Assessment of Maturity for Vermicompost Using Germination Index

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Abstract: In this paper, a series of experimental studies conducted with regard to bioconversion of organic fraction of municipal solid waste along with sugar mill waste at different Carbon to Nitrogen (C/N) ratios using vermicomposting technology. The compost obtained from composting of organic fraction of municipal Solid waste, sugar industry filter cake and saw dust using different initial mix ratios (1:3, 1:6, 1:9) was used to evaluate phytotoxicity of green gram (Vigna radiata) using seed germination method. The result shows that composting generally reduces the phytotoxicity of the mixtures. The germination index was highest in mix ratio of 1:3 in the compost obtained from the addition of sugar industry filter cake. The maximum vigor index obtained in the mix ratio of 1:3 from the compost obtained with the addition of sludge.
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1. Introduction

Vermicomposting is a process of bio-oxidation and stabilization of organic matter involving the joint action of earthworms and microorganisms. The presence of earthworms doubles the rate of carbon loss due to joint action of earthworms and microorganism activity that accelerates the mineralization of Carbon[1]. This results in faster decomposition process to convert organic substances in to inorganic substances. About 5.2 million tonnes of press mud produced in our country every year. Press mud contains trace quantity of micronutrients and prevents soil erosion, crusting and cracking, adjusts soil pH, improves drainage and promotes normal bacterial and microbial growth in the soil. It is used as both soil reclamant as well as soil conditioner. Application of press mud at 40MT/ha is reported to reduce the pH of red loamy soil from 8.55 to 7.60 as per Department of sericulture, Government of Tamilnadu, India.

Another problem associated with the application of immature compost is the release of phytotoxic compounds during the composting process[4, 10]. Compost maturity refers to the degree of decomposition of phytotoxic organic substances produced during the active composting stage[9]. The objective of this work is to evaluate the effect of water extracts from different mixtures of compost from composting of organic fraction of municipal solid waste (MSW), sugar industry filter cake and saw dust in the germination process and root and shoot growth of green gram seeds (Vigna radiata) in order to determine their phytotoxicity.

2. Material and Methods

The study was conducted at the Vellalore Composting yard of Coimbatore Corporation, Coimbatore, India. In this study, different ratios of waste mixtures and sawdust, as required for individual trials amounting to approximately 50 kg for each mix ratios were placed in 12 heaps and mixed together. The static pile was placed over an appropriate sloping concrete floor for drainage. The effective length of the pile was 0.6 m with a width and height of 0.5m and 0.3m, respectively. The organic fraction of MSW collected from Vellalore Municipal composting yard and saw dust from saw mills near Kinathukadavu, Coimbatore. Sugar mill waste was obtained from Amaravathy sugar mills, Udumalpet, Tamilnadu. The materials were mixed in different proportions manually with the addition of effective microorganisms as indicated in Table 1and turned into piles. Turning was done with the help of a wooden rod uniformly on alternate days to provide air for the microbes digesting the organics[5].

The major composition of the waste included vegetable and fruit waste. A 500 ml solution containing Effective microorganisms like Phospobacteria, Azospirillum lipoferum, Acetobacter aerogens, Trichodema viridi was added to the piles during loading. 2000 ml of deionized water was also added initially and watered on alternate days to keep the moisture level at an optimum range between 55% to 60%[6].

About 6 kg of partially degraded waste was collected after 15 days when the temperatures subsided to ambient levels for vermicomposting process. Six kg of cow dung, 1kg of coir pith and 6

litres of water was also added to each mix ratios to initiate the vermicomposting process. The process was carried out in specially designed vermibins made of wooden boxes (60 cm x 60 cm x 60 cm) containing the waste mixture for 28 days. The wastes were loaded into the bins as shown in Figure 1.Ten numbers of European earthworm species Eoesina foetida of size 2 to 5 inches that was locally available at the compost yard were introduced into the vermibins during the start of the vermicomposting cycle. These worms are violet in color.

3. Results

Initial characteristics of biodegradable portion of municipal solid waste obtained from Vellalore yard, Coimbatore (Table 2) indicate high initial nutrient values in the waste. Initial C/N ratio of 40.31 found suitable to carry out the composting process. Initial characteristics of the sugar mill filter cake waste (Table 2) indicate the presence of high amount of organic matter. The initial and final characteristics during the vermicomposting process is given in Table 3 for the different mix proportions, 1:3, 1:6 and 1:9 in the vernibins A, B, C respectively.

Figure 1. Design of vermibin

Hay	5cm
Cow dung	3cm
Worms	10 Numbers
Saw Dust	8cm
Partial compost	30cm
Cow dung	3cm

Table 1. Mixture Specification

Mix ratio*	Saw Dust (kg)	OFMSW (kg)	Sugar mill waste (kg)	EM (ml)
1:3	12.5	35.5	2	500
1:6	7	35.5	7.5	500
1:9	5	35.5	9.5	500

*Saw dust: (OFMSW+ sugar mill waste)

Table 2. Initial Characteristics of Feed Materials

Sl.no	Parameters	OFMSW	Saw dust	Filter cake
1	Temperature (^{0}C)	28.3	30.8	31.1
2	Moisture content (%)	35.5	10.28	20.52
3	pH	9.43	7.08	7.82
4	Bulk Density (gm/cc)	1.66	0.64	1.13
5	TOC (%)	31.86	52.54	33.54
6	Organic Matter (%)	73.24	90.59	57.83
7	Electrical Conductivity (dS/m)	1.55	0.215	0.398
8	Total Nitrogen (%)	1.24	-	1.8
9	Phosphorus (%)	0.362	0.198	0.281
10	Potassium (%)	2	0.4	0.8

GERMINATION TEST

A modification of the "paper towel" method was used [2]: green gram seeds (Vignaradiata) were placed on a single, wet paper towel, spread on a parafilm, rolled, sealed and placed on the bottom of a container. All experiments were performed in a randomized design in four replicates. Each replicate consisted of 10seeds. Results are based on all experiments. Seed germination and the length of the longest root and shoot produced by the seeds were measured after 72 hours in all the extracts and they were compared with those of the water control. The germination index (GI) was obtained by multiplying germination percentage (G %) and relative root growth (RRG), both expressed as percentage (%) of control values (Tiquia and Tam, 1998). The vigor index (VI) was also obtained.

GI = (G% × RRG %) × 100,

Where,

G% = (No. of seeds germinated in sample / No. of seeds germinated in control) × 100

RRG% = (mean root length in sample / mean root length in control) × 100

VI = Germination % x (Mean root length+ Mean shoot length)

The GI values in composting mixtures of initial mix ratio of 1:3, 1:6 and 1:9 was found as 92.91, 86.26, 91.46 on day 3, in the compost obtained from vermibins A, B and C respectively (Table 4). Zucconi et al (1981) reported that a GI value of more than 80% is an indication of phytotoxic-free and mature compost. Similar suggestions were also reported [7]. The GIs in the composting mixtures of initial mix ratios 1:3, 1:6 and 1:9 were over 80% during the composting. The GI value was maximum (92.91%) in vermibin A with a mix ratio of 1:3. Vigor index was highest in vermibin A with a mix ratio of 1:3 containing compost from OFMSW and sugar industry filter cake. The relatively low germination value in vermibin B may be attributed to the release of toxic concentration of ammonia and low molecular weight short chain volatile fatty acids, primarily acetic acid [3,9].

Table 3. Characteristics of Vermicompost

Sl.No	Parameters	A		B		C	
		Initial	Final	Initial	Final	Initial	Final
1	Temperature	29.5	20.3	25.9	22.3	28.5	25.6
2	Moisture	30.5	46.3	29.8	55.3	25.6	52.1
3	pH	7.75	7.56	8.01	7.6	8.01	7.83
4	Bulk Density	0.32	0.216	0.39	0.336	0.83	0.6
5	Organic carbon (%)	38.47	18.83	37.84	18.23	37.23	17.27
6	Volatile solids	56.4	41.2	59.6	38.7	58.3	41.6
8	Electrical Conductivity (dS/m)	2.6	1.5	2.7	1.4	2.4	1.5
9	Total Nitrogen (%)	0.78	0.96	0.86	1.01	0.83	0.98
10	C/N	49.32	19.61	44	18.04	44.85	17.62
11	Phosphates (%)	0.497	0.612	0.46	0.682	0.483	0.652
12	Potassium (%)	0.416	0.602	0.51	0.675	0.516	0.672

Table 4.Summary of seed germination results

Compost	MRL	MSL	MSG%	RRG%	GI%	VI
A	12.36	4.00	95	88.88	92.91	1554.91
B	11.79	4.28	92.5	93.54	86.26	1486.01
C	12.17	3.82	95	90.68	91.46	1519.52
Control	12.64	4.38	100	100	100	1702

4. Conclusion

The physicochemical and phytotoxicity changes during the reactor composting of OFMSW, sugar industry filter cake and sawdust have been investigated at initial mix ratios of 1:3, 1:6 and 1:9. The stability and maturity in composting mixture of initial mix ratio 1:6 was superior to those in composting mixtures of initial C/N ratio of 1:3 and 1:9.Composted sugar industry filter cake and organic fraction of Municipal solid waste is a valuable source of organic matter, nitrogen, phosphorus and other nutrients.

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