

Research Article

Heavy Metal Accumulation by Earthworm *Eudriluseugeniae* in Distillery Solid Waste and Other Carbonaceous Waste Using Vermicomposting

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Citation: Moorthi M, Nagarajan K, Senthil kumar A (2017) Heavy Metal Accumulation by Earthworm *Eudriluseugeniae* in Distillery Solid Waste and Other Carbonaceous Waste Using Vermicomposting. J Earth Environ Sci: JEES-131. DOI: 10.29011/JEES-131.100031

Received Date: 16 July, 2017; **Accepted Date:** 28 August, 2017; **Published Date:** 07 September, 2017

Abstract

Vermicomposting is proper a more acceptable and reasonable method for treating distillery solid waste and other carbonaceous waste. The relevance of vermicompost created by on top of solid waste material to soil can be used as agriculture soil fertilizer its due to presence of nitrogen, phosphorus, potassium and other nutrients. Conversely, presence of heavy metals in the form of compost and vermicompost restricts its use as soil condition. In this study, the possibility of heavy metal (Cadmium, Nickel, Lead, Zinc and Iron) accumulation by earthworm *Eudriluseugeniae* in Distillery solid waste and other carbonaceous waste was investigated on end of the vermicomposting (45th days). Composting there were prepared of different ratio, the ratio was Distillery solid waste and Cow dung (60: 40; 70: 30 and 80: 20) followed by other carbonaceous waste such as water hyacinth, sugar cane trash and tea leaf residue. Analysis of heavy metals by Atomic Absorption Spectroscopy (AAS) in end of the vermicompost result showed a slowly declined of heavy metal in all the ratios with compare to compost. Vermicompost is really effective organic fertilizer which can be used in sustainable agriculture practice.

Keywords: Carbonaceous and Earthworm; Distillery Solid Waste

Introduction

The human society is dependent upon agriculture for the fundamental needs like food, clothing and shelter [1]. Due to intensive farming system, the depletion of soil nutrients occur to a greater degree which in turn creates an imbalance in nutrient availabilities, loss of soil fertility and drastic reduction of crop production. Nowadays, organic waste management and recycling processes become more essential towards fulfilling partial requirement of plant nutrients and sustainable soil health through enhancing the physico-chemical properties and the microbial diversity. In addition, a steady rise in fertilizer prices and increase in farm energy costs make farmers worry and these have necessitated organic waste recycling through eco-friendly technologies in agriculture for sustainable agriculture. Distillery industry is one which produces enormous quantity of liquid and solid wastes that can be a great source of energy for recycling through green technologies. This not only proved to be manure but also to a certain extent

a solution to the problem of pollution [2]. According to the Indian Directorate of Economics and Statistics, India produces an average of 270 million tons of sugarcane per year. In India, sugar industries occupy the most important processing industry among others.

During the production of sugar the wastes in the form of sludge and effluents represent an important environmental problem in many parts of the world [3]. These wastes can be efficiently utilized for our agricultural processes in a way, which is mixing the distillery wastes with a few carbonaceous wastes. Eventually the mixture can be converted into a manure which helps agriculture to some extent, instead of letting these wastes into the soil or water which leads to environmental pollution and sometimes cause serious health problems to the mankind [4]. Disposal of solid waste can be done by many methods like land filling, incineration, pyrolysis, recycling, conversion to biogas and composting.

In terms of both organic waste management and environmental protection, vermicomposting can be the most suitable method. In general, composting is the most widely applicable process of handling biodegradable organic wastes, which provides a way not

only of reducing the amount of waste that needs to be disposed of, but also paves way to convert it into a product that is useful for agriculture. As a natural process, composting has many advantages. It is an effective and environmentally acceptable method for organic waste disposal which helps to recycle valuable nutrients to soil and plant systems. Appropriate techniques of composting organic wastes with suitable additives can greatly improve bio-fertilizer value of manures and at the same time it accomplishes protection of the agriculture environment [5].

Vermicompost, a by-product of earthworm mediated organic waste re-cycling, is rich in plant nutrients and growth promoting substances and it is considered as an inseparable component of sustainable farming [6,7]. Several factors, such as soil, temperature, substrate moisture, waste substrate, besides stocking rate of earthworm density influence extend of success of vermicomposting processes. Present study the heavy metal accumulation by earthworm *Eudriluseugeniae* in distillery solid waste and other carbonaceous waste using vermicomposting

Materials and Methods

Collection and characterization of distillery sludge

The distillery sludge required for composting and vermin composting was collected from a distillery industry located in Erode District, Tamil Nadu, and South India. The sludge was shadow dried before composting. A small quantity of dried sludge was ground well and sieved before it was subjected to physico-chemical characterization.

Collection and characterization of carbonaceous wastes

Carbonaceous wastes selected were Cow dung, Water hyacinth, Sugarcane trash and Tea leaf residue otherwise called spent tea powder. Fresh cow dung was collected from the cattle shed and it was dried. A small portion of dried cowdung was powdered and subjected to physico-chemical characterization. Water hyacinth was collected from the banks of river Cauvery and were cut into small pieces and dried. About 1 kg of water hyacinth was taken and dried in a hot air oven at 70°C for 24 hours.

The dried hyacinth was powdered and subjected to chemical characterization. Sugarcane trash was collected from nearby sugarcane field. 1 kg of the sample was initially washed in running water followed by in distilled water and dried at 60°C in a hot air oven. The dried sugarcane trash was powdered for characterizing physico-chemical parameters. Tea leaf residue was collected from a tea shop nearer to the study area. From the sampled material, 500g of tea leaf residue was taken and rinsed several times with distilled water to ensure complete removal of soluble and colored compounds. It was dried in a hot air oven at 60°C for 24 hours. The dried tea leaf residue was ground well and sieved. This finely powdered material was used for the chemical characterization.

Composting

Composting is the process of transforming organic material of plant or animal origin into humus. The carbonaceous wastes such as cowdung, water hyacinth, and sugarcane trash and tea leaf residue were mixed in various ratios with distillery sludge. Composting was done by heaping method [8]. The distillery sludge and the carbonaceous wastes were spread as alternate layer. The final quantity of compost was 20kg.

Compost IA - 60% Distillery sludge + 40% Cow dung

Compost IB - 70% Distillery sludge + 30% Cow dung

Compost IC - 80% Distillery sludge + 20% Cow dung

Compost IIA - 60% Distillery sludge + 40% Water hyacinth

Compost IIB - 70% Distillery sludge + 30% Water hyacinth

Compost IIC - 80% Distillery sludge + 20% Water hyacinth

Compost IIIA - 60% Distillery sludge + 40% Sugarcane trash

Compost IIIB - 70% Distillery sludge + 30% Sugarcane trash

Compost IIIC - 80% Distillery sludge + 20% Sugarcane trash

Compost IVA - 60% Distillery sludge + 40% Tea leaf residue

Compost IVB - 70% Distillery sludge + 30% Tea leaf residue

Compost IVC - 80% Distillery sludge + 20% Tea leaf residue

There were about three main phases during the process of composting, the heating phase or thermophilic phase, the cooling phase and the maturation phase.

Preparation of vermibed

Rectangular wooden containers of 80 cm height, 40cm length and 25cm width with sufficient number of perforations to ensure better aeration. About 25 young clitellated earthworms, weighing 500-550mg were introduced in the vermibed. *Eudriluseugeniae* being an epigeic form, it came up over the surface only for feeding and spent the remaining time under the soil. So that vermibeds were designed to feel at home by placing small twigs at the bottom of the container and red soil over it upto 10cm.

The moisture level of the containers was maintained around 65-70% throughout the study by sprinkling water. All containers were incubated in a humid and dark place at room temperature. This vermibed were kept undisturbed and allowed to produce vermicasts. The vermicomposts were collected, they were shadow dried, ground and sieved. The vermicompost were tested for the following parameters. Total Cadmium, Total Nickel, Total Lead, Total Zinc and Total Iron were analyzed using atomic absorption Spectrophotometer [9]. Two-Way Analysis of Variance (ANOVA) was computed using SPSS (version No.10) to test the level of sig-

nificance of difference between various composts and vermicomposts with respect to nutrient parameters.

Results and Discussion

Compost and Vermicompost

Heavy metals Cd, Ni, Ld, Zi and Fe in the composts were analyzed and are presented in (Table 1). The amount of heavy metals in the compost depended on the final characterization of the distillery sludge and carbonaceous wastes. The combination with water hyacinth showed higher heavy metal concentrations than other carbonaceous waste like cowdung, sugarcane trash and tea leaf residue. However, a small reduction of all the heavy metals was observed in the end of the day's vermicompost in comparison to compost (Table 2).

Parameters	Distillery sludge with Cowdung (ppm)			Distillery sludge with Water hyacinth (ppm)			Distillery sludge with Sugar-cane trash (ppm)			Distillery sludge with Tea leaf residues (ppm)			P-Value
	IA 60:40	IB 70:30	IC 80:20	IIA 60:40	IIB 70:30	IIC 80:20	IIIA 60:40	IIIB 70:30	IIIC 80:20	IVA 60:40	IVB 70:30	IVC 80:20	
Cd	0.160	0.163	0.164	1.248	1.303	1.285	0.161	0.167	0.169	0.181	0.184	0.190	0.998**
Ni	0.712	0.721	0.729	2.121	2.194	2.386	0.394	0.410	0.424	0.291	0.296	0.298	0.991**
Pb	0.144	0.147	0.150	1.866	1.892	1.931	0.149	0.152	0.158	0.156	0.158	0.159	0.993**
Zn	0.511	0.521	0.536	2.211	2.302	2.326	0.221	0.231	0.248	0.316	0.326	0.328	0.997**
Fe	1.942	1.952	1.957	2.244	2.256	2.261	1.952	1.956	1.981	2.371	2.375	2.459	0.996**
** Insignificant (p>0.05) * Significant (P<0.05)													

Table 1: Heavy metals (ppm) in different combinations of compost.

Parameters	Distillery sludge with Cowdung (ppm)			Distillery sludge with Water hyacinth (ppm)			Distillery sludge with Sugar-cane trash (ppm)			Distillery sludge with Tea leaf residues (ppm)			P-Value
	IA 60:40	IB 70:30	IC 80:20	IIA 60:40	IIB 70:30	IIC 80:20	IIIA 60:40	IIIB 70:30	IIIC 80:20	IVA 60:40	IVB 70:30	IVC 80:20	
Cd	0.102	0.107	0.108	1.152	1.210	1.230	0.150	0.161	0.166	0.132	0.139	0.142	0.997**
Ni	0.616	0.619	0.630	1.230	1.401	1.492	0.224	0.290	0.295	0.138	0.144	0.149	0.993**
Pd	0.112	0.121	0.127	1.235	1.241	1.259	0.119	0.126	0.131	0.143	0.137	0.139	0.999**
Zn	0.325	0.338	0.344	1.908	1.910	1.928	0.015	0.022	0.025	0.065	0.069	0.077	0.703**
Fe	1.840	1.875	1.876	1.916	1.919	1.924	1.815	1.819	1.859	1.146	1.148	1.156	0.995**
** Insignificant (p>0.05) * Significant (P<0.05)													

Table 2: Heavy metals (ppm) in different combinations of vermicompost.

Vermicompost contains lower level of all the heavy metals than in compost. A comparison of the results showed that heavy metal content in the vermicomposts was slightly lesser than in the composts. The decrease in heavy metal concentration could be related to leaching of the cations by excess water drainage [10], or accumulation by the earthworm.

The decrease in the metal concentration was attributed to the accumulation of metals in the body of the earthworm. Suthar and Singh [11] reported considerable amounts of metals in tissues of earthworms inoculated in distillery sludge for long periods. They correlated the metal loss from substrate with the metal level in earthworm tissues. Kaushik and Garg [12,13] have reported slightly lower heavy metal concentrations in the final product. They ex-

plained, the decrease in heavy metal concentrations could be related to leaching of these cations by excess water drainage.

Conclusion

Heavy metals like Cd, Ni, Ld, Zi and Fe were decreased from their initial day of compost measure up to vermicomposting. The composting process, the metals content can be declined by microbial organism. The microorganism could be very useful to improve the composting development by enhancing enzymatic activity and quality level of the compost is suitable, with very low heavy metal content. During the vermicomposting earthworm can accumulate the high concentration of heavy metals in the non-toxic forms and capable be reducing possible toxic effects of unessen-

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tial heavy metals by utilizing them for physiological metabolism. Vermicomposting that has the potential to reduce the organic waste management and this is future prospects and economy on the use of organic fertilizers in the agricultural sector.

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