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RESEARCH ARTICLE OPEN ACCESS

Stabilization of Sewage Sludge Using Cow Dung, Poultry Manure and Horse Dung by Vermicomposting

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ABSTRACT
Toxic concentrations of heavy metals have been reported to be present in STPs as many industries dispose their waste directly in domestic sewers without prior treatment and thus they are carried to the sludge generated during the treatment processes. This study used one such technique of vermi composting for stabilizing the toxic sludge. The work aimed at reducing the heavy metal content (Cr, Cd, Ni and Pb) from aerobic sewage sludge by the vermicomposting method using earthworm Eiseniafoetida with the different activators (Cow Dung, Poultry Manure and Horse Dung) at 50:50 proportion by mass for 105-day period. The results showed that both cow dung and poultry manure are commensurable for causing the decomposition of the sewage sludge and were better than horse dung. And for stabilizing the heavy metals, cow dung acted as the best activator. The lab analysis depicted high values of chromium which made it the main toxic element that needed removal. The study further showed that there are high heavy metal contents in the activator themselves which contribute to the high values in the pit material at the initial stages but still considering their stabilization effect they are added. The sewage sludge waste in case of heavy metals, cow dung acts as the best stabilization material.
Keywords: Sewage Sludge (S.S); vermicomposting; Cow Dung (C.D); Poultry Manure (P.M); Horse Dung (H.D)

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I. INTRODUCTION

Due to the consequences of climatic change on urban environment, it is very necessary to pay considerable attention. Significant load of sewage sludge is originated against the wastewater treatment plants. Disposition of sewage sludge precisely to soil and water bodies may acutely pollute land and water, by virtue of existence of hazardous matters, both organic and inorganic matter including heavy metals and pathogenic organisms. The sewage sludge odor is very unpleasant. It may influence the public health by causing respiratory problems and it may also cause death. Biosolid is favorable enough for the biological treatment essentially vermicomposting to attain the firm product. Animal manure, agricultural leftovers might be used along with sewage sludge for composting process to abstain possible risk and to amend organic matter biologically. The preferable biological operation is vermicomposting for the humification of organic matter just as cattle dung, sewage sludge, plant waste and metropolitan solid waste. Interaction between microorganism and earthworms to sustain the organic matter is termed as vermicomposting. Microorganisms primarily break down the organic matter, and are encouraged by the earthworms, through conversion of substrate properties i.e. feeding, aeration and cast excretion. The earthworms sustain aerobic condition in organic matter. It changes the organic matter into worm biomass and respiration products, and evacuates the leftover moderately sustained by-product. Research works on vermicomposting of sewage sludge have concentrated on the physical-chemical parameters, i.e. heavy metals and nutrients. This biological technique for the breaking down of sewage sludge is an eco-efficient, low cost, which exaggerates humification and stabilization. Vermicomposting fossilize most of all organic waste and commute the leftover material into stabilized humic-like materials. Additionally, the end product is used as plant nutrition and soil conditioner. Earthworms are very constitutive for the vermicomposting process so earthworms are added to stimulate the bio-stabilization process. For attaining excellent earthworms activities, organic materialsshould show chemical and physical properties, such as pH (6-7.5), moisture content (60-70%) and C/N ratio (around 25), at acceptablerange. The objectives of this study was to stabilize the aerobic sewage sludge by vermi-composting using cow dung, poultry manure and horse dung as activators, to analyze and compare the effect of particular

activators on the quality of final product and to monitor the heavy metal concentration removal during compost period.

II. MATERIALS AND METHODS

Vermi-composting is the wearing down of organic material along the utilization of worms and microorganisms. In nature, organic material is decomposed through these creatures. The vermi-composting of sewage sludge is done by means of the red worms as the agent of disintegration as well as poultry manure (P.M), horse dung(H.D) and cow dung(C.D) act as activator (within a convinced proportion along through the sludge).

2.1 Collection of raw material

The aerobic sewage sludge (S.S) was gathered from a sewage treatment palnt (STP) situated in Bhattian, Ludhiana. The sewage sludge was semi-solid, had a moisture content of 31.48 percent. The activators cow dung (C.D) and horse dung (H.D) were collected from the Gill village, and poultry manure (P.M) was collected from the JaspalBhangar poultry farm.

2.2 Formation of vermi-bed

Bed or pit arrangement wants a few detailed regions. A variety of parameters similar to quantity of untreated matter use in exact amount can be considered behind significantly the exact region only, also it help out the worms to get a scrupulous edge in this effort used for the method of vermicomposting. Three vermi-beds of size 3´×3´×0.5´ were finished on the material floor. There is no typical amount fot the compost beds, actual concrete blocks were located on the boundary of each vermi-bed. The altitude of the vermi-bed was reserved at 0.5 feet arrange to preserve the aerobic environment for worms to maintain.

2.3 Input of raw materials

The raw materials were introduced in the vermi-bed in the mixed form to allocate equivalent amount of nutrient level in the vermi-bed for the homogeneous vermi-activity. The sewage sludge as well as activators (cow dung, poultry manure and horse dung) were added in the vermi-beds in the ratio of 50:50 by mass on a trial basis. The amount of raw material of each category added in the pits is as follows:

- Pit 1 {Sewage Sludge (61kg) + Cow Dung (61kg) }
- Pit 2 {Sewage Sludge (47kg) + Poultry Manure (47kg) }
- Pit 3 {Sewage Sludge (52kg) + Horse Dung (52kg) }

2.4 Input of red worms

The worms which within our event were EiseniaFoetida, presented the raw materials on the topmost bed levels, they drain down after consuming the foremost layer. This type of worms was offered at the RDC complicated itself as the straightforward vermi-composting, therefore vermi-composting initiates from the levels on top of the part and actions downwards. Because the nutrients are eaten chances are they shift down until the underside coating thus creating top of the levels prepared for the utilization.

2.5 Lab analysis

- pH
- Moisture content
- Temperature
- Total Organic Carbon
- Nitrogen content
- Total phosphate
- Total potassium
- Heavy metals (Cr, Cd, Ni and Pb)

III. RESULTS AND DISCUSSION

During the vermicomposting of sewages sludge with different activators (Cow Dung, Poultry Manure and Horse Dung) impressive changes in the physico-chemical properties were shown. Irrespective of weather conditions the pH remained in the straight range of 6– 8 that matches the all earlier researches. Ammonia which casts an extensive portion of nitrogenous material secreted by earthworms may cause a temporary increase in pH. The pH However, as the decomposition ceased, the pH moved towards neutrality. Due to the occurrence of the red worms in the pit this factor was of less attention. The temperature was favored by the natural atmospheric conditions present in the surroundings and remained well within the survival range of Eiseniafoetida that is 20-35 degree celsius. It was also monitored at the working site. The reduction of carbon content is an indicator of enhanced decomposition as CO_2 is used as an energy source by earthworms. As CO_2 is used by the earthworms as a energy source, caused by net reduction of dry mass in terms of CO_2, nitrogen content during vermicomposting increases. Phosphate in the configuration of P_2O_5 is a significant nutrient content likely to be within the compost at least volume so as to increase the productivity of the soil. In vermicomposting, an apparent escalation in phosphate material was observed following the supplement of the worms that indicates the worms work as significant decomposers. Potassium is another large-scale nutrient directly after phosphates whose existence is necessary in the ultimate product. Like the former nutrient, their concentration also rises with time. However, the high level of heavy metals in sludge usually stops the reuse of sludge in agriculture. The toxicity of large materials and the risk of bioaccumulation in the foodstuff sequence signify an important environmental wellness

problem. Removing heavy metals from sludge before disposal or request to farmland is a required stage to accomplish a more secure sludge consumption or disposal.

Table 1: initial characteristics of raw materials

PARAMETERS / SAMPLE		SEWAGE SLUDGE (S.S)	COW DUNG (C.D)	POULTRY MANURE (P.M)	HORSE DUNG (H.D)
pH		6.6	6.2	6.5	6.8
Moisture Content		31.48	77	17.15	77.97
Total Nitrogen		2.802	1.218	1.121	4.203
Total Carbon		18.53	41.92	26.45	44.55
Total Phosphate		1.10	2	0.5	0.3
Total Potassium		1.57	1	0.8	0.6
Heavy Metals (mg/kg)	Chromium (Cr)	420.8	25	157.8	26.62
	Cadmium (Cd)	3.76	0.1	0.08	0.1
	Nickel (Ni)	45.5	6.12	3.46	2.74
	Lead (Pb)	12	2.6	6.6	4.2

Table 2: Nutrients value in the final compost

PARAMETERS / SAMPLE		SAMPLE 1 (S.S + C.D)	SAMPLE 2 (S.S + P.M)	SAMPLE 3 (S.S + H.D)
pH		7.13	7.07	7.24
Moisture content		66	66	68
Total carbon		21.1	20.6	19.2
Total nitrogen		5.36	4.88	5.94
Total phosphorus		2.95	1.42	1.52
Total potassium		2.76	2.42	1.95
Heavy metals (mg/kg)	Chromium (Cr)	27.9	112.6	56.3
	Cadmium (Cd)	0.58	1.35	1.6
	Nickel (Ni)	12.66	7.05	17.3
	Lead (Pb)	3.33	2.8	4.5

Table 3:pH results

DAY / SAMPLE	*0*	*15*	*30*	*45*	*60*	*75*	*90*	*105*
Sample 1 (S.S+C.D)	6.68	6.76	6.89	6.94	7.01	7.08	7.11	7.13
Sample 2 (S.S +P.M)	6.54	6.63	6.71	6.79	6.86	6.98	7.03	7.07
Sample 3 (S.S + H.D)	6.75	6.81	6.90	6.98	7.07	7.15	7.23	7.24
Standard	6.5-8.5							
Testing as per Point 1, Part- D, Schedule IV (Organic Fertilizers) of FCO (1985)								

Irrespective of weather conditions the pH remained in the straight range of 6– 8 that matches the all earlier researches. Ammonia which casts an extensive portion of nitrogenous material secreted by earthworms may cause a temporary increase in pH. The pH However, as the decomposition ceased, the pH moved towards neutrality.

Table 4: Moisture content (%)

DAY / SAMPLE	*0*	*15*	*30*	*45*	*60*	*75*	*90*	*105*
Sample 1 (S.S +C.D)	60	66	64	66	68	67	70	66
Sample 2 (S.S + P.M)	60	63	68	65	69	68	70	66
Sample 3 (S.S + H.D)	61	64	70	68	65	70	71	68
Standard	65-75							
Testing as per Organic Fertilizer of FCO Point 2, part-D, Schgedule IV								

Table 5: Total carbon content values (%)

DAY / SAMPLE	*0*	*15*	*30*	*45*	*60*	*75*	*90*	*105*
Sample 1 (S.S+C.D)	33.6	30.5	27	24.04	22	21.6	21	21.1
Sample 2 (S.S+P.M)	35.05	32	28	25.03	23.4	21.4	20.8	20.6
Sample 3 (S.S+H.D)	30.10	28	22.60	20.51	19.70	19.50	19.20	19.2
STANDARD	Min. 18							
Testing as per Organic Fertilizer of FCO (1985) Point 5, Part-D, Schedule IV								

The reduction of carbon content is an indicator of enhanced decomposition as CO_2 is used as an energy source by earthworms.

Table 6: Total Nitrogen content (%)

DAY / SAMPLE	0	15	30	45	60	75	90	105
Sample 1 (S.S+C.D)	1.68	2.91	3.75	4.45	4.81	5.18	5.3	5.36
Sample 2 (S.S+P.M)	1.4	2.66	3.51	4.14	4.54	4.75	4.83	4.88
Sample 3 (S.S+H.D)	2.8	3.96	4.75	5.33	5.70	5.85	5.91	5.94
STANDARD	Min. 1							
Testing as per Point 6, Part- D, Schedule IV (Organic Fertilizers) of FCO (1985)								

As CO_2 is used by the earthworms as a energy source, caused by net reduction of dry mass in terms of CO_2, nitrogen content during vermicomposting increases.

Table 7: Total Phosphorus Content (%)

DAY / SAMPLE	*0*	*15*	*30*	*45*	*60*	*75*	*90*	*105*
Sample 1 (S.S+C.D)	1.56	2.15	2.52	2.72	2.85	2.92	2.94	2.95
Sample 2 (S.S+P.M)	0.75	1.03	1.21	1.33	1.38	1.41	1.42	1.42
Sample 3 (S.S+H.D)	0.67	0.98	1.17	1.31	1.42	1.48	1.51	1.52
STANDARD	Min. 0.8							
Testing as per Organic Fertilizer of FCO (1985) Point 8, Part-D, Schedule IV								

Table 8: Total Potassium Content (%)

DAY / SAMPLE	0	15	30	45	60	75	90	105
Sample 1 (S.S+C.D)	1.38	1.93	2.33	2.51	2.64	2.72	2.75	2.76
Sample 2 (S.S+P.M)	1.23	1.69	2.03	2.25	2.36	2.42	2.43	2.42
Sample 3 (S.S+H.D)	0.97	1.36	1.58	1.75	1.86	1.91	1.93	1.95
STANDARD	Min. 0.8							
Testing as per Point 9, Part- D, Schedule IV (Organic Fertilizers) of FCO (1985)								

Table 9: Heavy Metals Contents (mg/kg)

SAMPLE / DAY		0	15	30	45	60	75	90	105
Chromium (Cr)	Sample 1	303.4	221.3	160.7	111.2	69.6	41.6	31.8	27.9
	Sample 2	394.2	300.7	230.5	181.7	151.7	127.5	115.8	112.6
	Sample 3	276.6	186.8	143.3	120	99.6	72.3	59.6	56.3
Cadmium (cd)	Sample 1	1.78	1.5	1.16	1.01	0.91	0.7	0.62	0.58
	Sample2	2.76	2.38	2.17	1.95	1.72	1.57	1.42	1.35
	Sample3	3.06	2.88	2.59	2.20	1.99	1.75	1.65	1.6
Nickel (Ni)	Sample1	64	50.22	39.81	29.68	21.5	16.5	13.2	12.66
	Sample2	28	20.2	15.16	11.3	9.16	7.7	7.2	7.05
	Sample3	36.38	27.58	25.6	20.24	19.02	18.3	17.6	17.3
Lead (pb)	Sample 1	21.2	16.4	12.5	8.85	6.18	4.75	3.5	3.33
	Sample 2	19	16.02	10.4	8	5	3.9	3.01	2.8
	Sample 3	21.6	15.8	13.2	11.05	8.2	6	4.8	4.5
STANDARDS	Cr = 50, Cd = 5, Ni = 50, Pb = 100								
Testing as per Point 10, Part- D, Schedule IV (Organic Fertilizers) of FCO (1985) All values are in mg/kg									

IV. CONCLUSION

Following conclusions were drawn after the study and analysis of results:

1. Cow dung and poultry manure showed commensurable results for parameters like pH, total carbon and NPK during decomposition of the sewage sludge waste but in case of heavy metals, cow dung acted as the best stabilization material.
2. The research revealed that chromium acts as a major threat to the effective use of sewage sludge as manure with its concentrations being 8-9 times the permissible values.
3. The activators especially poultry manure used for heavy metal stabilization themselves added to the increase in heavy metal concentrations in the substrate (but they are still added to enhance the activity of earthworm species).

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