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Management of Municipal sewage sludge by vermicomposting technique

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Abstract: Study was carried out to dispose the **Municipal sewage sludge** biologically using ***Eisenia fetida* (Lumbricidae)** earthworms. The Sewage sludge in various concentration 5%, 10%, 20%, 30% and 50% mixed with *Eichhornia crassipes* a **water hyacinth** (chopped pieces of fresh plants) were subjected to vermitub treatment for a period of 60 days. During the period of study data were collected on reproductive strategies of earthworms and chemical analysis of wastes before and after treatment. Results obtained indicate that 20% concentration of sludge mixed with *Eichhornia crassipes* was ideal for *Eisenia foetida.* This study offers a simple and economical alternative through vermicomposting to resolve the management of sewage sludge.
Keywords: Sewage sludge; *Eichhornia crassipes*; Heavy metals; Bioaccumulation;*Eisenia fetida (Lumbricidae);* vermicompost.

Introduction

Earthworms belonging to Phylum Annelida, Class Chaetopoda, and Order Oligochaeta occupy a unique position in animal kingdom[8]. They are the first group of multicellular, eucoelomate invertebrates who have succeeded to inhabit terrestrial environment. They form major soil macrofauna. Their species richness, abundance, and distribution pattern reflect on edaphic and climatic factors of the geographical zone. They serve as bio indicators to understand the physicochemical characteristics of their habitat. Distinctive habitat, food niches, and adaptive mechanisms of earthworms have opened up new fields for investigations on their role in organic waste management. One of the advantageous factors in this field is the use of earthworms to minimize the degradable organic matter and to use the same as bio resource for organic manure production. The manure produced serves as good source of soil amendment. The ecologically distinguished epigeic earthworms are used for producing the organic manure, "vermicompost". This has gained attention of garden lovers, agriculturists, and agro industries to convert organic matter generated at different levels into rich, odourless, free flowing compost to support sustainable agriculture. Earthworms form one of the major macrofauna among soil biota to maintain dynamic equilibrium and regulate soil fertility. Their existence depends on adequate moisture, soil texture, pH, electrolyte concentration, and food source in the given ecosystem. This clearly indicates the interdependency of the environmental factors to the survival of earthworms; when such conditions are created, they further contribute to soil fertility through their activity. Urbanisation brings prosperity but at the same time creates environmental problems like pollution, accumulation of solid waste and poor sanitation. Vermicomposting is an innovative technology for the treatment of wastewater sludge. The efficient potential of earthworms in bioaccumulation of heavy metals in their tissues serves as ecological indicator of soil contaminants. Water hyacinth, *Eichhornia*

crassipes, is a floating macrophyte whose appetite for nutrients and explosive growth rate has been put to use in cleaning up municipal and agriculture wastewater. It has been discovered that water hyacinth's quest for nutrients can be turned in a more useful direction.

Experimental

This study was conducted during the period from December 2009 to February 2010. The sludge used in this study was obtained from from Vidyaranyapuram decentralised effluent treatment plant, Mysore. Fresh plants of *Eichhornia crassipes* was collected from Kukarahalli lake Mysore, rinsed with water and chopped into pieces. The vermicompost experiments were performed in five plastic Bins provided with tight-fitting lid, drainage holes in bottom and air vents on top and sides, the dimention of the bins were 20cm x 30cm x 10cm (length ×width ×depth). Moist drained bedding to worm bin is provided with strips of Newspaper. The sludge (5, 10, 20 ,30, 50%) with 65 % moisture was mixed with *Eichhornia crassipes* to provide a suitable C/N ratio . The mixture was composted for 30 days at 75°C to kill pathogenic microorganisms and decompose phytotoxic substances, and then sieved (<20-mm mesh) to remove large bark pieces and stored in swathes[2-5]. The swathes were mixed with *Eisenia fetida (Lumbricidae)* earthworms. 12 numbers of adult healthy *Eisenia fetida* earthworms with approximate weight of 0.9-1.1 grams, were placed in all vermicompost plastic bins . Moisture content in the plastic bins was maintained between 60-70 % during the study. The duration of study was 6 0 days. The ambient temperature and the plastic bins were measured by thermometer. The moisture content of the mixture was maintained at 60 to 70 percent throughout the vermicomposting period by adding water once a week and the temperature in plastic bins were kept in the dark at 20-30^{o}C. The composite samples were taken from each bin for the analysis of heavy metals. The number of worms was manually checked and recorded at the end of 10, 30 and 45 days. Processing of vermicompost was done by removing excreta after every ten days. Final vermicompost is made into heap with small amount of cowdung inside to remove earthworms from the compost . The vermicompost is sieved and spread in thin layer for air drying.

The heavy metal contents of the vermicompost were measured by taking one gram from different stages of the vermicomposting cycle. These samples were subjected to acid digestion, and then heated at 90 ^{0}C to reduce the concentration[1]. During digestion, care was taken to ensure that the samples did not dry out heavy metals were quantified in accordance with the official procedures.

Results and Discussion

Vermicomposting is a biodegradation system which stabilizes sludge and reduces its pathogenicity. The various combinations of sewage sludge and water hyacinth was used as organic waste for the process of vermicomposting. *Eisenia fetida* (epigeic species of earthworms) were inoculated in all the tanks with vermitechnology setting. Mean while the vermiculture plastic bins were sprinkled with water on weekly basis to maintain moisture[6] . The results of heavy metals (Cr, Pb, and Zn) contents for *Eisenia fetida* earthworms, pre- and post-vermicompost samples are summarized in Table-1. The proportion of 20% sewage sludge and water hyacinth for culturing of earthworms has shown highest number of cocoons and earthworm population. There was significant weight gain with 20% sewage sludge.

Conclusion

It is possible to transform the sludge of biologically infectious waste into a biosolids that could be used in agriculture. The survival percentage, biomass production and reproduction of earthworms are the best indicators to evaluate the vermiculturing process. In this study distinct variation in earthworm biomass and cocoon production rate with different treatments was observed and it is related to high level toxicity of sewage sludge heavy metals[7].

Table 1 Growth parameters of *Eisenia fetida* earthworms cultured on various proportions of sewage sludge mixed with *Eichhornia crassipes*

Sl. No.	Duration	Sewage sludge (%)	No. of earthworms	No. of Cocoons/kg	Wt. of earthworms (gm)
	0 days		12		0.9-1.1
1	**after 10**	5	12	16	0.9
2		10	12	17	1.1
3		20	12	19	1.3
4		30	12	18	1.0
5		50	12	18	0.9
6	**after 30**	5	21	35	16.0
7		10	28	36	20.5
8		20	30	39	24.5
9		30	16	19	4.6
10		50	14	23	5.5
11	**after 45**	5	102	21	16.5
12		10	113	18	20.5
13		20	120	17	25.6
14		30	10	-	5.8
15		50	8	-	6.2

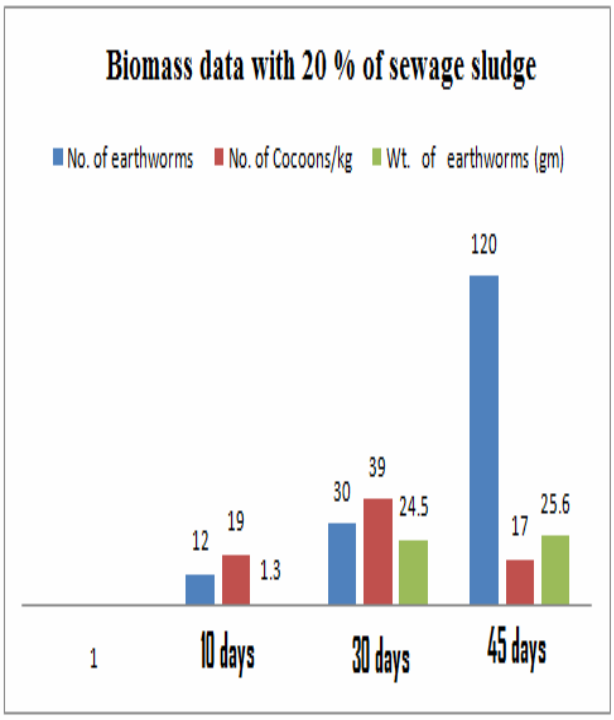


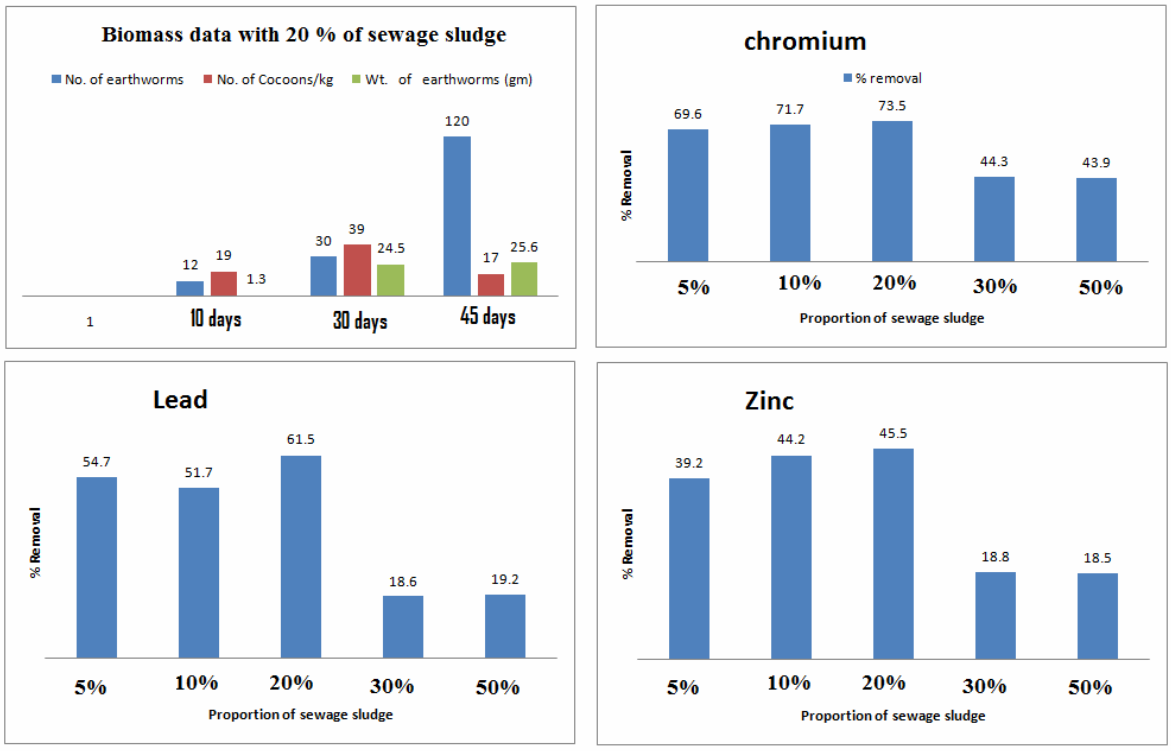
Table-2 Concentration of Cr, Pb, and Zn(mg/kg) in vermicompost produced by *Eisenia foetida* earthwoems using various proportions of sewage sludge

Time (day)	Cr (mg/kg)					Pb (mg/kg)					Zn (mg/kg)				
	Sewage Sludge (%)														
	5	**10**	**20**	**30**	**50**	**5**	**10**	**20**	**30**	**50**	**5**	**10**	**20**	**30**	**50**
0	112	120	128	140	155	190	203	210	220	245	289	312	325	340	356
10	102	105	107	120	122	177	180	186	200	234	256	300	300	327	340
20	97	98	99	103	115	164	176	182	199	220	148	249	279	300	300
30	74	78	82	98	97	140	154	175	190	211	98	215	253	288	294
40	43	46	44	90	94	100	123	163	188	199	83	204	225	282	291
60	34	34	39	78	87	86	98	122	179	198	76	174	182	276	290
% remov	69.6	71.7	69.5	44.3	43.9	54.7	51.7	41.9	18.6	19.2	73.7	44.2	44.0	18.8	18.5

Table-3 Nutrient status of vermicompost with 20% sewage sludge and hyacinth

Parameters	Values
Organic Carbon	17.98 %
Total Nitrogen	1.5 %
Available Phosphorus	1.2
Available Potassium	1.1
Calcium mg/kg	49
Chromium mg/kg	78
Zinc	122
Sulphur mg/kg	340
Lead mg/kg	182.9

Figure-growth parameters and percentage removal of heavy metals in vermicompost



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