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Assessment of vermicompost and vermiwash by using different waste and epigeic species of earthworms

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Abstract
The investigation entitled “Assessment of Vermicompost and Vermiwash by Using Different Waste and Epigeic Species of Earthworms” was conducted at Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri. Vegetable Waste (VW), Flower Waste (FW), Fruit Waste (FW), Municipal Waste (MW) waste as a main substrate for preparation of vermicompost along with two species of earthworm’s *viz. Eudrilus eugeniae* and *Eiseniab foetida*. The results of the experiment showed that on composting the pH of all organic residues slightly decreased, there was gradual increase in electrical conductivity of composting materials from 60 DAI to the 90 DAI of composting. Considering the macronutrients, highest total nitrogen, phosphorus and potassium content *viz.* 1.38%, 0.56% and 0.52% respectively was noted in municipal waste compost while the lowest total nitrogen, phosphorus and potassium content *viz.* 1.12%, 0.40% and 0.42% respectively was noted in fruit waste.

Keywords: Vermicompost, vermiwash, vegetable waste, flower waste, fruit waste, municipal waste, macronutrients

Introduction
Modern agriculture over the last some year has depended heavily on the inorganic chemical fertilizers. Several adverse effect of chemical fertilizers on soil, environment and the plant health have been reported (Singh, 2003) [8]. India is the second largest producer of fruits and vegetables in the world (Next to china) with 221.423 million metric tonnes. The cumulative wastage are estimated to 5.8 to 11% of the total produced fruits and vegetables. Earthworms play a key role in the soil biology and can eat all types of organic matter equal to their body weight each day and leaving worm castings as by product. These worm castings are called vermicompost. The selection of suitable earthworm species for vermicomposting is an important step of the overall process. Out of the thousands of species of earthworms, only a few are suitable for vermicomposting of organic wastes. The epigeic species of earthworms are widely used for vermicomposting of different organic wastes. Organic wastes are extensively increasing with increased human populations, intensive agriculture and industrialization. The disposal of wastes has become important for a healthy quality of environment (Senapati and Julka, 1993) [7]. The processing of waste material through controlled bio-oxidation processes such as vermicomposting reduces the environmental risk by transforming the material into a safer and more stable product suitable for application to soil (Lazcano *et al*., 2009) [5]. It also reduces the transportation costs because of the significant reduction in the water content of the raw organic matter. The vermicompost itself is beneficial for the land in many ways including as a soil conditioner, as fertilizer, addition of vital humus or humic acids and as a natural pesticide for soil. Indeed the use of red wriggler worms to produce vermicast has good potential for the production of organic fertilizer. The present study “Assessment of Vermicompost and Vermiwash by Using Different Waste and Epigeic Species of Earthworms” is planned to convert the different wastes to generate in huge amount to produce good quality vermicompost.

Material and Methods
Different waste material such as Vegetable Waste (VW), Flower Waste (FW), Fruit Waste (FW), Municipal Waste (MW) was used as a main substrate for preparation of vermicompost. Vegetable waste were collected from the local mandai of vegetable market likewise, fruit wastes were collected from fruit market and fruit juice centres where as flower wastes were collected from various temples.

Sorting of non-compostable materials like plastic, stone, polythene, *etc*. was done. All material heaped on ground and exposed to sun. This helped in killing several unwanted organisms and removed foul smell. All organic substrate materials were cut into smaller pieces for enhancing decomposition and vermicomposting.

All the organic wastes *viz*., kitchen wastes, municipal wastes, fruit waste and flower waste were shredded and chopped into small pieces and mixed with cow dung (one week old) in its required proportions as per the treatment details. The mixed substrates were kept for two weeks for pre-decomposition under shade and rain proof shed.The dung obtained from all the cattle placed separately for one week under shade in an open area to settle the substrate material. Thereafter, substrates were utilized for the purpose of vermicomposting. The species of earthworm, *Eisenia fetida* and *Eudrilus eugenie* was used for vermicomposting which brought from M/s. Institute of Natural Organic Agriculture, Pune. Bottom of the pot was covered with 3 cm thick layer of broken pieces of bricks, on which 5 cm layer of sieved soil was spread. On that layer 50 earthworms were introduced and immediately above, a 40 cm thick layer of partially decomposed waste material (7.00 kg) as per the respective treatment was spread and was sufficiently moistened to maintain the moisture around 50 per cent. Then the pots was covered with gunny bags to maintain adequate moisture and body temperature of earthworms and to protects against birds, termites, ants and rats. The organic residues were watered three to four times in a week so as to maintain an optimum moisture level of 50 per cent for composting.

pH of vermicompost (at 60 and 90 days of vermicomposting) was determined with the help of digital pH meter having combined electrode with thermo probe using 1:10 compost: water suspension ratio (Jackson, 1973) [2]. Electrical conductivity of treatment wise vermicompost samples at 60 and 90 days of vermicomposting, was determined from clear supernatant of overnight kept 1:10 compost: water ratio with the help of conductivity meter (Jackson, 1973) [2]. Total nitrogen in treatment wise vermicompost samples at 60 and 90 days of vermicomposting, was determined by Kjeldahl's modified sulfuric salicylic acid mixture method (Jackson, 1973) [2]. Total phosphorus in treatment wise vermicompost samples at 60 and 90 days of vermicomposting, a known quantity of di-acid extract was used for the determination of phosphorous by vanadomolybdate yellow colour method (Jackson, 1973) [2]. Total potassium in treatment wise vermicompost and vermiwash samples at 60 and 90 days of vermicomposting, was determined by flame photometer method (Piper, 2010) [6].

Results and Discussion

pH of vermicompost

The change in pH during composting of organic residues were found to be significant with respect to individual effect of organic wastes on 60 DAI as well as on 90 DAI of composting. The lowest pH of 7.01 was recorded with treatment flower waste, while maximum pH value of 7.61 was noted with treatment fruit waste. On 60 DAI of composting, treatment M_3 containing fruit waste was found significantly superior over treatment M_2 receiving flower waste. The treatments M_1 and M_4were found to be at par. At the end of composting lowest pH value of 6.90 was noted in treatment flower waste, while maximum value of 7.50 was noted in the treatment vegetable waste. On 90 DAI of composting, treatment M_1 receiving vegetable waste was found significantly superior over the treatments M_2 receiving flower waste and treatment M_4 receiving municipal waste (Table 1). Haini and Huhta (1987) [1] while studying the vermicomposting of some organic residues concluded that the lower pH of end product (vermicompost) might be due to the production of CO_2 and organic acids by microbial decomposition, during the process of bioconversion of different substrates in the beds. Jadhav (1995) [3] found that initially the pH of farm waste was in neutral range, while that of dried leaves and local grass was in slightly acidic in range.

Electrical conductivity (dSm^{-1}) of vermicompost

The changes in values of electrical conductivity of the organic residues during the period of composting had increasing trend from 60 days to 90 days. (Table 2). The reason for high electrical conductivity in vermicompost may be due to loss of organic matter and release of different mineral salts in available forms (such as phosphate, ammonium and potassium). These results are in conformity with the findings of Kaviraj and Sharma (2003) [4] who reported that the electrical conductivity (EC) increased during the period of the composting as well as vermicomposting process.

Total nitrogen content of vermicompost

The total nitrogen content of different organic residues varies significantly right from 60 days to till the end of composting. (Table 3). At 60 DAI, it was observed that the maximum total nitrogen (1.23%) was observed in treatment M_4 *i.e.* municipal waste while minimum total nitrogen (0.91%) was recorded in treatment M_3 *i.e.* fruit waste. Treatment M_4 containing municipal waste was found significantly superior over all other treatments. At 90 DAI, maximum total nitrogen (1.38%) was recorded in treatment M_4 *i.e.* municipal waste, while minimum total nitrogen (1.12%) was recorded in treatment M_3 *i.e.* fruit waste. The enhancement of N in vermicompost was probably due to mineralization of the organic matter and increased rates of conversion of ammonium-N into nitrate noted by Suthar and Singh (2007) [9].

Total phosphorus content of vermicompost

The total phosphorus content of different organic residue were found significant at 60 DAI and 90 DAI of composting (Table 4). At 60 DAI, regarding the different organic residue, it was observed that the maximum total phosphorus (0.53%) in treatment M_4 *i.e.* Muncipal waste while minimum total phosphorus (0.31%) was recorded in treatment M_3 *i.e.* fruit waste. Treatment M_4 containing municipal waste was found significantly superior over rest of the treatments. At 90 DAI, maximum total phosphorus (0.56%) was recorded in treatment M_4 *i.e.* Municipal waste while minimum total phosphorus (0.40%) was recorded in treatment M_3 *i.e.* fruit waste. In general, the compositing of waste along with cow dung in different proportions resulted into increase in phosphorus content of final products. The increase in the total phosphorous content may be due to the contribution of phosphorous by worm cast. The vermicompost increased phosphorus availability by phosphorus solubilisation through phosphatases of earthworms' gut Suthar and Singh (2007) [9].

Total potassium content of vermicompost

The changes in total potassium content were showed significant results (Table 5). At 60 DAI, regarding the different organic residues, it was observed that the maximum potassium (0.52%) was in treatment M_4 *i.e.* Municipal waste, while minimum total potassium (0.38%) was recorded in treatment M_3 *i.e.* Fruit waste. At 90 DAI, maximum total potassium (0.60%) was recorded in treatment M_4 containing municipal waste while minimum total potassium (0.42%) was found in treatment M_3 containing fruit waste. The increase in potassium content of the vermicompost in relation to that of the simple compost and substrate was probably because of physical decomposition of organic matter of waste due to biological grinding during passage through the gut, coupled with enzymatic activity in worm's gut, which may have caused its increase. An increase in the total potassium content of final product was also reported by Talashikar *et al.* (1996) [10]. Kaviraj and Sharma (2003) [4] opined that acid production by the microorganisms is the major mechanism for solubilizing of insoluble potassium at the time of decomposition.

Table 1: Changes in pH during composting of organic residues

Treatment effect		60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean
M_1	Vegetable Waste	7.50	7.62	7.56	7.46	7.53	7.50
M_2	Flower Waste	7.04	6.98	7.01	6.86	6.93	6.90
M_3	Fruit Waste	7.54	7.67	7.61	7.44	7.43	7.44
M_4	Municipal Waste	7.35	7.59	7.47	7.36	7.41	7.38
Mean		7.36	7.47	7.41	7.28	7.32	7.30
		M	E	M x E	M	E	M x E
S.E. ±		0.06	0.04	0.08	0.03	0.02	0.05
C.D. at 5%		0.18	NS	NS	0.10	NS	NS

Table 2: Changes in electrical conductivity (dS m^{-1}) during composting of organi residues

Treatment effect		60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean
M_1	Vegetable Waste	0.392	0.385	0.389	0.489	0.525	0.507
M_2	Flower Waste	0.411	0.378	0.395	0.519	0.536	0.527
M_3	Fruit Waste	0.377	0.374	0.375	0.500	0.471	0.485
M_4	Municipal Waste	0.429	0.397	0.413	0.548	0.476	0.512
Mean		0.402	0.384	0.393	0.514	0.502	0.508
		M	E	M x E	M	E	M x E
S.E. ±		0.014	0.010	0.019	0.013	0.009	0.018
C.D. at 5%		NS	NS	NS	NS	NS	NS

M - Material effect E – Earthworm effect
NS- Non Significant E_1 – *Eudrilus eugeniae*
E_2 – *Eisenia fetida*

Table 3: Periodical changes in total nitrogen (%) content during composting of organic residues

Treatment effect		60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean
M_1	Vegetable Waste	1.04	1.01	1.02	1.36	1.31	1.34
M_2	Flower Waste	0.95	0.93	0.94	1.27	1.22	1.25
M_3	Fruit Waste	0.94	0.88	0.91	1.12	1.12	1.12
M_4	Municipal Waste	1.24	1.23	1.23	1.42	1.35	1.38
Mean		1.04	1.01	1.03	1.29	1.25	1.27
		M	E	M x E	M	E	M x E
S.E. ±		0.01	0.01	0.02	0.01	0.01	0.02
C.D. at 5%		0.03	0.02	NS	0.04	0.03	NS

Table 4: Periodical changes in total phosphorus (%) content during composting organic residues

Treatment effect		60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean
M_1	Vegetable Waste	0.43	0.41	0.42	0.49	0.47	0.48
M_2	Flower Waste	0.39	0.37	0.38	0.48	0.48	0.48
M_3	Fruit Waste	0.33	0.30	0.31	0.40	0.40	0.40
M_4	Municipal Waste	0.55	0.52	0.53	0.59	0.54	0.56
Mean		0.42	0.40	0.41	0.49	0.47	0.48
		M	E	M x E	M	E	M x E
S.E.		0.01	0.01	0.01	0.01	0.01	0.01
C.D. at 5%		0.02	0.02	NS	0.02	0.02	NS

Table 5: Periodical changes in total potassium (%) content during composting of organic residues

Treatment effect		60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean
M_1	Vegetable Waste	0.51	0.49	0.50	0.50	0.49	0.50
M_2	Flower Waste	0.44	0.41	0.42	0.46	0.43	0.45
M_3	Fruit Waste	0.38	0.38	0.38	0.43	0.41	0.42
M_4	Municipal Waste	0.55	0.49	0.52	0.61	0.59	0.60
Mean		0.47	0.44	0.45	0.50	0.48	0.49
		M	E	M x E	M	E	M x E
S.E. ±		0.01	0.01	0.01	0.01	0.01	0.01
C.D. at 5%		0.03	0.02	NS	0.02	0.02	NS

M – Material effect E – Earthworm effect
NS- Non Significant E_1 – *Eudrilus eugeniae*
E_2 – *Eisenia fetida*

Conclusion

Based on the findings of the present investigations, it can be concluded that amongst the various organic sources evaluated municipal waste was best source preparation of better quality of vermicompost followed by vegetable waste. Between the two species of earthworms, *Eudrilus eugeniae* species of earthworm found superior over *Eisenia fetida* species of earthworm in respect of most of the parameters studied. The manurial value of all the organic residues improved due to vermicomposting.

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