

ABSTRACT

The main objectives of this work were to investigate physico-chemical and heavy metal contaminations in water and heavy metals accumulation and toxicity in selected fish species of River Kabul. For this purpose water sample A (control site 3), water sample B (polluted site 4), water sample C (polluted site 1) and water sample D (polluted site 2) upstream and downstream of River Kabul were collected during low and high flow periods and analyzed for eight physico-chemical parameters (pH, TSS, TDS, TA, Cl, K, EC, Na) and nine heavy metals (Zn, Ni, Cr, Cu, Cd, Pb, Mn, Fe, Hg) and compared with water sample A and NEQS recommended limits. All the studied physico-chemical and heavy metal parameters in water samples A, B, C and D except TSS and Hg were below the NEQS proposed limits, where the values of TSS and Hg were above the NEQS recommended limits in all the water samples A, B, C and D. Thus the overall sequence of different water samples was $D > C > B > A$. This highlights that water sample D had higher and sample A had lower physico-chemical and heavy metal contaminations. Water samples A and B had highest TDS and lowest K for low flow and had highest TSS and lowest K for high flow seasons. Similarly water samples C and D showed highest TDS and lowest pH for low flow and showed higher TSS and lower K for high flow periods. Among heavy metals water sample A had highest Zn and lowest Pb for both low and high flow periods. Water sample B showed higher Zn and lower Hg for low flow and greater Zn and smaller Cu for high flow periods. Similarly water samples C and D had greater Zn and smaller Cr for low flow and higher Zn and lower Cu for high flow seasons, respectively.

This investigation was further aimed to determine bioaccumulation of heavy metals including Zn, Ni, Cr, Cu, Cd, Pb, Mn, Fe and Hg in intestine, skin, liver, gills and muscle of *Wallago attu*, *Ompok bimaculatus*, *Cyprinus carpio*, *Labeo dyocheilus* and *Aorichthys seenghala* of River Kabul and compared with permissible limits of RDA. Overall accumulation of metals in *Wallago attu* was highest in skin and lowest in liver, in *Aorichthys seenghala* was higher in skin and lower in intestine, in *Labeo dyocheilus* was high in skin and low in muscle, in *Cyprinus*

carpio was maximum in intestine and minimum in muscle and in *Ompok bimaculatus* was more in gills and less in muscle. Thus overall order of heavy metals concentration in different fish organs was intestine > skin > liver > gills > muscle and in different fish species was *Cyprinus carpio* > *Ompok bimaculatus* > *Aorichthys seenghala* > *Labeo dyocheilus* > *Wallago attu*. This shows that highest metals accumulated organ was intestine and fish was *Cyprinus carpio* while lowest metals accumulated tissue was muscle and fish was *Wallago attu*. Overall order of metals concentration in different tissues showed that Zn was the highly and Cd was the lowest accumulated metals. Comparing this result with RDA renders that in skin Zn, Ni, Cr, Cd, Pb and Hg and in muscle Ni, Cr, Cd, Pb and Hg levels were above the RDA recommended limits.

Further more the present investigation was conducted to assess genotoxicological impacts of heavy metals in various tissues and organs of selected fish species. Therefore degree of DNA damage like TCS and comet class 0, class 1, class 2, class 3 and class 4 were determined in blood, intestine, skin, gills, liver and muscle cells of *Wallago attu*, *Ompok bimaculatus*, *Labeo dyocheilus*, *Cyprinus carpio* and *Aorichthys seenghala* of River Kabul. Overall degree of DNA damage cells in *Wallago attu* were highest in blood and lowest in muscle, in *Aorichthys seenghala* were greatest in intestine and smallest in muscle, in *Labeo dyocheilus* were more in blood and less in muscle, in *Cyprinus carpio* were high in blood and low in muscle and in *Ompok bimaculatus* were maximum in intestine and minimum in muscle. Overall trend of DNA damage cells in different tissues was intestine > blood > skin > liver > gills > muscle and in different fish species was *Cyprinus carpio* > *Ompok bimaculatus* > *Aorichthys seenghala* > *Labeo dyocheilus* > *Wallago attu*. This indicates that highest degree of DNA damage cells were found in intestine and lowest in muscle. Similarly higher frequency of DNA damage cells was observed in *Cyprinus carpio* and lowest in *Wallago attu*.

This study was further meant to investigate histopathological impacts of heavy metals in various tissues and organs like intestine, gills, liver and muscle of *Wallago attu*, *Ompok bimaculatus*, *Labeo dyocheilus*, *Cyprinus carpio* and *Aorichthys seenghala*. The observed lesions in intestine of selected studied fish species were degeneration of epithelium, complete

degeneration of cilia, inflammation, coagulative necrosis and degenerative cilia, in gills were disquamation and distortion of secondary lamellae with epithelial cell exudate, clumping of gills lamellae, necrotic area, epithelial disquamation, non specific inflammation, vacuolation and oedema, in liver were inflammation, hydropic degeneration, coagulative necrosis, non specific inflammation, liquefactive necrosis and spongiosis hepatis and in muscle were fibrillar degeneration, inflammation, coagulative necrosis and non specific inflammation. Overall pathological abnormalities in *Wallago attu* were the highest in liver and lowest in the gills, in *Aorichthys seenghala* were more in liver and less in gills, in *Labeo dyocheilus* were maximum in gills and minimum in intestine, in *Cyprinus carpio* were higher in intestine and lower in muscle and in *Ompok bimaculatus* were greater in liver and smaller in gills. Overall order of different pathological lesions in different fish organs was liver > intestine > gills > muscle and in different fish species was *Cyprinus carpio* > *Ompok bimaculatus* > *Labeo dyocheilus* > *Aorichthys seenghala* > *Wallago attu*. This highlights that highest histopathological disorders were found in liver and lowest in muscle. Similarly highest pathological alterations were observed in *Cyprinus carpio* and lowest in *Wallago attu*.

Key Words: River Kabul, Physico-chemical parameters, Heavy metals, Bioaccumulation, Genotoxicity, Histopathology.