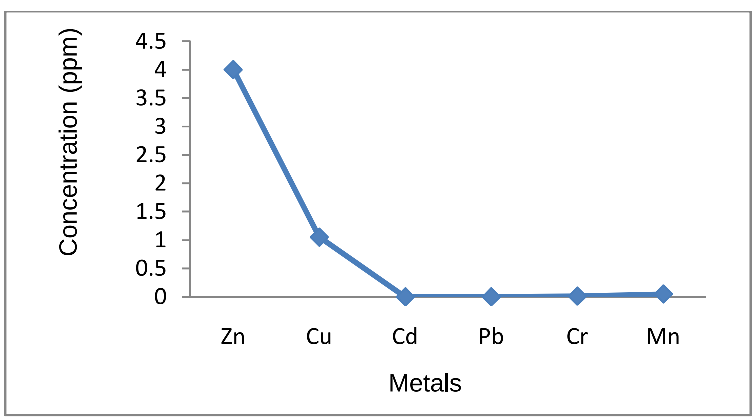

Fig. 10. Heavy metals concentration at site 9.

This alarming state of high pollution contents has created not only unsuitable fish habitat, but has also created a pollution blockade for many fish migratory species of River Indus system which migrate from main stream of River Indus to spawning grounds of swat River through Kabul River during the breeding process. One of such migratory fish is Indus Mahseer *Tor macrolepis* (Heckel, 1838) which is under severe pressures and its population has declined sharply (Iqbal *et al*., 2013). This factor has also contributed significantly towards decline of this famous angling fish of the Indus river system in a recently concluded study by Pervaiz (2011).

This study concludes that anthropogenic activities including industrial effluents, civic wastes and various kinds of pollutants along the River Kabul have affected very badly the fish quality at study area in River Kabul. This is quite evident from the high level of heavy metals and physiochemical parameters found beyond the suitable range and international permissible limits. As a result, fish, fauna have affected badly causing severe damage to the biodiversity ultimately to the ecosystem. If the proper, timely remedial measures are not adopted, the situation will be aggravated and may cause the loss of precious biodiversity in the country.

ACKNOWLEDGEMENT

We are grateful to the Pakistan Council of Scientific and Industrial Research for funding this study under HEC (2011-2012) program. Many thanks to Hameed Ur Rehman KUST; Gohar Ayaz (Ph. D. Scholar), BZU Multan; Miss Sundus Zahid (Ph.D. Scholar) Department of Zoology; Wahid Raza (Ph.D. Scholar) Islamia College, University Peshawar and all staff in PCSIR for their help during lab work.

REFERENCES

M.P. Alvi, Economy and development History, Travel Pakistan (2007).

J.M. Burgera and M. Gochfeldb, Heavy metals in commercial fish in New Jersey. *Journal of Toxicology and Environmental Health,* **36**: 355–365 (2005).

M. Costa, J. Simmons-Hansen, C.W. Bedrossian, J. Bonura and R.M. Caprioli, cellular distribution, and carcinogenic activity of particulate nickel compounds in tissue culture. *Cancer Res,* **41**: 2868–2876 (1981).

K.E. Dineley, T.V. Votyakova, and I.J. Reynolds, Zinc inhibition of cellular energy production: implications for mitochondria and neuro-degeneration. *J Neurochem,* **85**: 563–570 (2003).

J.K. Dunnick, M.R. Elwell, A.E. Radovsky, J.M. Benson, F.F. Hahn, K.J. Nikula, E.B. Barr and C.H. Hobbs, Comparative carcinogenic effects of nickel subsulfide, nickel oxide, or nickel sulfate hexahydrate chronic exposures in the lung. *Cancer Res,* **55**: 5251–5256 (1995).

S.D. Ebbs and L.V. Kochian, Toxicity of zinc and copper to Brassica species: implications for phytoremediation. *J Environ Qual,* **26**: 776–778 (1997).

G.M. Gadd, Heavy metal accumulation by bacteria and other microorganisms. *Experientia*, **3**: 273–280 (1990).

J.L. Gardea-Torresdey, L. Polette, S. Arteaga, K.J. Tiemann, J. Bibb and J.H. Gonzalez Determination of content of hazardous heavy metals on *Larrea* tridentata grown around a contaminated area. In: L.R. Erickson, D.L. Tillison, S.C. Grant, J.P. McDonald, NM (eds) Proceedings of the eleventh annual EPA conference on Hazardous Waste Research (HSRC/WERC Joint Conference on the Environment), pp 660–669 (1996).

Y. Han and S.M. Wu, Modulation of glycine receptors in retinal ganglion cells by zinc. *Proc Natl Acad Sci, USA* **96**: 3234–3238. doi:10.1073/pnas.96.6.3234 (1999).

A. Hartwig and T. Schwerdtle, Interactions by carcinogenic metal compounds with DNA repair processes: toxicological implications. *Toxicol Lett*, **127**: 47–54. doi:10.1016/S0378-4274(01) 00482-9 (2002).

Z. Iqbal, K. Pervaiz and M.N. Javed, Population Dynamics of *Tor macrolepis* Teleostei: Cyprinidae) and other fishes of Attock region, Pakistan. *Canad. J. Pure & Applied Sciences,* **7(1)**: 2195-2201(2013).

J.Y. Koh, S.W. Suh, B.J. Gwag, Y.Y. He, C.Y. Hsu and D.W. Choi, The role of zinc in selective neuronal death after transient global cerebral ischemia. *Science* **272**: 1013–1016. doi:10.1126/science, 272.5264.1013 (1996).

Kumar, S. (1989). Effect of seed treatments with Ni, Cd and Zn on seedling growth of two cultivate of *Hoedeum vulgare*. *Geobios*, **6**:15–20.

R. Lakshmanan, K. Kesavan and P. Vijayanand, Heavy Metals Accumulation in Five Commercially Important Fishes of Parangipettai, Southeast Coast of India. *Advance Journal of Food Science and Technology*, **1**: 63-65 (2009).

P. Madoni, The acute toxicity of nickel to freshwater ciliates. *Environ Pollut.,* **109**: 53–59. doi:10.1016/S0269-7491(99)00226-2 (2000).

R.R. Miller, Phytoremediation, technology overview report prepared for Ground-Water Remediation Technologies Analysis Center, Pittsburg, PA, 152 pp (1996).

A.S. Moffat, Plants proving their worth in toxic metal cleanup. *Science,* **269**: 302–303. doi:10.1126/science.269.5222.302 (1995).

K. Pervaiz, Some Aspects of biology of Mahseer Fish Species from Attock region Pakistan. PhD thesis, Department of Zoology University of the Punjab Pakistan (2011).

I.S. Ross, Reduced uptake of nickel by a nickel resistance strain of *Candida utilis*. *Microbios,* **83**: 261–270 (1995).

A.R. Shakoori, A. Rehman and R.U. Haq, Multiple metal resistance in the ciliate, *Vorticella microstoma*, isolated from industrial effluents and its potential in of toxic wastes. *Bull Environ Contam Toxicol*, **72**: 1046–1051. doi: 10.1007/s00128-004-0349-5 (2004).

S.W. Suh, J.Y. Koh and D.W. Choi, Extracellular zinc mediates selective neuronal death in hippocampus and amygdala following kainate-induced seizure. *Soc Neurosci Abstr*, **22**: 2101 (1996).

R.J. Vandenberg, A.D. Mitrovic and G.A. Johnston, Molecular basis for differential inhibition of glutamate transporter subtypes by zinc ions. *Mol Pharmacol*, **54**: 189–196 (1998).

B. Veer, Effect of Ni and Zn on seedling growth and hydrolytic enzymes in *Phaseolus aureus* cv, R-851. *Geobios* **16**: 245–248 (1989).

A. M. Yousafzai, A. R. Khan and A. R. Shakoori, An assessment of chemical pollution in River Kabul and its possible impacts on fisheries. *Pakistan Journal of Zoology*, **40**: 199-210 (2007).

M. Zarei, Asad and M. Shekofeh, Levels of some heavy metal in fishes tissue of southern Caspian Sea. *International Journal of the Physical Sciences*, **6**: 6220-6225 (2011).