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Effect of Some Additives on Vermicomposting of Garden Waste Using *Eudrilus eugeniae,* an Epigeic Earthworm

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Abstract: Earthworms have been used in the degradation of various types of wastes from prehistoric times. These wastes include industrial, agricultural and domestic wastes etc. This study examines the potential of the African night crawler *Eudrilus eugeniae* in the bioconversion of garden waste and cow dung into vermicompost and effect of some additives. Garden waste was mixed with different proportions of cow dung to make it feasible diet for earthworms. Garden waste and cow dung in the ratio of 1:1 was found to be the best ratio and this ratio was selected for further studies. It was found that a mixture of waste paper and cow dung acts as a good medium for the survival and reproduction of earthworms. Free choice experiment showed the preference of earthworms towards differentially treated media. Trichoderma treated media was the most preferential medium followed by Vermiwash and Jaggery+buttermilk and control. Significant increase was found in all the parameters like percent increase in number, weight, percent population growth and biomass production. Physico-chemical parameters also showed increment in comparison to control. Vermicomposting is thus a very useful and economic stabilization of waste.

Key words: Cow dung · Waste management · Vermirsources · Biomass production

INTRODUCTION

During the past few decades the generation of wastes has increased at an enormous rate and the main reasons for this have been population explosion, industrialization and urbanization. Earthworms are important Vermiresources having simple, cylindrical, coelomate and segmented body characterized by presence of setae. Many organic by-products of agricultural production and processing industries are currently seen as. waste' and thus become potential environmental hazards. A portion of this waste is currently reused, recycled or reprocessed: however a majority of it is disposed off in Landfills (anaerobic composting), which is a matter of concern due to many factors including cost and environmental issue. During recent years, applied use of earthworms in the breakdown of a wide range of organic residues, including sewage sludge, animal wastes, crop residues and industrial refuse to produce vermicompost, has been recommended [1-9]. Vermicompost is rich in microbial populations and diversity particularly fungi, bacteria and actinomycetes [7]. The importance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture has been highlighted by several workers [10-16]. Nutrients present in vermicompost are readily available for plant growth and vermicompost has a higher concentration of available nutrients than the wastes from which it is formed. The worms actually enhance microbial activity and diversity [17,18] and lead to rapid degradation of waste and recovery of nutrients.

The use of some bioinoculents in vermicomposting has been continuing but the literature available in this direction has been minimal. Keeping this thing in mind the present study was taken with an objective to investigate the role of *Eudrilus eugeniae* in the vermicomposting of garden waste mixed with cow dung and also to observe the effect of various additives.

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MATERIALS AND METHODS

Collection of Cattle Dung and Garden Waste: The fresh cattle dung was procured from nearby buffalo dairy farm. The moisture content of the medium was maintained at about 50%-60% and the garden waste was obtained from the Charak Udyan Garden, Jiwaji University Gwalior. The garden waste mainly consisted of leaves and flowers. The garden waste was chopped into smaller pieces in order to make it feasible for worms.

Collection of Earthworms: Earthworms were procured from vermicomposting center, located in charak Udhyan of Jiwaji University, Gwalior. Separate vermi-beds were made using ten days old cattle dung for mass culture of *Eudrilus eugeniae*. The culture was constantly monitored throughout the period of study with time by time spraying of water. Mature clitellate worms for experimental purpose were taken from this stock culture.

Experimental Setup: Two sets of experiments were conducted in the present study.

Free Choice Experiment: For determining the preferences of earthworms towards cultured media, a free choice experiment was conducted in ceramic tanks of 45x30x15 cm measurement. The sink was divided into four equal size chambers with the help of thermocole sheets arranged around a middle chamber (perforated plastic container). Thermocole sheets were provided with some holes so that earthworms can pass through from one chamber to another, according to their preferential habits. In the first chamber (A) mixture of dung and garden waste was filled, which was predecomposed with a solution of *Trichoderma harzianum* (containing 5 g in five litres of water (TR1)., in the chamber (B) mixture of dung and garden waste was filled which was predecomposed by adding vermiwash(TR2), in the chamber (C) dung and garden waste was filled, which was predecomposed sprinkling with a solution containing of butter milk and of jaggery, (450ml+250 gm in 5 litre of water) and in the chamber (D) mixture of dung and garden waste was filled, which was predecomposed by using simple water (TR4). The quantity of the medium in all the four chambers was kept constant (3 kg). In the middle chamber 100 adult earthworms were filled and the whole assembly was covered by garden mesh net. The worms had a freedom to migrate and distribute themselves in any one of the media of their own choice. Free choice experiment was repeated three times and the results were recorded after 15 days by counting the number of earthworms and calculating the percent distribution of earthworms in each chamber.

Composting Experiment: The composting experiment was conducted in a series of plastic containers having a capacity of 3 kg waste. After pre-decomposition of 15 days, 25 worms were released in each container and were continuously sprinkled with their respective treatments during the study period of 60 days. After the 60 day time a fine vermicompost was found in each container. It was sieved and the earthworms were separated. Observations were made on Quarterly basis and the parameters analyzed include change in number of - adult worms, cocoons and juveniles, change in weight of - adult worms, cocoons and juveniles. Physico-chemical parameters of the Vermicompost obtained were also analysed.

Data was analyzed statistically by using Analysis of Variance (ANOVA).

RESULTS

Free Choice Experiment: Free choice experiment was conducted to determine the preference or liking of earthworms towards differentially treated bedding material (1:1 ratio of Dung and garden waste). The maximum number (42%) of earthworm's preferred the medium that was treated with Trichoderma for their settlement during experimental period of 15 days, Vermiwash treated medium was next with 30% showing their preference followed by jaggery and buttermilk (17%) Least preference was shown by control with 11% preferring this medium (Fig. 1).

Number of Adult Worms: The data obtained for the change in number of adult worms during a period of 60 days is depicted in Table 1. A significant increase in the number of adults was recorded in the *Trichoderma* treated media (TR1). The number of adults in this treatment was increased from 25 to 61, followed by 25 to 45, 25 to 40 and 25 to 35.66 in TR 2, TR3 and TR4, respectively.

At the end of experiment, maximum mean value (35.4±7.11) of adult worms was observed in TR1 which was statistically significant from the values obtained for all other treatments ($p<0.5$). The next preferred additive was TR2 with 30.8±3.95 number of adults, followed by 29.00±2.91 in TR3 and 27.8±2.13 adult worms in case of control (no additive). The differences among all these three treatments were non-significant.

Fig. 1: Plastic Containers containing waste

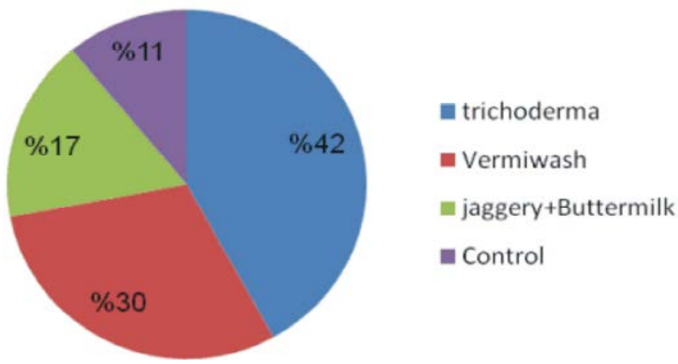

Fig. 2: Pie diagram showing the relative preference of earthworms towards differentially treated media

Table 1: Showing change in number of adults in differentially treated media

		Treatments			
S.No.	Intervals (day)	Trichoderma	Vermiwash	Jaggery+Buttermilk	Control
1	1st	25±0.00	25±0.00	25±0.00	25±0.00
2	15th	25±0.00	25±0.00	25±0.00	25±0.00
3	30th	25±0.00	25±0.00	25±0.00	25±0.00
4	45th	41.66±0.66	32.66±0.88	29.66±0.33	28.00±0.57
5	60th	61.00±0.57	45.00±0.57	40.00±0.57	35.66±0.66
Mean		35.4±7.11*	30.8±3.95**	29.00±2.91**	27.8±2.13

Values are expressed as Mean ± SE, * value denotes statistically significant ($p<0.5$), ** values denotes statistically at par i.e, Not significant

Table 2: Showing change in number of cocoons in differentially treated media

		Treatment			
S.No.	Interval (day)	Trichoderma	Vermiwash	Jaggery+Buttermilk	Control
1	1st	0	0	0	0
2	15th	15±1.15	11±0.88	8±1.45	6±0.88
3	30th	25±1.45	21±0.88	17±1.20	13±1.20
4	45th	40±1.66	36±1.15	30±1.20	27V0.88
5	60th	60±2.30	50±2.02	42±1.76	38±1.45
Mean		28±10.34*	23.6±8.89	19.4±7.55	16.8±6.97

Values are expressed as Mean ± SE, * value denotes statistically significant ($p<0.5$)

Table 3: Showing change in number of juveniles in differentially treated media

		Treatment			
S.No.	Interval (day)	Trichoderma	Vermiwash	Jaggery+Buttermilk	Control
1	1st	0	0	0	0
2	15th	22±1.45	19±1.45	15±0.88	10±1.20
3	30th	34±1.15	29.00±0.88	23±1.15	16±1.85
4	45th	47±2.02	43±1.20	38±1.15	31±1.45
5	60th	68±1.76	57±0.88	42±1.52	37±1.20
Average		34.2±11.48*	29.6±9.82	23.6±7.69	18.8±6.79

Values are expressed as Mean ± SE, * value denotes statistically significant (p<0.5)

Table 4: Showing change in weight of adults in differentially treated media

		Treatment			
S.No.	Interval (day)	Trichoderma	Vermiwash	Jaggery+Buttermilk	Control
1	1st	33.00±0.88	32.45±0.88	32.00±0.88	32±1.15
2	15th	35.03±0.57	34.90±1.00	34.60±0.88	34.15±1.20
3	30th	37.00±0.88	36.86±0.88	36.50±1.0	36.00±0.88
4	45th	54.66±1.33	43.33±0.93	39.44±1.15	37.24±1.15
5	60th	81.13±2.73	59.85±1.00	53.20±0.88	47.42±1.15
Mean		48.16±9.09*	41.47±4.93	39.14±3.71	37.36±2.66

Values are expressed as Mean ± SE, * value denotes statistically significant (p<0.5)

Data further revealed that the number of adult worms was increased significantly in TR1 from the day 1 to last day of the experiment values being 25 to 61.00±0.57. In case of TR 2 and TR3, non-significant increase was observed in the number of adult worms. Whereas, in TR4, small increase was observed in the number of adult worms and the values obtained were 25 to 35.66±0.66.

Number of Cocoons: The results which were obtained for the change in number of cocoons during a period of 60 days are depicted in Table 2. A significant increase in the number of cocoons was recorded in the Trichoderma treated media (TR1), the value of which was statistically significant (p<0.5). The number of cocoons in this treatment was 60 followed by 50, 42 and 38 in TR2, TR3 and TR4, respectively.

At the end, maximum mean value (28±10.34) number of cocoons was observed in TR1. The next preferred additive was TR2 with 23.6±8.89 number of cocoons, followed by 19.4±7.55 in TR 3 and 16.8±6.97 number of cocoons in case of control (no additive).

The results further revealed that the number of cocoons had increased significantly in TR 1 from the day 1 to last day of the experiment values being 0 to 60±2.30. In case of TR2 and TR3, non-significant increase was observed in the number of adult worms. Whereas, in TR4, small increase was observed in the number of adult worms and the values obtained were 0 to 38±1.45.

Number of Juveniles: The results obtained for the change in number of juveniles during a period of 60 days is depicted in Table 3. A significant increase in the number of adults was recorded in the Trichoderma treated media (TR1). The number of juveniles in this treatment was 68 followed by 57, 42 and 37 in TR2, TR3 and TR4, respectively.

At the end of experiment, maximum mean value for number of juveniles was observed in TR1 (34.2±11.48) which was statistically significant (p<0.5) The next preferred additive was TR2 with 29.6±9.82 number of juveniles, followed by 23.6±7.69 in TR3 and 18.8±6.79 number of juveniles in case of control (no additive).

Results also revealed that the number of juveniles had increased significantly in TR 1 from the day 1 to last day of the experiment values being 0 to 68 ±1.76. In case of TR 2 and TR 3, non-significant increase was observed in the number of juveniles. Whereas, in TR 4, small increase was observed in the number of juveniles and the values obtained were 0 to 37±1.20.

Weight of Adult Worms: The figures which we obtained for the change in weight of adults during a period of 60 days is depicted in Table 4. A significant increase in the weight of adults was recorded in the Trichoderma treated media (TR1). The weight of adults in this treatment was 81.13 ± 2.73g followed by 59.85±1.00 g, 53.20±0.88g and 47.42±1.15 g in TR2, TR3 and TR4, respectively.

Table 5: Showing change in weight of cocoons in differentially treated media

		Treatment			
S.No.	Interval (day)	Trichoderma	Vermiwash	Jaggery+Buttermilk	Control
1	1st	0	0	0	0
2	15th	0.29±0.008	0.27±0.014	0.25±0.014	0.21±0.012
3	30th	0.58±0.008	0.55±0.011	0.52±0.012	0.49±0.014
4	45th	0.77±0.014	0.74±0.011	0.70±0.012	0.69±0.012
5	60th	1.25±0.014	1.13±0.04	1.05±0.046	1.00±0.043
Mean		0.57±.21	0.53±.19	0.50±.18	0.47±.17

Values are expressed as Mean ± SE,

Table 6: Showing change in weight of juveniles in differentially treated media

		Treatment			
S.No.	Interval (day)	Trichoderma	Vermiwash	Jaggery+Buttermilk	Control
1	1st	0	0	0	0
2	15th	3.33±0.33	2.00±0.57	2.66±0.66	2.33±0.33
3	30th	5.66±0.33	5.33±0.88	5.00±0.57	4.00±0.57
4	45th	9.00±1.15	7.33±0.88	7.33±0.88	5.33±0.88
5	60th	12.33±1.12	11.00±0.57	9.00±0.57	8.66±1.20
Mean		6.46±2.06*	5.13±1.94	4.79±1.61	4.06±1.45

Values are expressed as Mean ± SE, * value denotes statistically significant ($p<0.5$)

Table 7: Physico-chemical parameters of differentially treated substrates

S.NO.	Treatment	pH	EC(dS/m)	N (%)	P (%)	K (%)
1.	*Trichoderma*	7.5±0.0314	0.36±0.002	0.50±0.0012	1.41±0.002	0.34±0.0012
2.	Vermiwash	7.6±0.0204	0.50±0.0012	0.43±0.002	1.30±0.002	0.30±0.002
3.	Jaggery+Buttermilk	7.5±0.0353	0.70±0.0023	0.41±0.0014	1.28±0.0032	0.29±0.0023
4.	Control	7.3±0.0204	0.85±0.0023	0.36±0.002	1.18±0.0012	0.22±0.002

Values are expressed as Mean±SE

At the completion of experiment, maximum mean value (48.16±9.09) of adult worms was observed in TR1 which was statistically significant ($p<0.5$). The next preferred additive was TR2 with 41.47±4.93 number of adults, followed by 39.14±3.71in TR3 and 37.36±2.66 cocoons in case of control (no additive).

The figures obtained also revealed that the weight of adults had increased significantly in TR1 from the beginning to end of the experiment values being 33±0.88 to 81.13±2.73. In case of TR2 and TR3, non-significant increase was observed in the weight of adult worms. Whereas, in TR4, small increase was observed in the weight of adult worms and the values obtained were 32±1.15 to 47.42±1.15

Weight of Cocoons: Results obtained for the change in weight of cocoons during a period of 60 days is depicted in Table 5. A significant increase in the weight of cocoons was recorded in the Trichoderma treated media (TR1). The weight of cocoons in this treatment (TR1) was 1.25g which was not stastically significant i.e., $p> 0.5$. This was followed by 1.13g, 1.05g and 1.00g in TR2, TR3 and TR4 respectively.

At the end of experiment, maximum mean value 0.57±.21 of weight of cocoons was observed in TR1. The next preferred additive was TR2 with 0.53±.19g weight of cocoons, followed by 0.50±.18g in TR3 and 0.47±.17g weight of cocoons in case of control (no additive).

The figures obtained also revealed that the weight of cocoons increased in TR1 from the beginning to conclusion of the experiment values being 0 to 1.25±0.014g.This change in weight of cocoons was stastically non significant. In case of TR2 and TR3, also a non-significant increase was observed in the weight of cocoons. Whereas, in TR4, very small increase was observed in the weight of adult worms and the values obtained were 0 to 1.00±0.043g.

Weight of Juveniles: The results which were obtained for the change in weight of juveniles during the period of 60 days is depicted in Table 6. A significant increase in the weight of juveniles was recorded in the Trichoderma treated media (TR1). The weight of juveniles in this treatment was 12.33g which is statistically significant, followed by 11.00 g, 9.00 g and 8.66 g in TR2, TR3 and TR4, respectively.

At the end of experiment, maximum mean value 6.46±2.06g weight of juvenile worms was observed in TR1. The next preferred additive was TR2 with 5.13±1.94 weight of juveniles, followed by 4.79±1.61g in TR3 and 4.06±1.45g cocoons in case of control (no additive).

The results obtained also revealed that the weight of juveniles had increased in TR1 from the day 1 to last day of the experiment values being 0 to 12.33 ±1.12g. In case of TR2 and TR3, also a non-significant increase was observed in the weight of cocoons. Whereas, in TR4, a small increase was observed in the weight of juveniles and the values obtained were 0 to 8.66 ±1.20g.

Physico-Chemical Analysis: The results of physico-chemical analysis of the vermicompost obtained from differentially treated substrates angd control are given in Table 7.

Maximum value of pH (7.6±0.0204) was observed in Vermiwash treated media followed by Trichoderma (7.5±0.0314) and Jaggery + Buttermilk (7.5±0.0353), while least value for pH was recorded in control (7.3±0.0204). The Elecrical conductivity values obtained for the compost obtained from various treatments were trichoderma (0.50±0.002), vermiwash (0.50±0.0012), Jaggery+Buttermilk(0.70±0.0023) and control/untreated (0.85±0.0023). With regard to percent Nitrogen in compost obtained from different treatments, the values were 0.50±0.0012, 0.43±0.002, 0.41±0.0014 and 0.36±0.002 in Trichoderma, Vermiwash, Jaggery + Buttermilk and Control, respectfully. Phosphorous and potassium content in the various treatments was also analyzed. The maximum phosphorous content was observed in Trichoderma (1.41±0.002) followed by Vermiwash (1.30±0.002), Jaggery + Buttermilk (1.28±0.002) and Control (1.18±0.001%). The potassium content was also maximum in Trichoderma treated compost (0.34±0.0012) followed by Vermiwash (0.30±0.002), Jaggery+ Buttermilk (0.29±0.0023). Minimum potassium content was observed in Control group (0.22±0.002) in which no any additive was added.

DISCUSSION

During composting, the organic wastes are decomposed by microbial action. The organic C is lost as CO_2 and total N increases as a result of carbon loss. The final N content of compost is dependent on the initial N present in the waste and the extent of decomposition [19,20]. Microflora in the intestine of worms and gut enzymes, as well as microflora present in the waste, are involved in decomposition [21,22]. Enhanced organic matter decomposition in the presence of earthworms has been reported, which results in lowering of C:N ratio [23,24,7].

The treatment of these wastes with these additives reults in the faster degradation of these wastes. This influence is attributed to stimulation of microorganisms like in case of jiggery+buttermilk, *Lactobacilli.* Earlier studies have also showed that microorganisms like *Trichoderma herzianum* which degrade cellulosic substrates can be used to improve vermicomposting [25-27]. Results obtained for number, weight & biomass production are more or less similar to the findings of [28,29,30] who reported increase in number & weight of earthworms on the basis of quality and quantity of available food. The results obtained for vermicomposting performanance were more or less similar to [25,26,31,32] who reported that the composting can be enhanced by adding different additives like *spirulina*, vermiwash, sugarcane and *Trichoderma.* Also the time of predecompostion was reduced by adding different additives. Our results are in agreement with the study which demonstrated that overall time required for composting can be reduced to 20 days by adding different additives [33].

CONCLUSION

It can be concluded that vermicomposting is a feasible technology for the conversion of garden waste after mixing with cowdung and pre-digestion with different additives into a valuable product – vermicompost.These additives actually enhance the process of decomposition and thereby reduce the timing of composting.

Competing Interests: The author(s) declare that they have no competing interests

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