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GROWTH EVALUATION OF MICRO-ORGANISMS IN VERMICOMPOSTING OF MUNICIPAL SOLID WASTES AND COW DUNG

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ABSTRACT Microorganisms are essential part of biodiversity and play a significant role in structuring and functioning of the ecosystem on the environment. An attempt was made for vermicomposting of Municipal Solid Waste (MSW) was mixed with Cow Dung (CD) using *Eisenia fetida* (*E. fetida*) and *Lampito mauritii* (*L. mauritii*) and analyzed microbial population such as bacterial, fungal and actinomycetes in the vermicompost. In the present examines the high number of bacterial (753.93), fungal (316.30), and actinomycetes (39.42) populations found in T_2 and control than other treatment. This T_2 shows suitable medium for microbial population. It could be due to the higher feeding rate, prolific breeding ability, suitable environment and multiplication of microbes while passing through the gut of worms and optimal moisture and activity of microbes.

KEYWORDS : *Eisenia fetida, Lampito mauritii*, Municipal solid waste, Cow dung, Microbial population.

INTRODUCTION

Vermicomposting process, when organic matter passes through the worms gut it undergoes physical, chemical, and biochemical changes by the combined effect of earthworm and microbial enzymatic activities. It is coated with muco-polysaccharides and are enriched, thus nutrients which act as important substrate for free living beneficial microbes. So, celluloytic, nitrifying and nitrogen fixing micro-organisms are found to establish on wormcast[1,2]. The role of microbial activity in the gut as well as in the casts is very essential for the degradation of organic waste and release of nutrients to plants, and this is large particulate surface areas that provide many micro sites for microbial activity and for the strong retention of nutrients[3,4,5]. Vermicompost is riching in microbial populations and diversity, particularly fungi, bacteria, and actinomycetes. Furthermore, during the vermicompost is total microbial activity and biomass, total number of cultural actinomycetes and the presence of other microorganisms of a variety of plant diseases[6,7,8]. The extent of the diversity of microorganisms in soil is seen to be critical to the maintenance of soil health and quality, as a wide range of microorganisms are involved in important soil functions[9].

Production of large quantities of organic waste all over the world poses major environmental (odour problems, contamination of ground water and soil) and disposal problems. At current situations, the problem of efficient disposal and management of organic solid wastes has become more vigorous due to urbanization, rapidly increasing population, industrialization and intensive agriculture. Therefore, decomposition and humification of biodegradable organic waste materials is predominantly carried out by microorganisms too have roles in humification[10,11]. It is significant nowadays to opt an efficient disposal and management method of shorter and cost-effectiveness suitable to Indian conditions; where large quantities of necessary plant nutrients contained in domestic wastes and agricultural byproducts are wasted that are deficient in tropical soils[12,13,14]. The natural decomposition of organic wastes is inefficient because the complex structural composition of organic wastes resists the breakdown, so the decomposition process become slow resulting in the accumulation and lead to environmental pollution problems[15]. Worldwide approximately 38 billion metric tons of organic wastes and in India 3000 million metric tons of organic wastes are produced. In overall, the predominant mode of waste disposal is open dumping (94%) and only 5% is composted[16,17]. The main aim of the present study is to test the role of *E. fetida and L. mauritii* on the population kinetics of bacterial, fungi, and actinomycetes during vermicomposting of MSW and CD across different time intervals (at 0, 15th, 30th, 45th and 60 days) for a period of 60th days.

MATERIALS AND METHODS

Earthworm collection and maintenance

E. fetida and L. mauritii were obtained from the stock culture maintained in the Department of Zoology, Annamalai University, Tamil Nadu, India stocked in plastic containers and cow dung was used as substrate to maintain the adult earthworms.

Collection of organic wastes

Municipal solid waste

Municipal solid waste collected from Sirkali Municipality, Nagapattinam (District), Tamil Nadu, India, after removing polythene covers, glass pieces, scraps, clothes and metals. MSW was air dried and brought by using jute bags to the vermi-biotechnology lab.

Collection of Cow Dung

Cow Dung collected from around the Chidambaram, Cuddalure District, Tamil Nadu, India, after the waste was dried and used to bedding materials before 10 days pre-composting

Preparation of the experimental media

In the present study, 10 proportions and controls of MSW mixed with CD were prepared in the following order (Table 1).

Inoculation of earthworm

The preclitellate *E. fetida* worms were weighed and inoculated at the rate of 15 g per Kg of each mixture after pre decomposition. The plastic troughs were covered with nylon mesh and maintained at the room temperature 27°C ± 2°C with 60-70% of moisture, the medium without MSW were treated as control. Six replicates were maintained in each combination. The substrate named as C_1, T_1 to T_5 were inoculated with *E. fetida,* and Substrate C_2, T_6, to T_{10} for *L. mauritii*.

Microbial population studies

The total number of fungi, actinomycetes, and bacteria present in normal compost and vermicompost samples were estimated by "Serial dilution method"[18]. Martin rose Bengal agar (RBA) for fungal culture, ken knights agar (kkA) for the culture of actinomycetes and nutrient agar (NA) for bacterial culture were used. The microbial populations (bacteria, fungi and actinomycetes) were enumerated in the samples of 0, 15th, 30th, 45th and 60 days by the following methods.

STATISTICAL ANALYSIS

Microbial population of the all data is calculated standard deviation (SD), percentage increase or decrease over initial to final. Further, the data were analyzed statistically (significance of difference of 0.05 levels) by using two-way analysis of variance (ANOVA).

RESULTS

Total number of bacterial population

The present investigation examines the bacterial population was found to be increased significantly (p<0.05) in control and other treatments. Among these treatments of bacterial population high in T_2 and T_7, treatments. The bacterial population gradually increased in all treatments and control (Table 2). The bacterial population in *E. fetida* was increased gradually from 0–60th days. The maximum number of bacterial population was found in the vermicomposts obtained in T_2 (753.93±1.83 in CFU×10^6) and it was followed by C_1 (652.34±2.33 in CFU×10^6), T_1 (607.63±2.08 in CFU×10^6), T_3 (523.57±1.95 in CFU×10^6), T_4 (505.67±1.92 in CFU×106) and T_5 (423.95±1.88 in CFU×10^6) on 60th day. In *L. mauritii* vermicompost, the bacterial

population was increased up to 60 days. On 60th day T_7 (593.60±2.05 in CFU×10^6), C_2 (522.71±2.19 in CFU×10^6), T_6 (515.83±1.76 in CFU×10^6), T_8 (472.61±1.87 in CFU×10^6), T_9 (418.42±2.32 in CFU×10^6), showed highest bacterial count and lowest count was observed in T_{10}(396.72±2.04 in CFU×10^6)

Total number of fungal population

The present investigation examines the number of Fungal population that was found to be increased significantly ($p<0.05$) in $T_2$and T_7which have more CD (Table 3). The fungal population gradually increased in all treatments and control (Figure 1a, b). The highest fungal colonies were observed in the vermicompost by *E. fetida* obtained in treatment $T_2$and the other treatment follows the C_1, T_1, T_3, T_4, and T_5. The percent change in the population of fungi collected on 60th days are (316.30) in T_2, (283.75) in C_1, (251.58) in T_1, (232.43) in T_3, (201.29) in T_4 and (172.86) in T_5. Similar results were observed in *L. mauritii* vermicompost. The T_7 Showed Significantly increased fungal population 243.54 on 60th day vermicompost, it was followed by C_2 (218.85), T_6 (232.40), T_8 (194.87), T_9 (159.08) and T_{10} (141.78) produced from different MSW mixture.

Total number of Actinomycetes

The actinomycetes population in worm-unwoked (initial) and worm–worked (vermicomposts) produced from MSW mixed with CD used by *E. fetida* and *L. mauritii* (Table 4). The maximum number of actinomycetes was observed in the vermicomposts by by *E. fetida* T_2 (39.42) followed by C_1 (29.92), T_1 (28.59), T_3 (26.78), T_4 (22.81) and T_5 (19.93) on 60th day. The T_2 treatment shows the maximum (80.2%) percentage change over the initial. In MSW mixture, the actinomycetes population was maximum in T_7(36.76) the efficiency of other treatments were found to be ranked in the following order i.e,) C_2 (34.43)>T_6 (33.23) T_8 (26.28)>T_9 (24.15) T_{10} (22.26) on 60th day vermicomposts by *L. mauritii*.

DISCUSSION

It can be concluded that the vermicompost of *E. fetida* possess higher microbial communities in all MSW with CD treatments than vermicompost of *L. mauritii.* This difference may be due to the type of worm costing. The enhanced microbial population was observed in all treatments and controls vermicomposts over the initial. The highest microbial population was observed in the vermicomposts of T_2 and T_7 than other treatments. Microorganism provided a source of nutrition for earthworms, of which fungi and protozoa constitute important compounds. During vermicomposting process, when organic matter passes through the worm's gut, it undergoes physical, chemical and biochemical changes by the combined effect of earthworms and microbial activities. The present study the changes in the different microbial communities in vermicomposting of MSW are in consistence with that of earlier reports. Vermicompost from 2:2 ratio of Cashew Leaf Litter admixed with CD had lower pH, OC, C-N ratio, lignin, cellulose, hemicellulose and phenol content, and higher N, P, K, dehydrogenase and humic acid content than the raw substrates and worm unworked normal compost[14]. There is no study available on level of this content in the CLL after the process of vermicomposting[15]. Furthermore, most the enzymes showed correlation with change in number and types of different microbial groups like bacteria, fungi, and actinomycetes during vermicomposting with maximum number of 126×10^6, 28×10^4, and 93×10^5 CFU g^{-1} sample respectively[11]. An attempt was made for vermicomposting of MSW was mixed with ED using *E. fatida* and *L. mauritii* and analyzed microbial population such as bacterial, fungal, and actinomycetes in the vermicomposts. So, the high number of microbial populations found in T_2 and control than other treatment. Treatment of T_2 shows suitable medium for microbial population[19]. Organic matter changes in the soil resulted from the incursion of earthworms powerfully modify the microbial communities[20]. Further, significant increase in the populations of bacteria in vermicompost by the 2nd week and maximum numbers was found between 45 to 60 days[21]. The present study shows that the bacteria, fungi and actinomycetes were more in the vermicompost of T_2 it may be due to the availability of optimum minerals for the multiplication of microbial groups. Similar to our present findings that the bacterial population gradually increased up to the 30th day in 20, 50 and 75 percent concentration of petrochemical sludge, whereas in 100 percent petrochemical sludge decline the population of microbes was observed from the 15th day and confirmed the fact that at 100 percent concentration survival rate of earthworm was very low and it was due to the higher concentrations of petrochemical sludge which is to be toxic to the earthworm. Moreover, the density of micro fungi was higher in the earthworm gut and vermicompost than in fresh substrate[22].

The present investigation is similar to the above results in improved populations of microbes in the vermicompost of *E. fetida* is also comparable with the reports of Parthasarathi *et al.,*[23] the improvement of microbial population, microbial activity and nutrient contents in the vermicompost at 31˚C and 60 to 70 percent moisture during vermicomposting of sugar industrial wastes. The microbial population and activity was increase to significant levels in vermicompost product derived from tannery fermented waste mixed with cowdung and leaf litter compared to control mixture by the earthworm *E. eugeniae* can utilize this waste mixture through the gut and can digest it with enzyme activity to produce a nutrient rich manure[24]. Vermicompost enhances soil biodiversity by promoting the beneficial microbes which intum enhances plant growth directly by production of plant growth-regulating hormones and enzymes and indirectly by controlling plant pathogens, nematodes and other pests, thereby enhancing plant health and minimizing the yield loss. Due to its innate biological, biochemical and physiochemical properties, vermicompost may be used to promote sustainable agriculture and also for the safe management of agricultural, industrial, domestic and hospital wastes which may otherwise pose serious threat to life and environment[25]. Manyuchi and Phiri,[26] who stated that increase in nitrogen availability influenced the decomposition rates of plant litter and organic matter. In the present study vermicomposts of *E. fetida* is rich in microbial communities and diversity, particularly bacteria, fungi and actinomycetes in different concentrations of MSW and CD mixture.

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TABLE-1

Treatment	MSW+CD Proportion	Weight of MSW+CD/ Kg
C_1,C_2	100% ED	1000g
T_1,T_6	10%+90%	200g +800g
T_2,T_7	20% + 80%	300g +700g
T_3,T_8	30% + 70%	400g +600g
T_4,T_9	40% + 60%	500g +500g
T_5,T_{10}	50% + 50%	600g +400g

PREPARATION OF THE EXPERIMENTAL MEDIA

Table-2 Bacterial Population In The Vermicompost From Msw With Cd By E. Fetida And L. *Mauritii*

Substrate Proportions	*E. fetida* Vermicomposting days					Substrate Proportions	*L. mauritii* Vermicomposting days				
	0	15	30	45	60		0	15	30	45	60
C_1	421.46±1.77	472.48±2.12	490.74±2.21	524.78±2.25	652.34±2.33	C_2	342.55±2.09	435.64±2.12	480.92±2.42	504.63±2.16	522.71±2.19
T_1	397.77±2.53	460.64±2.12	483.58±2.17	570.59±2.48	607.63±2.08)	T_6	335.73±2.07	419.46±2.17	446.71±2.12	495.80±2.20	515.83±1.76
T_2	394.42±2.32	468.97±1.91	603.71±2.16	636.87±2.16	753.93±1.83	T_7	325.87±1.76	462.60±2.05	485.20±1.83	528.19±2.41	597.60±2.05
T_3	365.11±1.84	461.61±2.10	470.93±1.99	476.51±2.02	523.57±1.95	T_8	316.51±2.03	345.90±2.12	375.63±2.04	410.51±1.87	472.61±1.87
T_4	355.07±2.22	425.58±1.98	441.38±1.78	485.66±2.09	505.67±1.92	T_9	296.86±2.17	333.09±1.89	372.89±2.22	399.88±2.19	418.42±2.32
T_5	311.50±1.95	335.84±2.11	370.80±1.78	410.57±1.96	423.95±1.88	T_{10}	291.69±1.88	301.19±2.06	318.88±1.83	356.00±1.82	396.72±2.04

Analysis of variance	Sum of square	Mean of square	F-value	P-value	Analysis of variance	Sum of square	Mean of square	F-value	P-value
Rows	118938.7	23787.73	14.79487	3.92E-06	Rows	20929.17	4185.833	1.095444	0.393493
Columns	143391.3	35847.83	22.29569	3.9E-07	Columns	99770.08	24942.52	6.527526	0.00157

C_1 & C_2 – Control, T_1 & T_6 (10% MSW + 90% CD), T_2 & T_7 (20% MSW + 80% CD), T_3 & T_8(30% MSW + 70% CD), T_4 & T_9(40% MSW + 60% CD), T_5 & T_{10} (50% MSW + 50% CD), Initial (0) – Worm unworked substrates, Mean ± SD of six observations, ($P<0.05$). (+/–) – Percent change of increase or decrease over the initial.

Table-3 Fungal Population In The Vermicompost From Msw With Cd By E. Fetida And L. *Mauritii*

Substrate Proportions	*E. fetida*					Substrate Proportions	*L. mauritii*				
	Vermicomposting days						Vermicomposting days				
	0	15	30	45	60		0	15	30	45	60
C_1	149.17±2.35	160.23±1.86	246.48±1.74	260.94±2.16	283.75±1.96	C_2	142.17±2.35	170.64±1.76	179.18±2.26	188.04±1.34	218.85±1.84
T_1	135.43±1.43	176.48±1.58	195.69±1.19	218.30±1.09	251.58±1.27	T_6	132.47±1.43	163.42±1.88	176.29±2.48	200.91±2.09	232.40±1.82
T_2	137.14±2.26	211.67±2.06	242.05±1.04	262.23±1.28	316.30±2.43	T_7	136.32±1.26	201.21±1.02	210.44±1.45	232.48±1.46	243.54±1.51
T_3	131.27±1.18	157.81±2.23	181.97±1.76	210.37±2.34	232.43±1.25	T_8	131.25±1.56	143.86±2.28	157.93±1.62	170.22±2.22	194.87±1.72
T_4	119.56±2.10	139.12±1.35	147.28±1.82	169.01±2.58	201.29±2.14	T_9	110.53±2.15	122.37±2.23	141.61±1.66	151.65±1.86	159.08±2.25
T_5	107.19±2.40	117.31±1.42	131.46±1.38	165.62±1.60	172.86±1.58	T_{10}	105.92±2.40	111.56±1.66	123.34±1.92	126.83±2.31	141.78±2.16

Analysis of variance	Sum of square	Mean of square	F-value	P-value	Analysis of variance	Sum of square	Mean of square	F-value	P-value
Rows	33544.95	6708.991	19.7656	4.03E-07	Rows	23857.24	4771.448	31.29352	8.43E-09
Columns	47140.97	11785.24	34.72093	9.73E-09	Columns	17632.97	4408.242	28.91144	4.63E-08

C_1 & C_2 – Control, T_1 & T_6 (10% MSW + 90% CD), T_2 & T_7 (20% MSW + 80% CD), T_3 & T_8(30% MSW + 70% CD), T_4 & T_9(40% MSW + 60% CD), T_5 & T_{10} (50% MSW + 50% CD), Initial (0) – Worm unworked substrates, Mean ± SD of six observations, (P<0.05). (+/–) – Percent change of increase or decrease over the initial.

Table-4 Actinomycetes Population In The Vermicompost From Msw With Cd E. Fetida And L. *Mauritii*

Substrate Proportions	*E. fetida*					Substrate Proportions	*L. mauritii*				
	Vermicomposting days						Vermicomposting days				
	0	15	30	45	60		0	15	30	45	60
C_1	16.15±1.75	20.37±2.12	23.48±1.83	26.23±2.35	29.92±1.76	C_2	22.18±1.70	24.24±2.14	27.46±2.24	31.95±1.59	34.43±2.28
T_1	17.54±2.03	18.98±1.87	21.22±1.83	23.46±2.12	28.59±2.28	T_6	23.56±1.87	25.83±1.93	29.28±2.24	27.55±1.81	33.23±2.05
T_2	19.31±1.73	23.66±2.20	28.72±2.28	31.38±2.42	39.42±1.82	T_7	22.34±1.73	26.68±2.22	31.09±1.82	33.84±2.27	36.76±1.58
T_3	16.84±2.38	19.56±1.87	21.19±2.17	24.52±1.54	26.78±1.83	T_8	18.86±2.12	20.42±1.64	23.65±1.63	25.72±2.03	26.28±2.32
T_4	14.68±2.29	17.11±1.70	19.95±1.83	21.13±2.05	22.81±2.22	T_9	17.69±2.29	19.23±1.72	21.07±2.12	23.48±1.65	24.15±1.87
T_5	13.78±2.32	15.42±1.82	18.05±2.17	18.99±1.63	19.93±2.30	T_{10}	21.44±2.04	17.36±2.27	19.82±1.79	21.68±2.12	22.26±1.73

Analysis of variance	Sum of square	Mean of square	F-value	P-value	Analysis of variance	Sum of square	Mean of square	F-value	P-value
Rows	373.5031	74.70061	19.7646	4.04E-07	Rows	29.44258	5.888515	0.246674	0.936599
Columns	477.7002	119.425	31.59797	2.18E-08	Columns	310.8253	77.70632	3.255171	0.032843

C_1 & C_2 – Control, T_1 & T_6 (10% MSW + 90% CD), T_2 & T_7 (20% MSW + 80% CD), T_3 & T_8(30% MSW + 70% CD), T_4 & T_9(40% MSW + 60% CD), T_5 & T_{10} (50% MSW + 50% CD), Initial (0) – Worm unworked substrates, Mean ± SD of six observations, (P<0.05). (+/–) – Percent change of increase or decrease over the initial.

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