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Assessment of Heavy Metals in Trout inhabited Streams of Miandam and Madyan Swat, Pakistan

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Abstract
Heavy metals are high atomic weight molecule having density 5 times greater than that of water. The reason of their wide distribution in the environment is their multiple domestic, agricultural, medical and technological applications which have adverse effects on human and environment. The current study was conducted in Miandam and Madyan valleys of district swat to find out the concentration of heavy metals (cu, Zn, Cd, Fe, Cr, Mn, Pb and Ni) in trout inhibited streams of these valleys. From different streams of both the valleys seven water samples were collected and standard methods were used for analysis of all the water samples. Atomic Absorption spectrophotometer equipped with graphite furnace and mercury hydride stream was used for determination of heavy metal concentration in water samples. Statistically significant difference ($p<0.05$) was only observed between the streams of the both valleys for Mn, Zn and Ni, otherwise no significant difference ($p>0.05$) was found between the remaining heavy metals in streams of both the valleys. In streams of Madyan the Fe concentration was found in permissible level but in greater concentration than in Miandam and the remaining heavy metals (cu, Zn, Cd, Cr, Mn, Pb and Ni) were within the normal range according to WHO standards.

Key words: Heavy metals, Trout fish, Diversity, Concentration, Madyan, Miandam.

Introduction

Madyan valley is known all over the Country because of its weather condition and trout farms established there located 56 km away from Mingora city lies on the road to Bahrain, Kalam and other beautiful destinations of Swat, while Miandam is a hill station in Khyber Pakhtunkhwa, Pakistan, located at a distance of 55 km away from Mingora, the main city of Swat Valley. (Yousafzai *et al*., 2013). The River Swat is join by the both tributaries of Miandam stream (one is Swatu tributaries and the other is Gujaro tributaries) in the Fatehpur Swat (Yousafzai *et al*., 2013). Heavy metals are naturally occurring high atomic weight molecule having density 5 times greater than water added to water bodies due to agricultural herbicides, pesticides, fertilizers and domestics waste. The high concentration of some heavy metals (Ar, Cd, Pb, Hg, Cr) create serious issue for aquatic life and human health. Trout requires clean and fresh water but the seasonal floods and environmental fluctuation effect the abundance of trout in streams and rivers (Harrell, *et al*., 1978). Any metal has highly toxic effect even if present in very small concentration

The heavy intake of some heavy metals such as cadmium, lead, manganese and chromium are reported to be harmful for living organism but some such as zinc, cobalt and zinc are reported to be very essential for normal functions and body growth of living organisms (Ouyang *et al.,* 2002). Heavy metals are considered significant pollutant due to bio accumulative, toxic and persistent properties of heavy metals and cause many health problems such as cardiac, skin, kidney, lungs, breathing and digestive problems (Cantor *et al*., 1997)(Pekey et al., 2004). The heavy metals can alter the function of kidney, liver and lungs and composition of blood by lowering the energy level. Long term exposure to heavy metal can cause many neuro degenerative, muscular and physical problems such as muscular dystrophy, Parkinson's, Alzheimer's etc. Fish are rich in omega-3-fatty acids and protein which are very important for health of human but when these fish consume heavy metals present in polluted water the absorption of these heavy metal occurs in their tissues which then transferred to body of human by eating these effected fishes. Due to long term exposure to heavy metals high mortality of adult fish and reduced breeding potential of juvenile fish has also been reported. The main objective of this study was to find out the concentration and sources of different heavy metal and their toxic effects on the bodies of living organism and environment.

Methodology

This study was conducted in streams of two different valleys of district swat, KPK, Pakistan. The first valley is Miandam which is situated at a distance of 55 km from the Mingora city of swat. The other valley is Madyan which is started from Madyan and end at Qandil Madyan. A total of 7 water samples were taken from the streams of both Madyan (4 water samples) and Miandam (3 water samples). The sample collection was done in both the valleys in ascending order i.e. in

Miandam started from river of Gujaro, river of Swatu and the junction of these both rivers. In Madyan the sample collection was started from Chail and ended at Qandil Bridge Madyan.

Sampling

This study was started from February to May with a total duration of 4 months. For analysis of both physical and chemical parameters of water, samples were collected in plastic bottles from different streams of Madyan and Miandam valleys. For water collection the triplicate which was used was rinsed with distilled water. The bottles were sealed properly in order to left no bubbles in bottles.

Physical and chemical analysis:

Heavy metals concentration was analyzed in collected water samples. The volume of collected samples of water (200ml) was reduced to 10 ml through evaporation for detection of heavy metals through absorption spectrometry and then 10 ml of 1 M HCL was added to make a final volume of 20 ml. chemical analysis was done in department of soil and environmental sciences, university of agriculture Peshawar. Heavy metals (Pb, Zn, Mn, Cu, Cd, Ni and Cr) analysis was done by using atomic absorption spectrometer (an analyst 700) equipped with graphite furnace and mercury hydride.

Statistical analysis:

Independent sample T test was performed for finding out the significant difference between the temperature of water samples of Miandam and Madyan. Multivariate analysis of variance was employed for determination of significant difference of heavy metals between all the four samples. Pearson's correlation test was performed for determining any association between the temperature and concentration of heavy metals. SPSS version 21 was used for statistical analysis.

Results

The temperature of water was checked varied from 10.1 to 15.9C due to little bit variation in their environment.

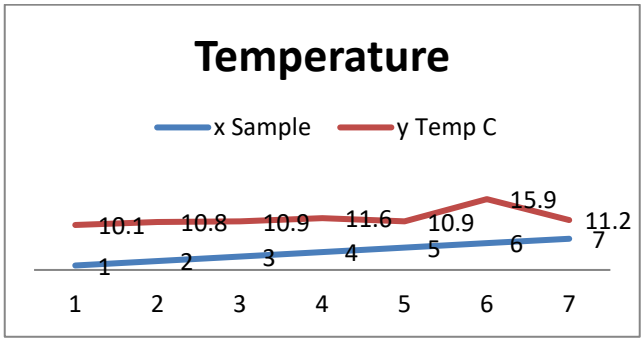


Figure: 1 Shows the temperature of Miandam and

Madyan Tributries of River Swat

Heavy metal Analysis

Chemical analysis of water samples showed the concentration of heavy meatal (Zn, Cu, Mn, Fe, Cd, Cr, Pb, and Ni) in the following increasing order: Ni>Cr>Zn> Pb>Ni>. In stream 1 and 3 the slight increase concentration of Cu > Cd was measured. In stream 2 and 3 the increase concentration of Mn >Fe was measured and in the increase concentration of Fe >Mn was measured in stream 1. The details are given in table no 1.

Table 01 Heavy Metals concentration at various locations of both the tributaries Madyan and Miandam

S.NO	Sample Locations	Zn	Cu	Mn	Fe	Cd	Cr	Pb	Ni
	mg L^{-1} or (ppm)								
1	35.051170, 72.557103	0.059	0.007	0.171	0.908	0.008	0.051	0.082	0.026
2	35.053389, 72.557210	0.059	0.014	0.159	1.116	0.007	0.05	0.073	0.027
3	35.052183, 72.556358	0.05	0.005	0.123	0.93	0.012	0.034	0.063	0.024
4	35.124535, 72.601340	0.047	0.006	0.118	0.764	0.008	0.024	0.085	0.022
5	35.128792, 72614993	0.067	0.006	0.106	1.288	0.007	0.013	0.078	0.021
6	35.106046, 72.505570	0.012	0.014	0.081	0.442	0.007	0.013	0.071	0.019
7	35.09744, 72.499854	0.089	0.017	0.1	2.907	0.007	0.031	0.066	0.017

Fig 2: Water sample collection points

Table 4 shows the increase concentration of Mn and Fe in sample 4-7 collected from Madyan streams. In streams 4 the order of heavy metals other than Mn and Fe was Cu > Cd>Ni>Cr>Zn> Pb. In stream 5 the order was Cu > Cd>Cr>Ni>Zn> Pb. In streams 6 and 7 a slight decreased concentration of Zn and Ni was measured. The overall result showed the higher concentration of Fe and Mn in all 7 samples

Statistical analysis:

The mean temperature of water samples taken from streams of Madyan was measured as 12.4 °C with standard deviation ±2.35089 and that of Miandam was measured as 10.6 °C with standard deviation ±2.35089. The statistical analysis showed no statistically significant difference (p=104) between the temperature of Madyan and Miandam streams.

Table: 02 p values of heavy metals

S.no	Heavy metal	P value
1	Zn	0.913
2	Cu	0.627
3	Mn	0.022
4	Fe	0.598
5	Cd	0.24
6	Cr	0.016
7	Pb	0.742
8	NI	0.011

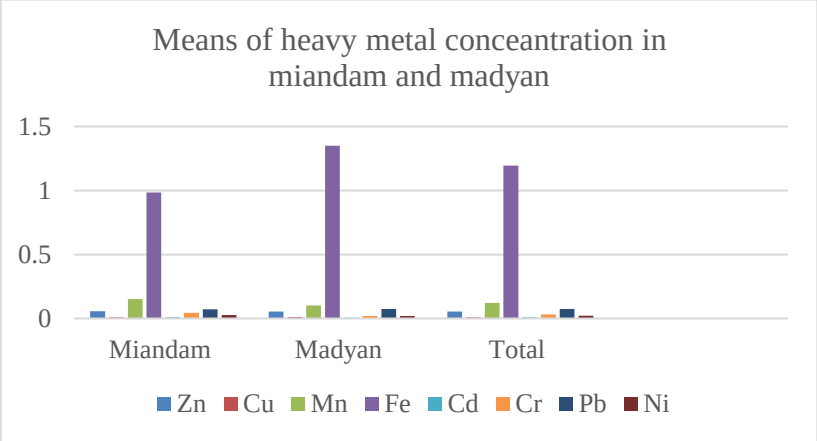
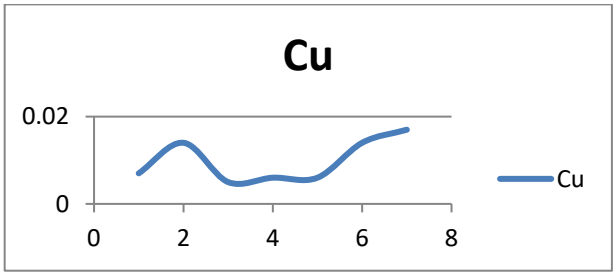


Figure: 3 Graphic Presentation of Heavy metal concentration at Miandam and Madyan

Table: 03 Means and standard deviations of heavy metals in Miandam and Madyan streams

S.No	Heavy metals	Madyan	Miandam
		Mean and SD	Mean and SD
1	Zn	0.05375±0.032694	0.05600±0.005196
2	Cu	0.01075±0.005620	0.00867±0.004726
3	Mn	0.10125±0.015435	0.15100±0.024980
4	Fe	1.35025±1.094829	0.98467±0.114269
5	Cd	0.00725±0.000500	0.00900±0.002646
6	Cr	0.00725±0.008846	0.04500±0.009539
7	Pb	0.07500±0.008287	0.07267±0.009504
8	NI	0.01975±0.002217	0.02567±0.001528

All the water samples of streams of both the valleys showed the highest concentration of Fe of 1.35025±1.094829 and 0.98467±0.114269. However the there was no statistically significant difference found among water samples of Miandam and madyan for Fe concentration. The water samples of both the valleys showed 2nd highest mean Mn contamination of 0.10125±0.015435 and 0.15100±0.024980 and the difference between means of Mn in water samples of madyan and Miandam was statistically significant ($p<0.05$). Water samples of Miandam and madyan showed the mean Zn contamination of 0.05600±0.005196 and 0.05375±0.032694, the mean Cu contamination of 0.00867±0.004726 and 0.01075±0.005620, the mean Cd contamination of 0.00900±0.002646 and 0.00725±0.000500 and the mean Pb contamination of 0.07267±0.009504 and 0.07500±0.008287 respectively. However the difference between means of Zn, Cu, Cd and Pb in water samples of Miandam and madian was not statistically significant. The difference between means of Cr and Ni was statistically significant ($p<0.05$) in water samples of Miandam and madyan streams with mean Cr contamination of 0.04500±0.009539 and 0.00725±0.008846 and mean Ni contamination of 0.02567±0.001528 and 0.01975±0.00221. The statistical analysis showed only strong negative correlation (r=-0.846) between temperature and Cr concentration. A strong negative correlation (r=-0.869) was also observed between temperature and Ni and temperature and Mn concentration. However no statistically significant association was detected in temperature and Zn, Cu, Fe, Pb and Cd concentrations.



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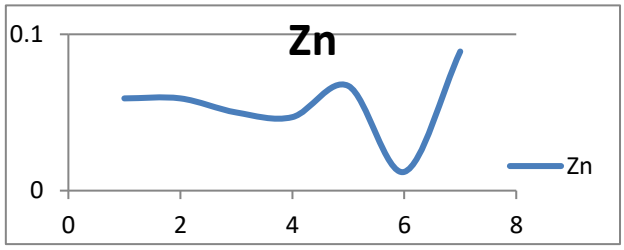

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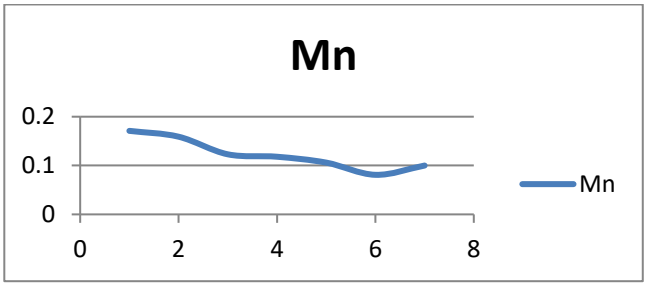

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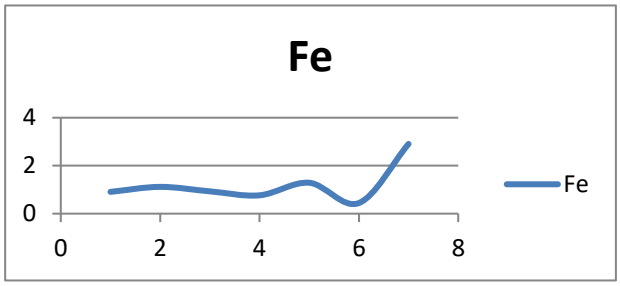
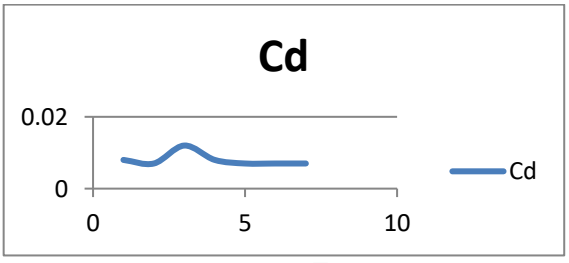


Figure: 7

Figure 4, 5, 6 and 7 show the ranges of Cu, Zn and Mn concentration with normal values. The concentration of Zn ranged from 0.005 to 0.017mg/l with a normal value of 0.014 mg/l. Cu concentration ranges from 0.081 to 0.171 mg/l with a normal worth of 0.1 mg/l. Mn concentration ranged from 0.081 to 0.171 mg/l with a normal worth of 0.1 mg/l. Fe concentration was ranged from 0.442to 2.907 mg/l with a normal worth of 1.2mg/l.



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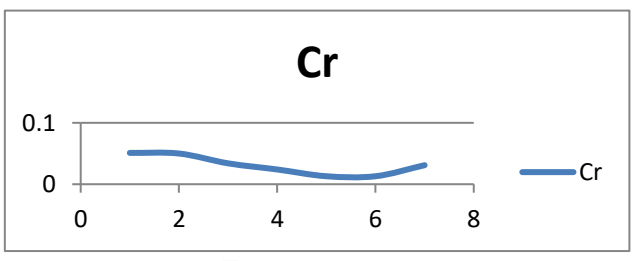

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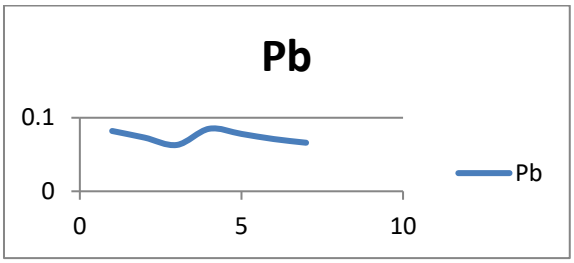

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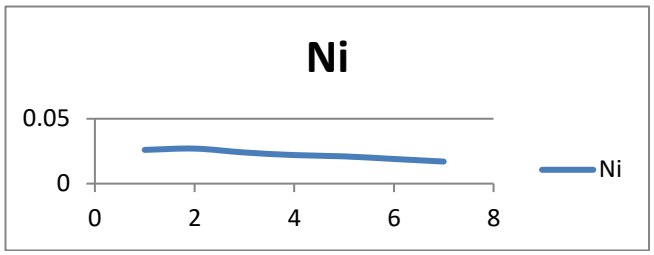

Figure: 11

Figures 8, 9, 10 and 11 show the ranges and normal values of Cd, Cr, and Pb and Ni concentration. Cd concentration was ranged from 0.007to 0.012mg/l with a normal worth of 0.007mg/l. Concentration of Cr was ranged from 0.013 to 0.051mg/l with a normal value of 0.012 mg/l. Pb concentration was ranged from 0.066.to 0.085mg/l with a normal value of 0.03mg/l and Ni concentration was ranged from 0.017- 0.027.

Discussions

Both natural and anthropogenic sources contribute to the release of heavy metals into the environment. These heavy metals originate from the earth and after releasing into the different domain of environment such as air, soil, water etc as a pollutant. Due to the devastating impacts of these heavy metals on the nature and their rapid increase in the environment, it became a matter of concern. They not only increase the toxicity of ecosystem but also cause many economic problems. The heavy metals adversely effect both the terrestrial and aquatic ecosystems after releasing from different sources and then deteriorate the health of living organisms (Ebrahimpour and Mushrifah, 2008). According to one study conducted for measuring heavy metals in water at 15 sites in Malaysia by (Ebrahimpour and Mushrifah, 2008) the concentration of heavy metals was reported in descending order of Pb>Cu>Cd but Cu was founded in higher concentration than Pb at site 2 and 13. (Ebrahimpour and Mushrifah, 2008) stated that the highest concentration of Cd was probably due to boating activities in the lake. This study showed the heavy metals concentration in Cu > Cd>Pb order in stream 4 and Cu> Cd> Pb> order in stream 5. For assessment of heavy metals copper, lead, chromium, cadmium, manganese, iron and zinc in river Panjkora lower Dir, KPK, water samples were analyzed through atomic absorption spectrophotometry by (Ahmad et al., 2014). According to their result Cu, Pb and Cr were not detected in water samples, Mn and zinc were detected but within the guideline of WHO but Fe was found in exceptionally highest concentration. In this study the Fe was also found in highest concentration among the all heavy metal and zinc and manganese were within the permissible concentration so this study matches partially with study of (Ahmad et al., 2014). The study on heavy metals assessment in River Indus Beka Swabi, KPK also showed the concentration of all the heavy metal in normal range of WHO and conclude that water of Indus River in Beka Swabi is suitable for fish production (Khan et al., 2014) just like result of this study. (Idrees et al., 2017) analyzed heavy metals Co, Cr, Cu, Mn, Ni, Sb and Zn in water samples collected from three rivers in Charsada and concluded that the water of all the water samples exhibited higher concentration of the mentioned heavy metals than permissible level except for Zn and Mn. They also stated that anthropogenic sources such as house hold effluents and industrial wastes. In this study only Fe was detected in higher concentration which was due to fish feed.

Conclusions

The concentration of all the 8 heavy metals Pb, Cd, Mn, Cr, Cu, Ni, Fe and Zn was found in normal range for survival of trout according to WHO. In all the water samples of both Madyan and Miandam rivers high concentration of Fe was measured. It was also determined that the heavy metal concentration in streams of Madyan was higher than that Miandam streams. According to factor analysis geogenic sources are responsible for the contamination of water of river swat. From the overall result of heavy metal analysis it was concluded that the water of river swat is very appropriate for raising of commercial fish species especially trout.

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