HEAVY METALS ASSESSMENT IN MUNICIPAL SOLID WASTE DUMPSITE, MYSORE, KARNATAKA, INDIA

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ABSTRACT

Unorganized segregation and unorganized dumping of solid waste is an important factor in developing countries like India and causes adverse impacts on the environment. Materials such as old batteries, electronic goods, painting waste etc., when dumped without the separation of hazardous waste at source can increase toxic effects on environment. The present study is an attempt to study the trace metal contents present in fine fraction of municipal solid waste collected from different piles of Mysore city. Heavy metals concentration of these samples was compared with the standards prescribed limits of Central Pollution Control Board for compost. The levels of heavy metals were measured at two points with different distances and directions from dumpsite in Mysore. The results indicated a steady decrease in the concentrations of Cd, Cu, Pb, Cr and Hg in the second point.

Keywords: SEM, XRD, AAS, Mysore, Characterization, Composition, Solid waste.

1.0 INTRODUCTION

Modern civilization is completely dependent on a large range of metals for all aspect of daily life. There is a long history association between metals and human development. Heavy metal pollution not only affects the production and quality of crops, but also influences the quality of the atmosphere, water bodies, and threatens the health, life of animals and human being (Marzieh, 2010). Heavy metals are environmentally problematic substances due to their high persistence and toxic effects (Hellweg et al., 2001 and Esakku et al. 2003). Landfills accumulate large amounts of heavy metals and therefore contribute greatly to this risk potential (Hellweg et al., 2001))

Municipal solid waste (MSW) is the waste, which is most commonly used in composting. It is an extremely heterogeneous material in its geometry, particle size and chemical composition
It may, moreover, contain high concentrations of Pb, Cu, Cd, and Zn, as has been shown by several studies (Flyhammar, P. (1998)) Consequently, subsequent application of MSW composts rich in heavy metals to agricultural soils may cause heavy metals accumulation to toxic levels (King, L.D et al., (1990) ; Veeken, A et al., (2002) ). When the compost from MSW is used as manure some heavy metals are being subject to bioaccumulation and may cause risk to human health when transferred to the food chain. Exposure of heavy metals may cause blood and bone disorders, kidney damage and decreased mental capacity and neurological damage. Therefore, heavy metal needs serious attention before the application of compost made from MSW. In certain cases the metal contents exceed the specified limits (Merian,1991). The occurrence of cadmium, cobalt, manganese, nickel, lead and zinc in MSW compost was reported by Ciba et al., (1999).

Heavy metals caused serious problems to the human quantities directly affect the flora, fauna as well as human and animal health by accumulation particularly in kidney population and liver. Different kind of heavy metals have caused the heavy metals disorder in human body.

2.0 MATERIALS AND METHODS

Mysore is the second largest city in Karnataka after Bangalore. Mysore was the capital of Mysore state until 1956, when the capital was shifted from Mysore to Bangalore. Mysore is spread over an area of about 128 sq. km with the growing population at faster rate due to influx of many service industry activities, the generation of municipal waste both garbage and sewage has been on the rise. Anthropogenic activities in society generate large quantities of wastes posing a problem for their disposal. Improper disposal leads to spreading of diseases and unhygienic condition besides spoiling the aesthetics. The city has several major and small industries present in Nanjangud 20 Km away from the Mysore city together with many educational and commercial establishments. In India, every year 30.3 million tons of Municipal solid waste is generated. This equate to about 350 gms of waste per person on average.

Municipal solid waste samples were collected from Municipal solid waste composting site, Vidyaranyapuram, Mysore. The study has been carried out in two parts that is pile A and pile B. Municipal solid waste samples from windrow platform is considered as pile A. In pile B the final material from the composting yard that is compost were taken. Samples were first dried at 105º C in hot air oven, crushed well and sieved through 0.2 mm mesh. The powdered samples were then used for further analysis and spectral characterization.

2.1 Heavy metal analysis

For estimation of Heavy metals Triacid mixture method was used. The sample were kept for 30min in hot plate and finally cooled to room temperature (Nitric acid: Sulphuric acid: Perchloric acid in 9:2:1 ratio) extract of the compost sample was used for AAS.

2.2 X-Ray Diffraction method

It is a tool used for determining the atomic and molecular structure of a crystal, in which the crystalline atoms cause a beam of X-rays to diffract into many specific directions. The overall structural changes during the decomposition can be studied using X-Ray Diffraction method. By measuring the angles and intensities of these diffracted beams, a crystallographer can produce a three-dimensional picture of the density of electrons within the crystal. From this electron density, the mean positions of the atoms in the crystal can be determined, as well as their chemical bonds, their disorder and various other information. Samples were ground to fine powder and spectra were recorded on RIGAKU Miniflex-II XRD Instrument.
2.3 Scanning Electron Microscope

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. Carl Zeiss, EVO 15-15-41, version 5.05 instrument was used.

3.0 RESULTS AND DISCUSSIONS

3.1 Heavy metals analysis

Various heavy metal concentrations for the composting samples from pile A and B are listed in Table 1 and 2.

Table 3.1: The heavy metal concentrations for the samples from Pile A

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Heavy metals</th>
<th>Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cadmium</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>Copper</td>
<td>4.322</td>
</tr>
<tr>
<td>3</td>
<td>Lead</td>
<td>0.578</td>
</tr>
<tr>
<td>4</td>
<td>Chromium</td>
<td>0.769</td>
</tr>
<tr>
<td>5</td>
<td>Mercury</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Sample from pile A were rich in copper content compared to other heavy metals. Metals such as Chromium and lead were found at lower concentrations whereas cadmium and mercury concentration was found to be 0.001 mg/L.

Table 3.2: The heavy metal concentrations for the samples from Pile B

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Heavy metals</th>
<th>Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cadmium</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>2</td>
<td>Copper</td>
<td>1.158</td>
</tr>
<tr>
<td>3</td>
<td>Lead</td>
<td>0.257</td>
</tr>
<tr>
<td>4</td>
<td>Chromium</td>
<td>0.315</td>
</tr>
<tr>
<td>5</td>
<td>Mercury</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Heavy metal concentrations have been decreased in pile B due to of composting process which is undergone for 30 days. This was due to release of metal ions from larger solid wastes materials during the decomposition and further decrease was due to leaching of metal ions by water.
3.2 X-Ray Diffraction analysis

X-Ray diffraction spectra of composting samples from pile A and B shown in fig 3.2 and 3.3. Each signal in XRD represents the plane of a crystal. The number of peaks got reduced in sample at pile B compared to that of pile A. From the overall data obtained from the X-Ray Diffraction spectra it is clear that particle size decreasing during the degradation of solid waste.

![Fig 3.2: XRD spectra of sample at pile A](image)

![Fig 3.3: XRD spectra of sample at pile B](image)

3.3 Scanning Electron Microscopy (SEM)

![Fig 3.4: SEM image of sample at pile A](image)

![Fig 3.5: SEM image of sample at pile B](image)

The collected material was taken under the SEM without any treatment. The SEM images are shown as in above figure. Observing the SEM image of Fig 3.4, it can be seen that the material looks bit porous in nature. Also it is observed that the material looks more coiled and bit clustered on the surface may due to the presence of high amount of organic materials along with inorganic and heavy metals too that are found to be present. From fig 3.5, we can observe that the coiling of materials found to be cleared at the surface. This means due to decomposition of the material for certain period, the material takes another form with the surface cleared with organic decomposition along with leaching of the heavy metals, which is important to be noted that the result is supported by AAS spectroscopy results.
CONCLUSION

Concentration of the heavy metals at the earlier stage of sample and further decrease in concentration of heavy metals revealed that the decomposition of organic matter followed by the formation of stable products in addition to variation in the different parameters were observed during the degradation of municipal solid waste by aerobic composting. Degradation of complex molecules into smaller constituents was confirmed by X-ray Diffraction studies. Decreased concentration of heavy metals by the AAS analysis at pile B has been observed clearly. From the above study it is clearly indicating the structural changes taken place during the composting phenomena.

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