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# Effect of Pre-thermocomposting on Decrease of Cadmium and Lead Pollution in Vermicomposting of Municipal Solid Waste by *Eisenia fetida*

*S. Ghyasvand, H.A. Alikhani, M.M. Ardalan, G.R. Savaghebi and S. Hatami*

Soil Science Department, Faculty of Soil and Water, Tehran University, Karaj, Iran

**Abstract:** Vermicomposting of organic waste has an important part to play in an integrated waste management strategy. In this study effect of thermocomposting as a useful pre-treatment on decrease of Lead and Cadmium pollution of municipal solid waste by vermicomposting was investigated. *Eisenia fetida* as a useful specious was used for vermicompost production and different duration of pre-thermocomposting of raw materials was selected as treatments. The results indicated that pre-thermocomposting for at least 240 hours had significant effect on decrease of Lead and Cadmium in final manure as a vermicompost of municipal solid waste.

**Key words:** Thermocomposting % *Eisenia fetida* % Vermicompost % Municipal solid waste

## INTRODUCTION

Municipal solid wastes that produced in cities are big problem and there are different methods to manipulate this problem. Every method has its restriction in addition to its efficiency. Vermicomposting is a new and useful technology that recently used for recycling the organic part of these wastes. Vermicomposting is the usual method that managed by earthworms and in addition to decomposing of organic waste [1], the availability of heavy metals like Pb and Cd decrease due to Bioaccumulation of these metals and organo-complex formation during this process [2,3]. For increasing the efficiency of this method different pre-treatment used. One of the useful pre-treatment that used and recently its efficiency has been proved is thermocomposting [4].

Thermocomposting is the first stage of composting, because the heat of waste pile due to rapid decomposition of simple hydrocarbon materials increases, the thermo prefix is added to the title of this process [5]. This is the most active phase in compost process and different changes occur in it. Changes in heat, acidity, humidity and biological and pathogen community are occurred in thermocomposting [4]. Becuse of this changes that with good management can be conducted to decrease in C:N ratio, pathogen community, High humidity of fresh wastes and neutralising of acidity Thermocomposting has useful effects on vermicomposting based on better condition for earthworms activity, reproduction and their nutrition that conducts to their biomass increase, different studies by many researches have proved this fact [6]. In this study according to the effect of thermocomposting on vermicompost process, different duration of this pre-treatment on decrease of Pb and Cd pollution was investigated. The objective of the study included the relationship between different duration of mentioned pre-treatment of raw materials and decrease of final vermicompost Lead and Cadmium availability. In order to achieve this objective *E.fetida* was used for vermicompost production and municipal solid wastes of Tehran city after different duration of thermocomposting pre-treatment was used as raw materials for recycling of these valuble wastes by vermicomposting.

## MATERIALS AND METHODS

**Preparation of the Pilot:** This study was conducted during the period from January to April 2007.The organic wastes used in this study was obtained from the Arad Kooh organization (organic waste recycling organization) located in south of Tehran city. The treatments were selected based on different duration of pre-thermocomposting from 3 till 24 days and samples were selected at 7-day intervals during this period. Treatments are as follow, 3-day pre-treatment (I), 10-day one (II), 17-day one (III), 24-day one (V). In order to prepare homogen raw materials sufficient sampling and subsampling operation were done and essential

**Corresponding Author:** S. Ghyasvand, Department of Soil Science, Faculty of Agriculture, University of Tehran, Karaj, Iran

parameters as homogeneity indexes were measured. The ratio of organic waste used was 1.4 kg of 80% moisture content mixed with 600 g Cow dung of 5% moisture content to provide a suitable C: N ratio and microorganism inoculation. The vermicompost experiments were performed in plastic

Worm-bins of 20, 14.5×14.5×3.14 $cm^2$, 23 cm that are lower diameter, upper diameter and height respectively, this plastic bins provided 23cm of exposed top surfaces. Iranian *E.fetida* was used in this study. These worms were collected in vermicompost station located in Karaj country, Tehran province. One hundred pieces of adult Iranian *E.fetida* with approximate weight of 0.4 to 0.5 grams were used in plastic worm bins. The characteristics of adult Iranian *E.fetida* were the same. The experiments lasted three months. The moisture content of the vermicompost samples was determined by over drying in 105EC to a constant weight. The ambient temperature and the plastic bins were measured by thermometer. The moisture content of the mixture was maintained at 60 to 70% throughout the vermicompost period and the temperature in plastic bins were kept in the dark at 20-30EC. The number of worms was manually checked and recorded. After three monthes the composit samples were taken from three different points in each bin to be analyzed for heavy metals availability.

**Heavy Metals Analysis:** Samples, devoid of any worms, analyzed under moist conditions for bio-available Cd and Pb by following the diethylenetriaminepentaacetic acid (DTPA) extraction method of Lindsay and Norvel [7]. In this method 1.967 g of DTPA and 1.470 g $CaCl_2.2Ho_2$ were taken in a beaker. To this, 20-25 ml of double distilled water (DDW) was added and thereafter 13.3 ml of triethyl acetate (TEA) followed by 100 ml of DDW were also added. Then, the volume was made up to 1 l. This solution was adjusted to pH 7.3 and was used for extracting this two metals remaining in bio-available forms. Estimation of these elements was carried out with the help an atomic absorption spectrophotometer.

**Statistical Anslysis:** All the reported results were expressed as mean of three replicates and all data were analyzed using MSTATC statistical analysis. Comparisons of the means were made using Duncans multiple range test ($P<0.05$).

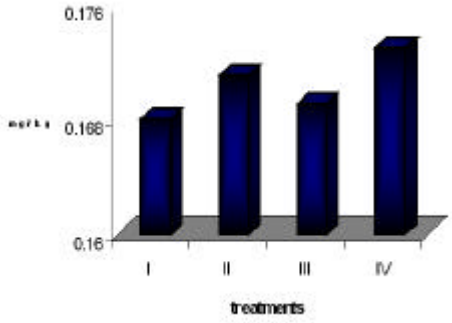


Fig. 1: Cd concentration of final vermicomposts treatments (mg kgG[1])

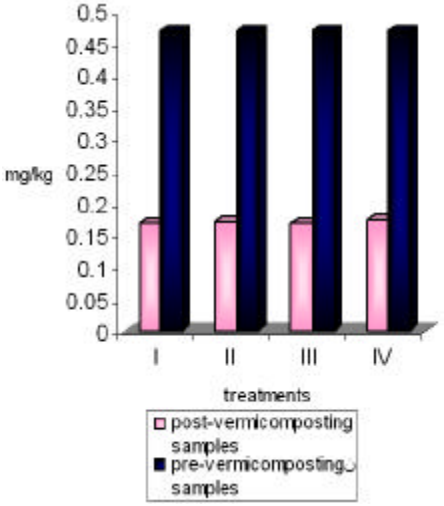


Fig. 2: Cd concentration of pre and post-vermicompost treatments

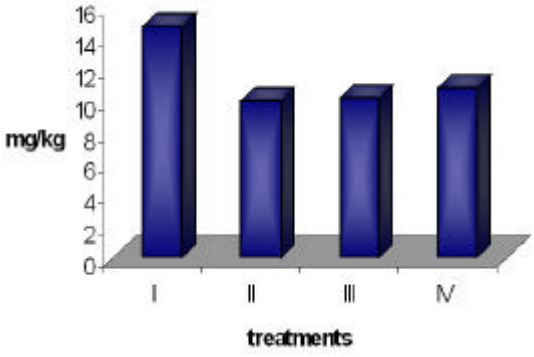


Fig. 3: Pb concentration of final vermicomposts treatments (mg kgG[1])

## RESULTS

The ambient temperature and that of the plastic bins varied from 15 to 21 and 17 to 22EC, respectively. The moisture content in plastic bins of vermicompost varied between 65 to 78% and the pH ranged from 7.1 to 7.3. A temperature range of 0-35EC, a moisture range of 60-90% and a pH range of 5-9 were utilized as suitable conditions for the growth of *E. fetida* [8]. Thus, favorable growth conditions were provided in this study. The results of

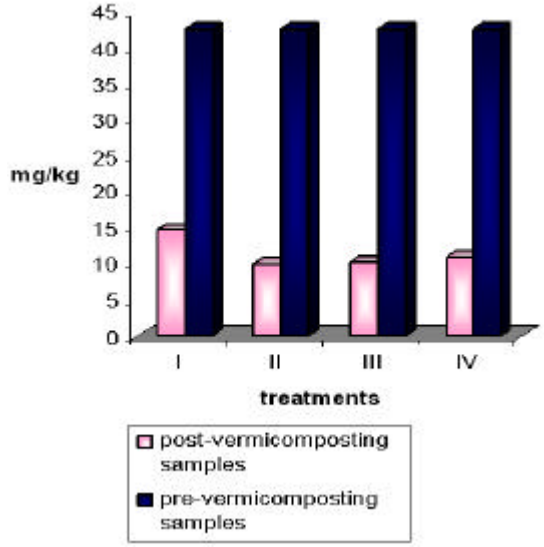


Fig. 4: Pb concentration of pre- and post-vermicompost treatments

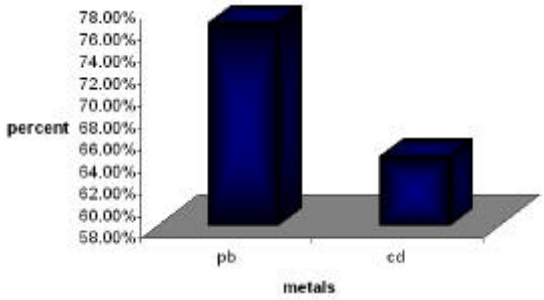


Fig. 5: Camprison in decrease of Cd and Pb bioavailability

Cadmium and Lead bioavailable concentration and their bioavailability in pre- and post-vermicompost samples are showed in Fig. 1 to 4. The comparison of Cd and Pb bioavailability decrease is showed in Fig. 5.

## DISCUSSION

According to Fig. 1 no significant difference was seen between treatments ($P<0.05$) it can be related to little amount of Cd in raw waste materials. The concentration of bio-available Cd in post-vermicompost samples decreased significantly as compared to pre-vermicompost ones ($P<0.01$) as showed in Fig. 2, its because of bioaccumulation of Cd in earthworm tissues and organo-complex formation of this metal in cast of earthworms [3,9]. According to Fig. 3 concentration of Pb decreased significantly in treatments II, III and IV as compared to treatment I ($P<0.05$). It can be due to intensity of vermicompost process in these treatments because of pre-treatment effects [4]. The concentration of bio-available Pb decreased significantly as compared with its bio-available concentration in raw waste material, its reason is as what mentioned for Cd. According to Fig. 5, bioavailability of Pb decreased more as compared to Cd and this can be due to more amount of bio-available Pb in raw waste materials.

## CONCLUSION

At least 10-day thermocomposting as useful pre-treatment increased earthworms' biomass and number significantly and hence intensified vermicompost process and decreased Pb bioavailability significantly. Little amount of Cd in raw waste materials restricted the effect of pre-thermocomposting.

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