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Effect of biofertilizers application on flower waste subjected to vermicomposting using *Eisenia fetida* and nutrient analysis of vermicompost

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Abstract

Flower wastes collected from markets, gardens, temples, etc., were mixed in six different combinations using cow dung flower waste and biofertilizers (*Azospirillum* Azo, *Phosphobacteria* PB, *Bluegreen algae* - BGA, *Rhizobium* Rhizo), and subjected to vermi composting using *Eisenia fetida* for 80 days. Chemical analysis indicated significant ($p < 0.05$) increases in the levels of N, P, K, Ca, Mg along with reduction of C: N ratio due to combined action of earthworms and microbes leading to accelerated rate of decomposition and mineralization of organic wastes. The reduced level of Na, Mn, Fe and Cu in the vermicompost may be due to their higher utilization by earthworms. It is concluded that biofertilizer mixed flower wastes produce nutrient rich vermicomposts.

Keywords : biofertilizer, *Eisenia fetida*, flower waste, nutrient analysis, vermicompost

INTRODUCTION

Waste is a valuable raw material located at a wrong place and it can be converted into useful product by making use of an appropriate processing technology (Sharma, 2000). There has been a phenomenal growth in the quantum and diversity of solid waste materials arising out of domestic, commercial, industrial and agricultural products that comprise of both biodegradable and non biodegradable materials. In India about 7000 million tons of wastes are generated annually and agricultural waste alone has been estimated to be about 320 million tons. The most common method of solid waste disposal is land filling, which cause pollution in soil as well as surface and ground water resulting in the mortality of aquatic organisms. Vermicomposting is a cost effective, eco-friendly and appropriate waste disposal technique for the effective recycling of animal waste, crop residue and agro-industrial wastes (Dash and Senapathi, 1985; CPCB, 1999). This paper deals with vermicomposting process of flower waste in combination with cow dung, bio-fertilizers such as *Azospirillum*, *Phosphobacteria*, Blue green algae, *Rhizobium* and nutrient analysis of the vermicompost produced.

MATERIALS AND METHODS

Flower wastes are collected from the markets, gardens, temples in Velur town, Tamil nadu State, South India and shade dried for a week. The dried flower wastes were mixed with dry cow dung1:1 ratio (w/w) and allowed for pre decomposition for 30 days. The pre decomposed substrate was divided into six combinations of feed mix (i)a control (C) without earthworms, (ii) E1- substrate with earthworms, (iii)E2- substrate + earthworms + *Azospirillum*, (iv) E3- substrate + earthworms + *Phosphobacteria*, (v) E4- substrate + earthworms + Blue green algae, (vi) E5 substrate + earthworms + *Rhizobium*. Biofertilizers were mixed at the rate of 1gm per kg of substrate (Subramanian, 2006). Three replicates were maintained for each treatment.

Each treatment bins have 2 kg of feed substrate and 25 clitellated *Eisenia fetida*. The treatment bins were maintained in the laboratory at 27 -30 ºC and 60 - 80 % moisture content. After 80th days the experiment was terminated and the composts were collected and subjected to nutrient analysis. The physicochemical parameters and nutrient analysis were determined following the procedures of Trivedy and Goel, (1986) and Tandon, (1993). The C: N ratio was calculated by dividing the percent of carbon with percent of nitrogen.

Statistical analysis: Vermicompost obtained from treatment bins were compared for level of nutrients by t test. Means and Standard deviation were calculated for each parameter. All statistical analysis were performed by using SPSS (Statistical version 7.5 for Windows XP, Chicago, IL, USA). The results were reported at significance levels of $P<0.01$ and $P<0.05$. Bray-Curtis similarity was performed using PAST (Statistical version 1.93 for Windows XP).

RESULTS AND DISCUSSION

The nutrient analysis of the control and worm worked vermicompost indicated that among the parameters tested *viz.*, pH, OC, OM, Na, Fe, Mn, Zn, Cu and C: N ratio showed decreased trends over the control. Other parameters N, P, K, Ca, Mg, showed increased trends over the control (Table 1). In all the treatments (E1 E5) pH decreased over the control (C) and got

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reduced towards neutrality. Reduction of pH towards neutrality should be an important factor in retaining N to promote nutrient availability of plants (Brady, 1988). The reduction of pH was between the range of 6.8 ± 0.2 7.2 ± 0.2 which was statistically significant (P<0.01). The pH is a good indicator of extent of biodegradation within the compost mass. Vermicomposting may proceed well at pH level between 5.5 - 9 (Hemalatha and Meenambal, 2005). Moisture content of all treatments (E1-E5) increased from 5.92 to 17.88 times over the control compost. During vermicomposting process the moisture content of E1-E5 substrates ranged between 73.66 ± 0.326 82.02 ± 0.032. The results show that approximately 70% to 80% moisture content is optimum for quicker stabilization of solid waste management by using earthworms. Viljoen and Reinecke (1989) reported that moisture level of 80% was most favourable for *E. eugeniae* in waste management. Edwards and Bater (1992) reported the optimum moisture content for the growth of *E. fetida*, *E. eugeniae*, *P. excavatus* and *D.veneta* to be 85 % in organic waste management.

Organic Carbon (OC) and Organic matter (OM) got decreased to values ranging between 27.8 ± 0.02 - 25.85 ± 0.13 and 47.93 ± 0.07 44.85 ± 0.36, respectively. During the process of vermicomposting even though the level of OC and OM were found to be reduced over the control, the vermicompost retained the quality of OC around 27.8 ± 0.2 and OM around 47.93 ± 0.70. The maximum narrowing down of C:N ratio was attained in E5 (11.05 ± 1.08). In other treatments the reduction of C: N ratio value was almost uniform (around 12), whereas in the control (C) it was 14.80 ± 1.08. The OC and OM in the soil and the vermicompost act as buffer for many deficiencies in soil and also form the main source of energy for both soil organisms and plants. C: N ratio is an important criteria for a good manure and should lie between 10 to 20. Plants cannot assimilate minerals, nitrogen, phosphorus unless the C:N ratio is 20:1 or lower (Edwards and Bohlen, 1996). In the present study there have been significant reductions of OM, OC, C: N ratio in vermicompost in all the experimental mixtures which fall in line with the already reported results (Kale *et al.,* 1992; Ramalingam, 1997; Karmegam and Daniel Thilagavathi, 2000; Christy and Ramalingam, 2005). The reduction of carbon and lowering of C:N ratio in the worm worked composts could be achieved one way by the respiratory activities of soil organisms (Edwards and Bohlen, 1996) and in another way by the increase of organic nitrogen by the microbial mineralization of organic matter (Syers *et al*., 1979), combined with the addition earthworms nitrogenous waste through excretion (Curry *et a*l., 1995). Riffalda and Leviminzi (1983) also observed that manure samples inoculated with *Eisenia fetida* decompose more rapidly and shows a high degree of humification than the wormless control compost.

The N, P, K, Ca, Mg level in all treatments were significantly higher ($p < 0.05$) over the control compost. A maximum N level was observed in E5- (2.23 ± 0.07), followed by 2.22 ± 0.52 in E2, 2.18 ± 0.28 in E3, 2.14 ± 0.40 in E4, and 2.06 ± 0.30in E1. Inoculation of earthworms in decomposting system enhances the amount of N efficiently due to earthworm driven rapid mineralization of nitrogen. Earthworms also enhance N level by adding their excretory products, mucus, body fluids, enzymes etc. to the substrate (Suthar, 2008). Maximum P level was recorded in E3 (1.00 ± 0.05). This may be partly due to earthworm's gut phosphatases and further release of P might be attributed by the *phosphobacteria* added in the substrate. Maximum K level was observed in E5 (1.82 ± 0.21) followed by E2 (1.74 ± 0.13), E3 (1.60 ± 0.74), E4 (1.27 ± 0.29) and E1 (1.26 ± 0.29). In all treatments by the end of the experiment increased K levels were observed. Higher level of Ca was recorded in E1 (1.02 ± 0.02) and similar increment of Mg level in E5 (0.73 ± 0.04). Significantly ($p < 0.05$) increased levels of N, P, K, Ca, and Mg in all the treatments (E1-E5) over the control compost C indicates the effective decomposition of substrate when they pass through the gut of earthworms. The increased nutrients in the worm worked composts were in conformity with the results of the earlier workers (Haimi and Huhta, 1987; Kale *et al.,* 1992; Karmegam and Daniel Thilagavathi, 2000; Christy and Ramalingam. 2005; Ramalingam and Ranganathan, 2001; Ramalingam and Thilagar, 2003). N, P, K were found to be high in the vermi composts, which could be attributed to the excretion of $CaCO_3$ by the earthworms which solubilizes the nutrients and makes it easy the absorption by the plant root systems (Logakanthi *et al*., 2000).

The reduction of Na content ranged between 0.07 ± 0.02 0.18 ± 0.02(Peak reduction in E4); Fe level decreased between 1817 ± 7.0 1907 ± 6.55. Mn content declined to the extent of 167 ± 14.10 209 ± 5.56. Zn reduction ranged between 52 ± 4.0 136 ± 8.88. Maximum narrowing down of Cu was recorded in E3 (3.1 ± 0.62) even though in all the treatments the Cu level decreased significantly. These results were in accordance with the observations of many other earlier reports which recorded reduced levels of Na, Fe, Mn, Zn, and Cu in the worm worked composts (Kale *et al*., 1994; Ramalingam and Ranganathan, 2001). So, it can be concluded that the reduction of Na and Fe in the worm worked compost may be due to the increased demand of Na and Fe by these worms for their growth and biomass production. Cynobacteria requires Na for the fixation of nitrogen in the soil and also a need for the early interactions in the Legume-*Rhizobium* symbiosis (Thomas and Apte, 1984). Earthworm species differ in their capability to take up the heavy metals (Mn, Zn, Cu) in their body tissues. Lee (1985) pointed out that the significance of the concentration of plant available heavy metals in the

Table 1. Nutrient analysis of the control and worm worked composts under different treatments at the end of 80 days. (Mean ± SD, n = 6). (See "Materials and methods" for details of the treatments E1 to E5)

Parameters	Control (C)	E1	E2	E3	E4	E5	't'
pH	7.4 ±0.1	6.8 ±0.2	7.2 ± 0.2	7.2 ±0.2	7.0 ±0.1	7.06 ± 0.11	0.009*
Moisture (%)	69.58 ±0.041	82.02 ±0.032	76.6 ±0.173	74.53 ± 0.251	75.09 ±0.055	73.66 ±0.326	0.01**
OC (%)	28.42 ±0.08	27.8 ±0.2	27.11 ±0.159	27.21 ±0.205	26.2 ±0.13	25.85 ± 0.13	0.011**
OM (%)	48.95 ±0.52	47.93 ±0.70	46.66 ±0.41	47.81 ± 0.35	45.85 ±0.27	44.85 ±0.36	0.016**
Nitrogen (%)	1.91 ±0.44	2.06 ±0.30	2.22 ±0.52	2.18 ± 0.28	2.14 ±0.40	2.23 ±0.07	0.0011*
Phosphorus (%)	0.89 ± 0.01	0.96 ±0.02	0.96 ±0.02	1.00 ±0.05	0.94 ±0.01	0.93 ±0.12	0.004*
Potassium (%)	1.16 ±0.15	1.19 ±0.20	1.74 ±0.13	1.60 ±0.47	1.27 ±0.29	1.82 ±0.21	0.044**
Calcium (%)	0.77 ±0.03	1.02 ±0.02	0.88 ±0.05	0.80 ±0.11	0.82 ±0.09	0.93 ±0.13	0.039**
Magnesium (%)	0.59 ±0.15	0.61 ±0.17	0.68 ±0.11	0.67 ±0.06	0.62 ± 0.09	0.73 ±0.04	0.029**
Sodium (%)	0.18 ±0.01	0.1 ±0.004	0.17 ±0.03	0.18 ±0.02	0.07 ±0.02	0.13 ±0.01	0.153
Iron (ppm)	1947 ±8.18	1907 ±6.55	1901 ±2.0	1887 ±16.64	1874 ±4.52	1817 ±7.0	0.012**
Manganese (ppm)	211 ±10.53	187 ±3.0	183 ±4.58	209 ±5.56	192 ±17.77	167 ±14.10	0.026**
Zinc (ppm)	328 ±26.05	52 ±4.0	119 ±7.93	136 ± 8.88	90.33 ±0.42	98 ±1.73	8.75E-05
Copper (ppm)	60 ± 4.0	41 ± 4.35	3.1 ±0.62	53 ±6.08	44.33 ±3.21	16 ± 2.0	0.038**
C:N ratio	14.8 ±1.08	13.5 ±1.65	12.6 ±0.4	12.53 ±0.35	12.3 ± 0.7	11.5 ± 1.08	0.001 *

* Significance at P<0.01, ** Significance at P<0.05.

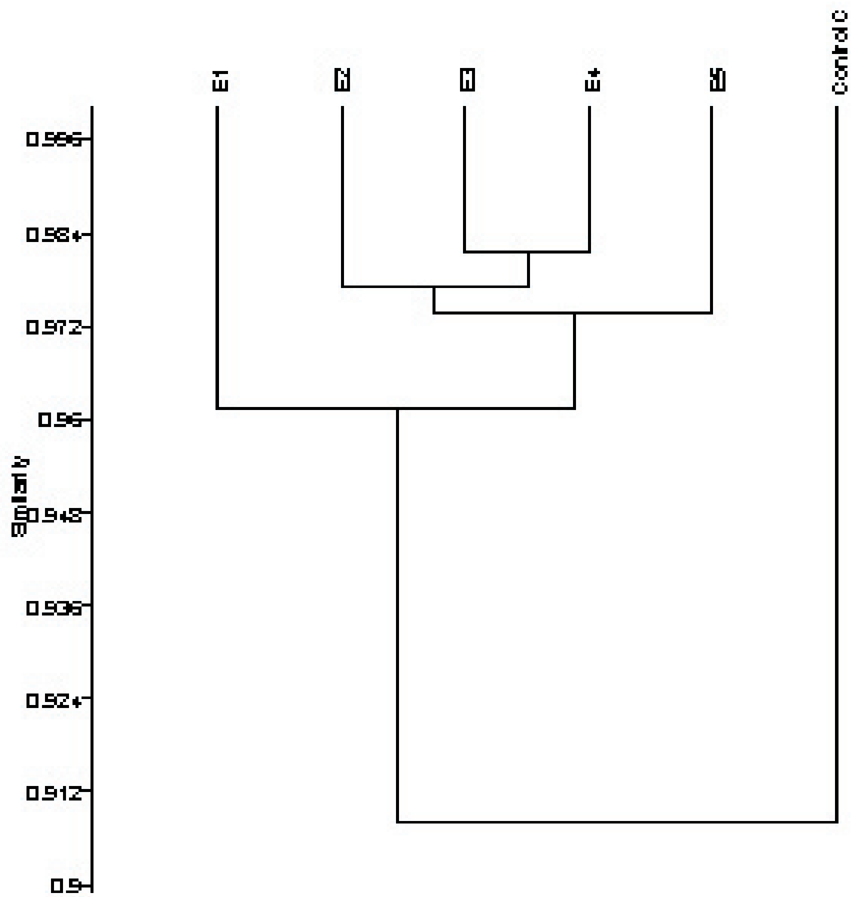

Figure 1. Bray - Curtis similarities between control and different treatments (See materials and methods" for details of treatments E1 E5)

Table 2. Bray - Curtis similarity and distance indices between control and different treatments. (See "Materials and methods" for details of treatments E1 E5)

	Control	E1	E2	E3	E4	E5
Control	1					
E1	0.877	1				
E2	0.900	0.954	1			
E3	0.908	0.950	0.977	1		
E4	0.895	0.961	0.977	0.982	1	
E5	0.882	0.939	0.969	0.959	0.974	1

earthworm tissues is difficult to assess.

Bray-Curtis similarities were calculated (root transformed) between control and treatments, and the resulting dendrogram and distance indices were shown in Table 2 and Figure 1. Overall the control and treatment E5 have more distances due to increased levels of N, P, K, Ca, Mg, Mn and decreased levels of other nutrients.

It was evident from this experiment that biofertilizers, *Azospirillum* (E2) and *Rhizobium* (E5) mixed substrates proliferated rapidly and fix nitrogen during vermicomposting process. They also helped to increase the nitrogen content by nitrogen fixation and reducing denitrification of the substrate. A high level of total available phosphorus (TAP) content was recorded in E3 by conversion of insoluable phosphate to soluable form, further release of P by addition of *Phosphobacteria* in the substrate.

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