Introduction

Mangroves are one of the most productive and unique ecosystems in the world. Heavy metals in sediments have received increasing attention of researchers due to the growing scientific and public awareness about environmental issues and due to the improvement in the analytical techniques for accurately measuring their concentrations. *Avicennia officinalis* is woody seed-bearing and highly specialized Mangrove species found along sheltered intertidal coastlines of estuaries.

The heavy metals originating from urban runoff, sewage treatment plants, industrial effluents, mining operations, boating activities, domestic garbage dumps and agricultural fungicides dramatically increase its concentration in intertidal sediments. They are major pollutants in the mangrove ecosystem. In addition, specific properties of non-biodegradable trace metal which has high affinity towards anoxic sediments due to presence of fine clay, silt and detrital particles, high pH and sulphate reduction lead to the accumulation of metals in the mangrove (Harbison 1986). The significant increase in the accumulation has potential biological consequences for the plants. Laboratory research had proven that high concentration of Cu, Pb and Zn contributes to significant reductions in seedling height, leaf number and root growth of some mangrove plants (MacFarlane and Burchett 2002). Generally, accumulation occurs at the root level with restricted transport to aerial portions of the plants. This indicates that plants actively avoid the uptake of trace metals. Marshes have been proposed as sites for phytoremediation of metals.

Several studies suggest that metals are present in stem and leaf litter deposited in feeders thus can enter in estuarine food webs. Phytoremediation of metals is a cost-effective “green” technology based on the use of specially selected metal-accumulating plants to remove toxic metals from soils and water. Wetland plants are important tools for heavy metal removal. Wetland plants are preferred over other bio-agents due to their low cost, frequent abundance in aquatic ecosystems, and easy handling. Constructed wetlands proved to be effective for the abatement of heavy metal pollution from acid mine drainage. In the present...
study, Zinc, Copper, Lead, Cadmium and Arsenic metal accumulation is analyzed in *Avicennia officinalis* (leaves and stem), soil and water collected from the Kanjurmarg creek of Mumbai, Maharashtra. Plants may alter the speciation of metals and may suffer toxic effects as a result of accumulating them. Metals in leaves may be excreted through salt glands and thereby returned to the marsh environment. Metal concentrations of leaf and stem litter may become enriched in metals absorption and incorporation of fine particles with adsorbed metals.

**Materials and Methods**

**Sampling Location:** All the plant, water and soil samples were collected from the polluted area in the month of December 2011 from Kanjurmarg creek, Maharashtra. Kanjurmarg is one of the suburban area of Mumbai city lies between latitude 19°07′43″N and longitude 72°55′41″E, the mangrove forest of Kanjurmarg is distributed to only east region from Ghatkopar to Mulund in about 3,000 acres.

**Sample preparations and Analysis:** Plant and soil samples were dried and powdered for the analysis. Water was directly used for the digestion. 1gm of each sample then digested by Ternary acid mixture (HNO3: H2SO4: HClO4) in 5:1:2 proportion (IARI, 1976) separately in the beaker. Final volume was made to 25 ml with distilled water before aspiring the sample in to the flame for absorbance. The estimation of heavy metals Lead (Pb), Copper (Cu), Cadmium (Cd), Zinc (Zn) and Arsenic (As) in the soil, water and mangrove plant *Avicennia officinalis* is carried out by Inductively Coupled Plasma - Atomic Absorption Spectroscopy (ICP-AAS) in IIT Powai, Mumbai. The results obtained were compared to MLRL (Maximum Level Recommended for Livestock) value (WHO/FAO 2001) as a standard limit.

**Results and Discussion**

Inductively Coupled Plasma-Atomic Absorption Spectroscopy (ICP-AAS) studies of samples indicate the presence of heavy metals in the plants, soil and water samples collected from the Kanjurmarg creek, Mumbai. The plant accumulates gross dose of heavy metals from the polluted soil and it indicates presence of pollution in the soil and surroundings area. *Avicennia officinalis* indicates 0.196 ppm accumulation of Zn in the leaves while 7.091ppm in the stem which is highest compared to the quantity of all other metals. (Table - 1, Fig. - 1). The Zn pollution can cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anaemia. Very high levels of zinc can damage the pancreas and disturb the protein metabolism and cause arteriosclerosis. The soil sample from studied area indicates 4.607 ppm of Zn which is highest in all the metals for soil sample. The study conducted by Lawson (2011) for Zn, Cu and Pb accumulation in mangrove swamps in Lagos city of Nigeria indicated supportive results. However, the concentration of these metals was slightly higher than our findings. Cu is essential for organisms but in high doses it can cause anaemia, liver and kidney damage. Yeragi and Mendhulkar (2014) found accumulation Zn in high quantity in mangrove plant, *Excoecaria agallocha* collected from Vikhroli mangrove area in Mumbai. Similar range the accumulation level for heavy metal concentrations is reported by Dang (2005), in marine environment of Singapore city. Although the metals are found in trace amounts, which may be beneficial as micronutrients or enzyme co-factors but, the sub lethal concentrations may become lethal to aquatic organisms (e.g. Fish) with prolonged periods of exposure. (Cenini and Turner, 1983; Collivin., 1984; Reash., 1986; Everall., 1987). *Avicennia officinalis* indicate 0.196 ppm of Zn in the leaf sample. The Zn content in polluted water sample was 0.002 ppm. For Cu the highest estimate observed was 1.248 ppm in Stem, 0.034 ppm in the leaves and 1.618 ppm in polluted soil. The Pb content was 0.481 ppm in stem and 1.21ppm in polluted soil and relatively less 0.03 ppm in the leaves (Table - 1, Fig. - 1). The high levels of Pb may result in toxic effects in humans which can cause problems in the synthesis of haemoglobin (Hb), effects on kidneys, gastrointestinal tract (GIT), joints and reproductive system and acute or chronic damage to nervous system. However, the water sample does not indicate the Cu and Pb content. Cd was observed in less quantity below pollution level. Arsenic was not detected in the any studied sample. Long exposure of Cd may cause kidney dysfunction and its high exposure may cause obstructive pulmonary disease and lung cancer. Arsenic if occurs in excess, causes harmful effects on the nervous, digestive and immune systems.

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**Table 1. Estimates of Heavy Metal Accumulation in *Avicennia officinalis***

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Samples</th>
<th>Heavy Metals in ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cu</td>
</tr>
<tr>
<td>1</td>
<td><em>A. officinalis</em> Leaves</td>
<td>0.034 ± 0.106</td>
</tr>
<tr>
<td>2</td>
<td><em>A. officinalis</em> Stem</td>
<td>1.248 ± 0.073</td>
</tr>
<tr>
<td>3</td>
<td>Polluted Water</td>
<td>ND</td>
</tr>
<tr>
<td>4</td>
<td>Polluted Soil</td>
<td>1.618 ± 0.00</td>
</tr>
</tbody>
</table>

[ND means less than 0.01 ppm]
lungs and kidneys and may be fatal. From studies it is confirm that *Avicennia officinalis* shows accumulation of Zn, Cu, Pb and Cd. The estimate of Zn indicated exceeding level of content when compared with MLRL (Maximum Level Recommended for Livestock) limit but rest of heavy metals Cu, Pb, As and Cd estimated below the MLRL. The level of metal concentrations indicates the risk of food chain contamination in the studied area for Zinc metal.

**Conclusions**

From the above study it is concluded that *Avicennia officinalis* stem accumulates Zinc above the permissible level and tolerate Pb. Soil also indicate accumulation of Cu and Pb heavy metals but below the MLRL level. Cd was observed in very less quantity below MLRL, that means studied area indicate the pollution of heavy metal. Copper, Lead and Cadmium in very less concentration. Study indicated no presence of Arsenic in any sample. From the results it is concluded that the mangrove indicate pollution of Zn only and not all other heavy metals above the MLRL. The concentrations Cu, Pb, As and Cd metals appear under permissible limit as per MLRL but Zn appears above the MLRL alarming for studied area.

**Acknowledgement**

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**Abbreviations**

- Zn - Zinc
- Cu - Copper
- Pb - Lead
- Cd - Cadmium
- As - Arsenic
- Hb - Haemoglobin
- MLRL - Maximum Level Recommended for Livestoc

**Bibliography**


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