EVALUATION OF HEAVY METALS IN TEXTILE EFFLUENTS IN RELATION TO SOIL AND POND WATER

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Abstract: In the present study, impact of textile effluents and their consequent impact on accumulation of some selected metals (Na, K, Mg, Fe, Mn, Cr, Ni, Pb and Zn) in water and soil samples in and around Manipal industrial area Karnataka were studied. Concentration of metals in textile effluents (SI), sediments (SII), adjacent polluted pond water (SIII) and water and soil samples from reference site (SIV) were measured by atomic absorption spectrophotometer. The results showed elevated levels of Na, K, Ca, Cr, Fe, Pb and Zn in the water samples from SI, SIII and soil samples from SII. The data showed that the textile effluents containing elevated levels of Cr and Pb having concentration of 3.488 mg/kg and 1.617 mg /kg respectively other metals such as Zn, Ni, Mn and Fe were found elevated levels in SII and SIII. The heavy metal accumulation in water and soil samples from SII and SIII was found in the following order. Soil > effluents > pond water. The estimated toxic heavy metals levels in three different stations are compared with water and soil samples from the reference site (SIV). Selected metal concentrations in SIV were well within the safe limit laid down by WHO. The comparison indicated that soil in the adjoining industrial area (SII) had accumulated enhanced levels of toxic metals such as Cr, Ni, Zn and Pb, which also manifested higher concentration levels in the adjacent polluted pond water samples. The soil and pond water in proximity to the industries have accumulated high concentration of toxic metals in SI, SII and SIII, with elevated levels in three media far exceeding the limit for their safe use laid down by WHO.

Key words: Textile effluents, Heavy metals

INTRODUCTION

Textile industries produce huge amount of polluted effluents that are normally discharged to surface water bodies and ground water aquifers. The waste water pollutants badly damage the terrestrial ecological system [1-3]. In Karnataka textile industries causing a long term serious adverse health effects. The problems of environmental pollution are arising tremendously because of disposal of industrial waste [4-6]. Toxic metals and trace metals flow from textile industrial effluents to water and soil are quite dangerous from health point of view [6,7].
The industrial growth in Manipal region Karnataka has been currently boosted up to substantially enhance economic growth. The environmental contamination situation in the area is becoming more serious day by day. This situation demands a strict treatment program for the effluents from textile industry involving safe disposal of effluents. Resources are safeguarded against elevated levels of the toxic metals, as reported for other parts of the world [8-10]. The present study was undertaken keeping in view the environmental significance of the potential influence of toxic textile and domestic effluents on near by water resources and soil system.

MATERIALS AND METHODS

Study area and sampling: The study area Manipal, (13.35°N; 74.78°E) Karnataka, housing textile industries generate effluents, partly treated and used for industrial purpose, large quantity of remaining waste water discharged to the main drain and nearby pond. The effluents from these units discharged independently in main drain that opens in adjoining land. Though the waste water treatment facility exists, but treated/untreated effluents and sludge discharged in to the adjoining land, adversely affect the environment.

Water samples were drawn from station I (untreated/treated) effluents discharged in to the loamy drain 50 m away from the industry; Station II (100 m down stream) from the first location, Station III (adjacent pond), Station IV unpolluted area 7.5 km away from industrial and domestic region bore well, for water analysis. The water samples and effluents sample from the source SI, SIII and IV were collected in duly labeled strong polythene bottles (1L). Upper productive soil (0 to 10cm) were randomly collected from polluted (SII) and unpolluted (SIV) site. The surface soil samples, considered affected by the effluents, were collected upto 50m from the discharge point. Sampling frequency was once in a month from April 2009 – Feb 2010 covers all four seasons. Soil samples were freed from extraneous matter (stones, pebbles etc) and hot air oven dried. After drying a 25.0 g portion of soil sample was dissolved in 50ml of distilled water and stirred mechanically on an electric shaker for 2min and allowed to settle subsequently for 30min (11,12) the supernatant layer of the solubilized metal matrix was separated through filtration and used for direct estimation of heavy metals using flame AAS system (Perkin Elmer 5000). Effluents and water extracts was used for metal analysis as the labile metals pose higher health risk. The effluents filtered through 0.5µ cellulose filters were directly aspirated without the addition of any pH adjusters and stabilizers. Where required sample solutions were diluted with distilled water appropriately in case if the concentration of a metal in the effluents was too high. The standard linear calibration method was applied for the quantification of metals using standard solution. Automatic background compensation was carried out by the AAS system throughout the study. SPSS ver 13.0 software was used to compute the relevant statistical analysis of the data (13).

RESULTS

The data pertaining to the average metal concentrations of selected metals in the effluent, soil and water samples from station I, II, III, and IV are presented in table 1. Data on the average metal concentration and their distribution in SI, II, III and IV on the basis of mean metal concentrations, in effluent samples shown Na, Ca, Mg, K and Fe with high mean concentration. The mean average values of the Na, Ca, Mg, K and Fe were 1395±342; 135.12 ± 25.9; 68.9 ± 22.2, 46.46  ± 22.31 and 24.27 ± 9.96 mgL⁻¹ respectively. In the SI samples toxic metals such as Cr, Ni, Pb and Zn mean concentration were 1.186 ± 0.654; 0.606 ± 0.184; 1.74 ± 0.546 and 1.023 ± 0.8 mg L⁻¹ respectively during the period of study. Calculated SD values related to the distribution of these metals in the SI samples show a very high dispersion around the mean metal concentrations in the effluents.

The soil samples collected from the SII (polluted region) the average metal concentrations of Na, Ca, K, Mg, and Fe were 25526.6 ± 9793; 4610
Fig. 1 Comparison of average metal levels in SI, and SIII water samples vs corresponding background levels (SIV)

Fig. 2 Comparison of average metal levels in soils (SII) vs. the background levels (SIV)
The concentration of metals in water samples from station I and III were found to be higher than the background level (SIV) and soil samples from polluted region (SII) concentration of metals was found to be higher than effluent sample (SI) and adjacent effluent contaminated pond water samples from SIII. From the results of mean metal concentration, it is evident that Na, Ca, Mg and Fe emerges as dominant metals followed by Cr, Pb, Mn, Ni and Zn in the samples from SI, SII and SIII. The concentration of these metals is highest in soil samples. It is in agreement with previous findings of Breckenridge and Crocket [14] that textile industrial effluents discharged from the treatment plants having toxic heavy metals flows in to the environment. Michaels and Lewis [15] have reported that textile waste water released in to the environment from the treatment plant contains high concentration of salt, heavy metals and significant amounts of unspent dye. Similar findings were recorded in the present study where SII and SIII were evidently contaminated with toxic metals.

Comparison is made between the mean metal concentrations in water samples from SI, SII and SIII were found to be higher than SIV in relation to corresponding background concentration. The average levels in the unpolluted region water samples were within WHO permitted levels for drinking water were shown in the figure 1.

### DISCUSSION

The concentration of metals in water samples from station I and III were found to be higher than the background level (SIV) and soil samples from polluted region (SII) concentration of metals was found to be higher than effluent sample (SI) and adjacent effluent contaminated pond water samples from SIII. From the results of mean metal concentration, it is evident that Na, Ca, Mg and Fe emerges as dominant metals followed by Cr, Pb, Mn, Ni and Zn in the samples from SI, SII and SIII. The concentration of these metals is highest in soil samples. It is in agreement with previous findings of Breckenridge and Crocket [14] that textile industrial effluents discharged from the treatment plants having toxic heavy metals flows in to the environment. Michaels and Lewis [15] have reported that textile waste water released in to the environment from the treatment plant contains high concentration of salt, heavy metals and significant amounts of unspent dye. Similar findings were recorded in the present study where SII and SIII were evidently contaminated with toxic metals.

In the present investigation samples from SI effluents having moderately high concentration of metals and low concentrations in the water samples from adjacent pond (SII). The distribution therefore, indicates a large flux of these metals accumulated in the soil and adjacent pond in the close vicinity of industries (SII, SIII). The calculated standard deviation values related

### Table 1: Selected metals in effluents (mg/L\(^{-1}\)) soil (mg/kg\(^{-1}\)) and water samples (mg/L\(^{-1}\)) of different sources in Manipal industrial region.

<table>
<thead>
<tr>
<th>METALS</th>
<th>EFFLUENTS (SI)</th>
<th>SOIL (SII)</th>
<th>POND WATER (SIII)</th>
<th>BACKGROUNDWATER (IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min Max Mean SD</td>
<td>Min Max Mean SD</td>
<td>Min Max Mean SD</td>
<td>Min Max Mean SD</td>
</tr>
<tr>
<td>Na</td>
<td>1121 2015 1395 342</td>
<td>10160 36768 25526.6 9793</td>
<td>199 396 294.8 59.8</td>
<td>70 11.0 8995 1.179</td>
</tr>
<tr>
<td>K</td>
<td>22.68 140 46.46 22.31</td>
<td>1069 2789 1967 604.5</td>
<td>101 228 182.6 59.8</td>
<td>0.01 0.05 0.25 0.01</td>
</tr>
<tr>
<td>Ca</td>
<td>103.0 176 135.12 25.99</td>
<td>1290 8714 4610 2116</td>
<td>49.8 79.8 66.7 8.11</td>
<td>9.6 13.25 11.36 1.520</td>
</tr>
<tr>
<td>Mg</td>
<td>33.8 98.0 68.9 22.3</td>
<td>101.8 349 225.4 79.5</td>
<td>29.0 93.8 57.8 23.32</td>
<td>4.35 6.75 5.736 0.807</td>
</tr>
<tr>
<td>Fe</td>
<td>10.4 39.0 24.27 9.965</td>
<td>116.98 1370 151.3 30.17</td>
<td>6.659 1.425 1.097 0.23</td>
<td>0.01 0.05 0.25 0.01</td>
</tr>
<tr>
<td>Mn</td>
<td>0.46 0.97 0.691 0.162</td>
<td>1.210 4.65 2.739 1.05</td>
<td>0.035 0.112 0.071 0.023</td>
<td>0.01 0.03 0.0173 0.014</td>
</tr>
<tr>
<td>Cr</td>
<td>0.04 2.714 1.186 0.654</td>
<td>2.160 5.950 3.488 1.275</td>
<td>0.01 0.950 0.456 0.288</td>
<td>BDL  BDL  BDL  -</td>
</tr>
<tr>
<td>Ni</td>
<td>0.013 0.98 0.606 0.184</td>
<td>0.328 3.268 1.790 1.05</td>
<td>0.08 0.068 0.367 0.248</td>
<td>BDL  BDL  BDL  -</td>
</tr>
<tr>
<td>Pb</td>
<td>1.014 2.068 1.74 0.546</td>
<td>0.690 2.650 1.617 0.597</td>
<td>0.26 0.689 0.369 0.194</td>
<td>0.05 0.18 0.18 0.0263</td>
</tr>
<tr>
<td>Zn</td>
<td>0.190 2.458 1.023 0.8</td>
<td>2.18 9.450 6.058 2.78</td>
<td>0.19 0.950 0.409 0.236</td>
<td>0.02 0.004 0.0033 0.0009</td>
</tr>
</tbody>
</table>

± 211.6; 1967 ± 604.5; 225.0 ± 79.5 and 151.3 ± 30.17 (mg kg\(^{-1}\)) respectively. The findings from these data on soil samples was relatively high concentration of Cr maximum metal concentration of Cr about 5.950 mg kg\(^{-1}\) against an average level of 3.488 ± 1.275 mg kg\(^{-1}\). (Table1).The mean concentration of Zn, pb, Ni and Mn were 6.058 ± 2.78; 1.617 ± 0.597; 1.790 ± 1.05; and 2.739±1.05 mg/kg\(^{-1}\) observed in dozens of soil samples indicates impact of industrial effluents in this area. The chromium content of station III water samples mean average value of 0.456 ± 0.288 mgL\(^{-1}\) against the background levels of unpolluted station IV were found below detectable limit for the water samples. Metal concentrations in the water samples from (unpolluted) station IV are shown in table 1, found to be well within WHO safe limit.
to distribution of these metals in the soil samples show high dispersion around mean concentrations. The following on the average in the order: Soil > Effluent > adjacent pond water > Unpolluted (SIV) background region. This relationship indicates the role of effluents towards enhanced metal accumulation in the nearby soil system. Therefore, the possible contribution of the textile industrial effluents towards soil and water contamination in the SII and SIII area cannot be ruled out. Similar findings were reported by Manzoor et al. and Sevketkandemir et al.[6,16]. To support this findings, the higher metal mean concentration of samples from adjacent pond water (SIII) were compared with those for background water taken from unpolluted distant area (SIV), indicating increased concentrations of toxic metals such as Cr, Ni, Pb and Zn from the effluent to soil and pond water in the polluted region.

Zafer Ayas et al. [17] were reported that heavy metal accumulation continuously disturbed the natural environment, particularly aquatic eco system, in which highest concentration of heavy metals in the sediment samples at Nallihan due to domestic and industrial waste water in the birds paradise, Turkey. In the region, urban and industrial effluents, use of heavy metals in industries has lead to wide spread environmental contamination. The accumulation of such heavy metals such as Pb, Cd, Cu and Ni was highest level recorded in water < fish samples < sediments [17]. Similar findings were observed in the present study. The quality of water samples from unpolluted region (SIV) similar to the findings of Kirshnamoorthi et al. [18].

In the present study reveals that the order of distribution of these metals in relation to the distribution in the effluents, soil and water samples is worth consideration. To support this view point, the background concentration levels in water and virgin soil samples were analysed (SIV) and compared with those in the effluents, pond water and polluted region soil samples. The comparison indicated that soil in the adjoining industrial area (SII) had accumulated enhanced levels of toxic metals like Cr, Ni, Zn and Pb, which also manifested higher concentration levels in the adjacent polluted pond water samples. The study, therefore, evidences that the soils and pond water in proximity to the industries have accumulated high concentration of toxic metals in SI, SII, and SIII, with elevated levels in the three media far exceeding the limit for their safe use laid down by WHO [19,20].

REFERENCES