Global Journal of Environmental Research 5 (2): 53-56, 2011
ISSN 1990-925X

Microbial Population and Humic Acid Content in the Vermicompost of the Earthworm, *Eudrilus eugeniae* (Kinberg) Reared in Banana Agro Wastes

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Abstract: Organic waste recycling is an efficient and environmentally friendly technology to convert wastes into value-added products. Vermicomposting uses earthworms to turn organic wastes into very high quality compost. The microbial population in the vermicompost plays an important role in further degradation process and they carry out many beneficial activities in soil. The present study has been carried out to estimate the total microbial population, enzyme activity and humic acid content of vermicompost produced by the earthworm species, *Eudrilus eugeniae* reared in banana wastes and cow dung medium in different ratios. The results of the study revealed that total microbial population and activity were significantly ($P<0.05$) increased in all the treatments (T_1 - T_5) and especially T_3, T_4, T_5 treatments were found to show higher microbial population and activity than initial substrate and worm unworked natural compost (control). Similarly, humic acid content in the vermicompost was higher than initial substrates and worm unworked natural compost. The results indicated that the banana waste could be converted into good quality manure by vermicomposting if mixed in appropriate ratio (20-60%) with cow dung.

Key words: Microbial activity · Humic acid · Banana wastes

INTRODUCTION

India produces about 3,000 million metric tones of organic wastes annually which are disposed by ocean dumping, incineration and land application. Wastes from domestic, agriculture, urban and industrial sources are the main cause of organic soil pollution [1]. Banana is an important food crop of the world which is cultivated over an area of more than four million hectares and its annual production is more than seventy million tones. India is one of the leading producers of banana, which are mostly grown in Tamil Nadu State. After the harvest of the fruits the whole plant (leaves, stem and rhizome) is left in the agriculture field for natural degradation, which takes several months.

Earthworms are physically aerators, crushers and mixers, chemically degraders and biologically stimulators in the decomposer system. The effectively harness the beneficial soil microflora, destroy soil pathogens and convert organic wastes into nutrient rich vermicompost. Microorganisms are the essential part of bio-diversity and play significant role in structuring and functioning of the ecosystem on the earth. The microorganisms and earthworms act symbiotically to accelerate and enhance the decomposition of organic matter. Earthworms are ubiquitous soil invertebrates that ingest large amounts of mineral soil and organic material containing variety of microorganisms [2]. Many investigators have shown increased microbial population and activity in vermicasts compared to surrounding soil [3-7]. Therefore, microorganisms are mainly responsible for the biochemical degradation of the organic matter during composting and vermicomposting process and, in the latter, earthworms play a very important role in both microbial activity and diversity [8].

Humic substances are essential for life on this earth and they influence plant growth and equilibrium in ecosystems through their effect on the physical, chemical and biological properties of soil and improve seed germination, plant growth and enhance plant nutrient

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absorption capacity [9, 10]. Earthworm can increase the velocity of decomposition of organic residues and also produce several bioactive humic substances [11-13]. Humic acids (HA) comprise one of the major fractions of humic substances. They are characterized by dark-coloured, alkali-soluble and high humified organic matter [14]. From the agricultural point of view, the humic acid could be considered as the most important component of the humic substances. So, microorganisms, soil enzymes and humic acid content are closely associated with soil fertility. Hence the present study was designed to evaluate the effect of epigeic earthworm (*Eudrilus eugeniae*) on the microbial changes, enzyme activities and humic acid content in a laboratory scale composting of banana waste mixed with cow dung in different ratios under controlled conditions.

MATERIALS AND METHODS

Banana wastes (dried leaves and pseudostem) were collected and subjected to initial decomposition in rectangular draining cement tanks (75 cm × 60 cm × 45 cm sizes) by sprinkling water, regular mixing and turning of the substrate material for 20 days. The pre-decomposed banana wastes (BW) were mixed with cow dung (CD) in different ratios on dry weight basis in plastic container of 15L capacity (diameter 60 cm, depth 16 cm). The details of feed composition in different treatments are as follows: treatment no. 1 (T_1): 1000g BW; treatment no. 2 (T_2): 800g BW + 200g CD; treatment no. 3 (T_3): 600g BW + 400g CD; treatment no. 4 (T_4): 400g BW + 600g CD and treatment no. 5 (T_5): 200g BW + 800g CD. The mixtures were turned manually every day for 5 days in order to decompose the waste. After 5 days, 20 adult individuals, having well developed clitellum, of *Eudrilus eugeniae* were inoculated into each treatment. The treatments were maintained in triplicates for each substrate material. The moisture content was maintained at 70 ± 10% by sprinkling of water throughout the study period (90 days). Same substrate material without earthworm served as control (worm unworked natural compost).

The total microbial population was determined by dilution plate techniques. The total microbial colonies developing on the media were estimated by using Que-Bee colony counter and expressed as CFU × $10^6 g^{-1}$. The inoculums preparation, inoculation method, using cultural media and temperature and time taken for incubation were followed by the method of Baron *et al.* [15]. Microbial activities (in terms of estimating dehydrogenase activity) were determined according to the method of Stevenson [16]. The humic acid content was measured using the method of Schnitzer [17]. The humic acid content was expressed in mg/5g substrates. The data were statistically analyzed following standard procedure for the interpretation.

RESULTS AND DISCUSSION

The total microbial population, microbial activity and humic acid content in different treatments of banana agro waste and cow dung mixtures of worm unworked natural compost (control) and worm worked vermicompost of *E. eugeniae* are represented in the Tables 1-3. In the present analysis total microbial population, microbial activity and humic acid content in the vermicompost were significantly increased in all the treatments (T_1 - T_5) and especially T_3, T_4 and T_5 treatments was found to show significantly ($p < 0.05$) higher microbial population, activity and humic acid content than initial substrate material and worm unworked natural compost (control). Many earthworm species have been found predominantly to utilize soil fungi as their food [18, 19]. Several investigators have shown increased population of bacteria and fungi in casts compared to surrounding soil [20-22].

Lee [3] reported increased enzyme activities in worm casts as compared with the surrounding soil. Loquet *et al.* [23] demonstrated an increase in cellulolytic, hemicellulolytic, amylolytic and nitrifying bacteria in worm casts compared to the surrounding soil. Earlier studies of Parthasarathi and Ranganathan [6] and Vinotha *et al.* [24] have shown enhanced microbial and enzyme activities and NPK contents in the pressmud vermicasts.

Table 1: Total microbial population in different treatments of banana agro wastes and cow dung mixture and vermicompost ($P < 0.05$)

	Total microbial population (CFU × $10^6 g^{-1}$)		
Treatment	Initial substrate	Natural compost	Vermicompost
T_1 (1000g BW)	3.92	4.13	4.26
T_2 (800g BW + 200g CD)	3.96	4.17	4.76
T_3 (600g BW + 400g CD)	4.12	4.29	5.29
T_4 (400g BW + 600g CD)	4.18	4.31	5.36
T_5 (200g BW + 800g CD)	4.21	4.36	5.47

Table 2: Microbial activity in different treatments of banana agro wastes and cow dung mixture and vermicompost ($P < 0.05$)

	Microbial activity (5µlH/5g)		
Treatment	Initial substrate	Natural compost	Vermicompost
T_1 (1000g BW)	3.21	4.27	5.82
T_2 (800g BW + 200g CD)	3.27	4.16	6.32
T_3 (600g BW + 400g CD)	3.31	4.82	7.21
T_4 (400g BW + 600g CD)	3.32	4.89	7.32
T_5 (200g BW + 800g CD)	3.37	4.85	7.34

Table 3: Humic acid content in different treatments of banana agro wastes and cow dung mixture and vermicompost ($P < 0.05$)

	Humic acid content (mg/5g)		
Treatment	Initial substrate	Natural compost	Vermicompost
T_1 (1000g BW)	0.276	0.417	0.467
T_2 (800g BW + 200g CD)	0.316	0.426	0.549
T_3 (600g BW + 400g CD)	0.323	0.481	0.705
T_4 (400g BW + 600g CD)	0.352	0.517	0.752
T_5 (200g BW + 800g CD)	0.357	0.519	0.761

In the present study, total microbial population (bacteria, fungi and actinomycetes) and activity were found to have increased in the vermicompost obtained from all the treatments (T_1-T_5) over worm unwormed natural compost. The significantly increased level of microbial population and activity in the vermicompost of *E. eugeniae* could be due to the higher nutrient concentration in the substrate and cast, multiplication of microbes while passing through the gut of worms, optimal moisture and large surface area of casts ideally suited for better feeding, multiplication and activity of microbes.

Earthworms have been shown to contribute to humification process and vemicomposts were shown to contain humic acid [25-27]. Numerous earlier studies have shown that the vermicasts have enhanced microbial population, microbial activity and humic acid content than food material ingested or the surrounding soil [5, 6 and 28]. In the present study, humic acid content were found to have enhanced in the vermicompost obtained from all the treatments (T_1-T_5) over worm unworked natural compost and initial substrate. Data revealed that the humic acid content in the vermicompost for treatment no. 3-5 was not significantly different from each other ($P < 0.05$). The enhancement of humic acid content in the vermicompost is mainly due to large number of microbial population in the substrate material and also due to the gut associated activity of the earthworm.

In conclusion, it was concluded that vermicompost produced by rearing *E. eugeniae* in banana waste and cow dung mixture harboring more microbial population, microbial activity and humic acid content than natural compost and can be applied to soils for better crop productivity and for soil fertility.

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