Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(3): 335-337

Received: 14-03-2016
Accepted: 15-04-2016

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Spectrometric analysis of heavy metals in soil and water of Kohat dams with respect to fish production, Khyber Pakhtunkhwa, Pakistan

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Abstract
This study was conducted to assess the concentration of heavy metals namely (Zn, Pb, Cr, Cu, Cd and Ni) in soil and water samples of five dams located near Kohat, KPK, Pakistan. Atomic absorption spectrophotometer was used for estimation of heavy metals. The average value of Pb in water (0.24mg/L) was found to be higher than the allowed value i.e. 0.01 mg/L. The average values of Zn, Cd, Cr and Cu in water are in the range of 0.52mg/L, 0.32mg/L, 0.082mg/L and 0.01mg/L which are below than the permissible value. Ni was found absent in all water samples. The average value of the heavy metals were also found in soil and found in the range of 1.43mg/L (Pb), 0.092mg/L (Ni), 0.92mg/L (Zn), 0.039mg/L (Cr), 0.134mg/L (Cu) and 0.20 mg/L (Cd), in which the value of Ni and Pb were found to be higher than the permissible value and other were found below the allowed level according to WHO. The health risks involved due to the high levels of metals when they enter the human metabolism, measures should be taken to minimize these levels in the potable waters to mitigate the imminent health risks.

Keywords: Heavy metals, concentration, Kohat dams

1. Introduction
Pure water does not exist in nature because the rainwater collects impurities while passing through the air and carried to the rivers, lakes or reservoirs that supply our drinking water [1]. Water is essential for life and is the most important single product in human civilization. Water is an amazing substance constantly moving from sea to land and back again. It shapes the earth's surface and moderates our climate. It is the medium in which all living process occurs. Water dissolves nutrients and distributes them to cells, regulates body temperature, supports structures, and removes waste products from the body [2, 3]. Heavy metals are widely used in mining industries, pesticides, dental amalgams, paints, automobile, photographic papers, agricultural runoff, domestic wastes and phytochemicals. These heavy metals polluted the surface water system through anthropogenic activities, which is the major problem faced all around the globe [5, 6].

Heavy metals are environmentally everywhere, readily dissolved in, transported by water, readily taken up by aquatic organisms and are considered to be persistent component in the aquatic environment. Fishes constitute major components of most aquatic habitats and they act as bio-indicator of heavy metal levels in aquatic environment [7, 8]. The fresh water ecosystem occupies a very small area in comparison to marine ecosystem. Now a day's fresh water resources degraded at large scale, due to water pollution. The effect of heavy metal on fresh water ecosystem has become global concern. The problem of water pollution by trace metal is known to be critical all over the world and especially in a developing country, where everybody is facing the problem of water pollution due to modern industrialization and civilization [9].

Heavy metals are bio-accumulated and bio-transferred both by natural and anthropogenic sources. The contamination by heavy metals in water is one of the major issues to be faced throughout the world and requires attention because heavy metals above their normal ranges are extremely threatened to both plant and animal life. All heavy metals exist in surface waters in colloidal, particulate, and dissolved phases, although dissolved concentrations are generally low. The solubility of trace metals in surface waters is predominately controlled by the water pH, the type and level of ligands on which the metal could adsorb, and the oxidation state of

the mineral components and the redox environment of the system [10, 11]. Heavy metal contamination may cause changes in the composition of the water and finally become inappropriate for human consumption [12]. The Industrial development in Pakistan from past few decades has launched many industrial zones at major Cities. These industries are producing tremendous amount of polluted products particularly heavy metals that are drained into nearby rivers and enter continuously in the river untreated [13, 14]. The aims of this study were to determine the concentration of heavy metals to highlight the concerned authorities to take immediate precautionary steps for the betterment of drinking water and aquatic life as well.

2. Materials and Methods

For the present investigation, water and soil samples were collected during summer season May, 2015. The samples of water and soil were collected in clean plastic bottles of 1 liter volume from each station at the depth of one and half feet below the surface of water from sampling station-1 (Ghandiali dam) sampling station- 2 (Tanda dam), sampling station-3(Darmalak dam), sampling station-4 (Ghurzandi dam) and sampling station-5 (Darwazai dam). Two samples (one water and one soil) were collected from each sampling site. The samples were then filtered through a membrane filter when necessary. The pH of all the water samples was noted immediately with Ph meter and water was acidified further with nitric acid. This acidified water was then brought into laboratory and stored at 4 ^{0}C until analysis. The heavy metals concentration like Zn, Cu, Ni, Cr, Pb, and Fe were determined by using spectroscopic techniques.

3. Results and Discussions

Heavy metal concentrations in water and soil in different dams are illustrated in table (1 and 2). Heavy metal concentration in water was found in the order: Pb>Zn>Cd and others were not detected in Ghandiali dam, follow the order of Pb>Zn>Cu>Cd and others metals were not detected in tanda dam, follow the order of Zn>Pb>Ni>Cr and (Cu, Cd) were found undetected in Darmalak dam, whereas they follow the order of Zn>Cd>Ni>Pb>Cr, Cu was not detected in the Darwazai dam, they follow the order of Zn>Cu>Pb>Cr, others metals were undetected in Ghurzandi dam respectively. Similarly Heavy metal concentration in soil was found in the order: Pb>Zn> and others were not dectected in Ghandiali dam, follow the order of Pb>Zn>Cd and others metals were not detected in tanda dam, follow the order of Zn>Cr=Cu>Pb and (Ni, Cd) were found undetected in Darmalak dam, whereas they follow the order of Cd>Zn>Cr and (Ni. Pb, Cu) were not detected in the Darwazai dam, they follow the order of Zn>Cr and others were undetected in Ghurzandi dam respectively. The overall average order of metals in the water and soil samples of five dams were as follow: Pb>Zn>Cd>Cr>Cu>Ni given in Table 1 and 2.

Table 1: Heavy metals concentration (mg/L) in water of the Kohat dams during breeding season of fish.

Samples	Dams	Pb	Ni	Zn	Cd	Cr	Cu
Water	Ghandiali dam	1.426±0.35	ND	1.04±0.01	ND	ND	ND
Water	Tanda dam	0. 78±0.49	ND	0.30±0.03	0.10±0.01	ND	ND
Water	Darmalak dam	0.03±0.17	ND	0.41±0.02	ND	0.05±0.03	0.05±0.1
Water	Ghurzandi dam	ND	ND	0.50±0.01	ND	0.07±0.02	ND
Water	Darwazai dam	ND	ND	0.36±0.03	1.5±0.03	0.21±0.03	ND

ND: Not detectable

Table 2: Heavy metals concentration (mg/L) in soil of the Kohat dams during breeding season of fish.

Sample	Dams	Pb	Ni	Zn	Cd	Cr	Cu
SOIL	Ghandiali dam	1.003±0.31	ND	0.24±0.08	0.05±0.02	ND	ND
SOIL	Tanda dam	5.12± 0.11	ND	0.31±0.03	0.09±0.02	ND	0.15±0.03
SOIL	Darmalak dam	1.55±0.49	0.22±0.06	1.82±0.02	ND	0.12±0.01	ND
SOIL	Ghurzandi dam	0.07±0.02	ND	0.64±0.01	ND	0.03±0.08	0.61±0.06
SOIL	Darwazai dam	0.48±0.14	0.31±0.01	1.65±0.01	0.92±0.03	0.06±0.02	ND

ND: Not detectable

The difference among the five dam's in metal content is significant (Table 1 and 2). Maximum values of heavy metal were attained at tanda dam. Other dam's showed minimum amount of metals. The minimum values of heavy metals were recorded at Ghurzandi dam; this may be due to higher number of plants and aquatic organism which absorb metals from water and soil.

3.1 Copper

Copper is odorless and play a key role in some biological processes. The present study was conducted to determine the concentration level of copper of five different dams located in Kohat, KPK. The concentration of copper is shown in the tables. It is found in small amount in unpolluted water, but trace amount are sometime found in very soft and acidic water. Higher concentration of Copper was found in the soil sample of Ghurzandi dam in the range of 0.61 mg/L. The maximum permissible concentration of copper in drinking water is 2 mg/L according to WHO. The value of copper content in all samples was found under the permissible level. High concentration of cupper may lead to neurological complications, hypertension, and liver and kidney dysfunctions [15].

3.2 Lead

Lead is a toxic metal cause's anemia, brain damage and vomiting [16]. The higher concentration of lead was found in tanda dam soil sample in the range 5.12 mf/L. This value of lead is more than the permissible concentration of lead in drinking water 0.1 ppm according to WHO [17]. Lead was found to be present in larger amount than the permissible value except Darmalak dam and Ghurzandi dam which showed less concentration than the allowed value. Lead was not detected in the water sample of Ghurzandi dam.

3.3 Zinc

During this study the average concentration of Zink was recorded 0.727 mg/L. Zinc found in trace amount in

unpolluted ground water. The maximum permissible concentration of zinc in drinking water is 5 mg/L according to WHO. The values of zinc content in all water and soil samples were found to be less than the permissible level. Zinc is very essential micronutrient in human being. High level of Zinc can harm animals and cause health problems in humans [18].

3.4 Chromium

The concentration of chromium was found about 0.21 mg/L from the water sample of Darwazai dam. The concentration of Cr in water remained below the allowed concentration of 50 µg/L according to WHO. Chromium naturally occurs in rocks, animals, plants, soil, and in volcanic dust and gases. The values of chromium content in water and soil samples of Darmalak dam and soil sample of Darwazai dam were found to be higher than the maximum permissible level. Chromium was found undetected in the samples of Gandiali and Tanda dams.

3.5 Cadmium

In the present study the high level of Cadmium concentration was found about 1.50 mg/L from the Darwazai dam water. 0.67 to 0.02 mg/L. this value is higher than the permissible level. The maximum permissible limit of cadmium is 0.01 mg/l, beyond this limit, the water becomes toxic.

High level of cadmium concentration arise due to industrial waste [19].

3.6 Nickel

Nickel was detected in soil samples of Darmalak and Darwazai dams in the range 0.22 and 0.31 mg/L. this concentration of nickel was recorded above the maximum permissible limit set by WHO 0.02 mg/L.

4. Conclusion

Quantitative analysis of heavy metals was conducted for water and soil samples of dam's in Kohat region of Pakistan. The studies reveal that different sampling sites have heavy metals in different concentrations. The concentration levels of certain heavy metals are alarmingly high in all the areas considered for sampling. Keeping in view the health risks involved due to the high levels of metals when they enter the human metabolism, measures should be taken to minimize these levels in the potable waters to mitigate the imminent health risks.

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