

Biological Properties of Vermicompost Produced by Locally Isolated Earthworms from Temperate Kashmir Region

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Abstract The experiment was laid in completely randomized design comprised of 16 treatments of 4 waste combinations. The ratio of waste combinations was maintained as: 0:1=(0% cow dung + 100% organic waste); 1:1=(50% cow dung + 50% organic waste); 1:2=(33% cow dung + 67% organic waste); 1:3=(25% cow dung + 75% organic waste). Treatment combina-

tion of *Eisenia foetida* (Shalimar) and cow dung + organic waste (1:1) was the best one with maximum bacterial, fungal, actinomycetes, phosphorus solubilizing bacteria, *Azospirillum*, *Azotobacter* and mycorrhizal population.

Keywords Actinomycetes, *Azospirillum*, Bacteria, *Eisenia foetida*, Mycorrhizal.

Introduction

Biodegradable solid wastes (vermicomposting involve use of earthworms as versatile natural bioreactors for effective recycling of non-toxic organic wastes to the soil resulting in soil improvement and sustainable agriculture. Due to high cost of fertilizers and reduced availability of organic manures, recycling of non-toxic organic wastes has gained importance in recent years. Vermicomposting of organic waste using epigeic earthworm is one of the recent technique for the recycling of organic wastes and is eco-friendly and ecologically sound method for waste management and manure production [1]. During winter months in Kashmir, due to very low ambient temperature, vermicomposting process gets drastically slow. The local earthworms are supposed to adapt to the low temperatures during winter months but there vermicomposting ability gets drastically reduced during winter months. Although *Eisenia foetida* has adapted to the temperature conditions of Kashmir villey but it also hibernates due unfavorable temperatures. Keeping in view these facts, the present study is done to see the vermicomposting potential of local

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Table 1. Effect of different waste combinations on total viable bacterial count ($\times 10^7 \text{ g}^{-1}$) of vermicompost. 0:1 = (0% cow dung + 100% organic waste), 1:1 = (50% cow dung + 50% organic waste), 1:2 = (33% cow dung + 67% organic waste), 1:3 = (25% cow dung + 75% organic waste).

Earth-worm isolates (S)	Isolated from	Viable bacterial count					Vermicompost Viable fungi count					Total viable actinomycetes							
		0:1	1:1	1:2	1:3	Mean	0:1	1:1	1:2	1:3	Mean	0:1	1:1	1:2	1:3	Mean			
<i>Apporectodea rosea</i>	Wadura	35.25	39.25	38.25	36.35	37.28	38.50	40.25	39.85	38.75	39.34	12.50	13.75	13.10	12.80	13.04			
<i>Eisenia foetida</i>	Shalimar	40.10	47.05	43.10	41.15	42.85	40.65	45.20	44.35	43.60	43.45	14.70	16.75	16.40	14.85	15.68			
<i>Apporectodea caliginosa</i>	Gulmarg	32.25	34.50	33.90	33.40	33.51	32.70	38.00	35.40	34.40	35.13	11.00	12.05	11.35	11.20	11.40			
<i>Eisenia foetida</i>	Standard	39.70	47.01	42.90	41.14	42.69	40.45	45.10	44.15	43.20	43.23	14.50	16.55	16.10	14.75	15.48			
	Mean		36.83	41.95	39.54	38.01		38.08	42.14	40.94	39.99		13.18	14.78	14.24	13.40			
			CD ($p \leq 0.05$)					CD ($p \leq 0.05$)					CD ($p \leq 0.05$)						
			Isolates (S) = 11.75			Isolates (S) = 12.44			Isolates (S) = 5.50			Isolates (S) = 5.50			Isolates (S) = 5.50				
			Combinations (C) = 3.44			Combinations (C) = 3.15			Combinations (C) = 3.15			Combinations (C) = 1.11			Combinations (C) = 1.11				
			S \times C = 16.40						S \times C = 14.25						S \times C = 7.21				

earthworms and also biological properties of vermicompost produced by these earthworms from temperate Kashmir region.

Materials and Methods

Experimental details

Collection and identification of earthworms from various areas of Kashmir

Earthworms were collected from three different locations Wadura (altitude of 1,589 meters ASL with atmospheric temperature of -05 to +35°C), Shalimar (altitude of 1,589 meters ASL with atmospheric temperature of -10 to +35°C) and Gulmarg (altitude of 2,650 meters ASL with atmospheric temperature of -20 to +35°C). The species *Eisenia foetida*, *Apporectodea rosea* and *Apporectodea caliginosa* were identified from Wadura; *Eisenia foetida* and *Apporectodea caliginosa* were identified from Shalimar and *Eisenia foetida* and *Apporectodea caliginosa* were identi-

fied from Gulmarg. Preliminary screening of the identified worms from each location was carried out on the basis of vermicomposting potential to select the best isolate. *Apporectodea rosea*, *Eisenia foetida* and *Apporectodea caliginosa* from Wadura, Shalimar and Gulmarg respectively were selected for vermicomposting process.

Details of layout

The experiment comprised of 16 treatments which included waste combinations and different earthworm species. Earthworm species used are S_1 : *Apporectodea rosea*, S_2 : *Eisenia foetida*, S_3 : *Apporectodea caliginosa* and S_4 : *Eisenia foetida* (standard isolate), waste combination used are C_1 = 0:1 (0% cow dung + 100% organic waste), C_2 = 1:1 (50% cow dung + 50% organic waste), C_3 = 1:2 (33% cow dung + 67% organic waste) and C_4 = 1:3 (25% cow dung + 75% organic waste). Organic wastes include a mixture of kitchen wastes, municipal waste, crop residues, sheep/poultry manure, apple pomace in equal proportions. The experiment was laid in completely randomized design comprised of 16 treatments and 3 replications

Table 2. Effect of different waste combinations on total phosphorus solubilizing bacterial ($\times 10^7$ g⁻¹) of vermicompost. 0:1 = (0% cow dung + 100% organic waste), 1:1 = (50% cow dung + 50% organic waste), 1:2 = (33% cow dung + 67% organic waste), 1:3 = (25% cow dung + 75% organic waste).

Earth-worm isolates (S)	Isolated from	Phosphorus solubilizing bacterial					Vermicompost (Azospirillum)					Vermicompost (Azotobacter)				
		0:1	1:1	1:2	1:3	Mean	0:1	1:1	1:2	1:3	Mean	0:1	1:1	1:2	1:3	Mean
<i>Apporectodea rosea</i>	Wardura	40.50	44.50	43.50	41.50	42.50	60.00	72.50	65.00	64.00	65.38	65.00	73.50	72.50	70.50	70.38
<i>Eisenia foetida</i>	Shalimar	45.00	103.00	71.50	55.00	68.63	72.50	78.00	74.50	74.00	74.75	74.00	104.50	93.00	75.50	86.75
<i>Apporectodea caliginosa</i>	Gulmarg	38.00	40.50	40.50	39.00	39.50	49.00	60.50	55.00	50.00	53.63	58.50	65.00	64.00	60.00	61.88
<i>Eisenia foetida</i>	Stan-dard	44.50	102.30	70.50	54.00	67.83	72.20	77.70	74.10	73.90	74.48	73.80	104.20	92.80	75.60	86.60
	Mean	42.00	72.58	56.50	47.38		63.43	72.18	67.15	65.48		67.83	86.80	80.58	70.40	
		CD ($p \leq 0.05$)					CD ($p \leq 0.05$)					CD ($p \leq 0.05$)				
		Isolates (S) = 33.01					Isolates (S) = 33.54					Isolates (S) = 31.25				
		Combinations (C) = 16.55					Combinations (C) = 9.50					Combinations (C) = 13.15				
		S \times C = 69.00					S \times C = 38.55					S \times C = 53.00				

each. All the organic wastes were shredded and chopped into small pieces and mixed with cow dung (one week old) in its required proportions. The mixed substrates were kept for three weeks for pre-decomposition under shade and rain proof shed.

The pre decomposed material was put in their respective vermibeds labeled and designed in CRD. Vermicomposting technique was used as per procedure outlined by Hopp [2]. Fifty earthworms were released on the substrate in each treatment combination. The temperature of the shed varied from 10 to 35°C and the moisture was maintained at 40 to 60% by sprinkling water every day to keep earthworms active. The vermibeds were covered with a hesian cloth and the compost material was turned upside down after every 15 days for proper aeration.

Harvesting of vermicompost and earthworms

During 45–90 days, worms converted all the organic wastes into vermicompost. Watering was stopped 7

days prior to collection of excrements, then it was dumped on the ground as a heap and within 6 to 8 hours, earthworms and cocoons moved down and settled at the bottom of the heap as a cluster and were separated and counted. The compost was dried in shade, mixed thoroughly, sieved and samples were drawn from each treatment in air tight poly bags for analysis of microbial composition.

Determination of microbial population in organic waste and vermicompost

To determine microbial populations, one gram of finely ground vermicompost was suspended in 10 ml of sterilized distilled water in a test tube and serial dilutions of the suspension were prepared. In order to determine the bacterial count, total viable fungal, viable actinomycetes, phosphorus solubilizing bacteria, *Azotobacter* and *Azospirillum* in the vermicompost samples in each treatment, nutrient agar medium [3], potato dextrose agar (PDA) medium [3], Ken-Knight's agar medium [4], Pikovskaya agar [5] containing tricalcium phosphate, Ashby's medium [6] and N- free

Table 3. Effect of different waste combinations on mycorrhizal spores (vesicular arbuscular mycorrhizal spores) [100^{-1} g] of vermicompost. 0:1 = (0% cow dung + 100% organic waste), 1:1 = (50% cow dung + 50% organic waste), 1:2 = (33% cow dung + 67 organic waste), 1:3 = (25% cow dung + 75% organic waste).

Earthworm isolates (S)	Isolated from	Vermicompost Pooled				Mean
		0:1	1:1	1:2	1:3	
<i>Apporectodea rosea</i>	Wadura	18.00	19.00	18.50	18.00	18.37
<i>Eisenia foetida</i>	Shalimar	19.00	20.00	19.50	19.50	19.50
<i>Apporectodea caliginosa</i>	Gulmarg	17.00	17.50	17.50	17.00	17.25
<i>Eisenia foetida</i>	Standard	15.00	16.00	15.50	15.50	15.50
	Mean	17.25	18.12	17.75	17.50	
CD ($p \leq 0.05$)		Isolates (S) = 3.20		Combinations (C) = 3.30		S × C = 3.70

bromothymol blue semisolid medium [7] was used respectively. The media was autoclaved and poured into sterilized petriplates. One ml of appropriate dilution as evenly spread over cooled medium in petriplates and incubated at $28 \pm 2^\circ\text{C}$ for 2–3 days and bacterial colonies developed on the medium were counted. Mycorrhizal spores were determined in the soil sample by using wet sieving and decanting method as given by Gerdemann and Nicolson [8]. The techniques and procedures adopted for the determination of micro-organisms in organic waste and vermicompost were carried out under absolute aseptic conditions in the laminar flow.

Results and Discussion

Eisenia foetida (Shalimar) recorded maximum total viable bacterial population of ($42.85 \times 10^7\text{g}^{-1}$) (Table 1), maximum total viable fungal population of $43.45 \times 10^7\text{g}^{-1}$, maximum total viable actinomycetes population of $15.68 \times 10^7\text{g}^{-1}$ and maximum phosphorus solubilizing bacterial population of $68.63 \times 10^7\text{g}^{-1}$ in vermicompost and was significantly more than other worms and minimum bacterial count of $33.51 \times 10^7\text{g}^{-1}$, minimum fungal count of $35.13 \times 10^7\text{g}^{-1}$, minimum actinomycetes population ($11.40 \times 10^7\text{g}^{-1}$) and minimum population of phosphorus solubilizing bacteria of $35.13 \times 10^7\text{g}^{-1}$ was recorded in *Apporectodea*

caliginosa (Table 2). Parthasarathi, Parthasarathi [9, 10] reported the presence of more cellulolytic, amylolytic, proteolytic and phosphate solubilizing microbes in the gut and casts of *Eisenia foetida*, *L. mauritii* and *P. excauatus*.

Waste combination of cow dung + organic waste 1:1 produced maximum bacterial count ($41.95 \times 10^7\text{g}^{-1}$), maximum fungal count ($42.14 \times 10^7\text{g}^{-1}$), maximum actinomycetes count ($14.78 \times 10^7\text{g}^{-1}$) and maximum phosphorus solubilizing bacterial count ($72.58 \times 10^7\text{g}^{-1}$). Waste combination of cow dung + organic waste 0:1 produced minimum count of microbial population.

Eisenia foetida (Shalimar) recorded maximum population of nitrogen fixers, *Azospirillum* ($74.75 \times 10^7\text{g}^{-1}$) and *Azotobacter* ($86.75 \times 10^7\text{g}^{-1}$) in vermicompost and was significantly more than other worms and minimum population of *Azospirillum* ($53.63 \times 10^7\text{g}^{-1}$) and *Azotobacter* ($61.88 \times 10^7\text{g}^{-1}$) was recorded in *Apporectodea caliginosa* (Table 3). Waste combination of cow dung + organic waste 1:1 produced maximum population and waste combination of cow dung + organic waste 0:1 produced minimum population of these nitrogen fixers among the interactions. Treatment combination of *Eisenia foetida* (Shalimar) and cow dung + organic waste (1:1) produced maximum spore population among the interactions.

High range of microflora in vermicompost could be attributed to higher quantities of organic carbon and other minerals in feed substrates. Treatment combination of *Eisenia foetida* (Shalimar) and cow dung + organic waste (1:1) was found most rich in microbial populations because these were given additional supplements like apple pomace. The high response of apple pomace was because of conducive pH at initial and high contents of sugars and other easily metabolizable substrates. Thus, the microbial multiplication and healing of the material rice very fast. Parthasarathi [10] have shown the higher N, P, OC, microbial content of pressmud to support better growth, reproduction and more vermicompost production of *Eisenia fetida*. This was supported by Suthar [11] who reported that the factors relating to the reproduction and compost production of earthworms may also be considered in terms of physico-chemical and nutrient characteristics of waste feed stocks Zargar et al. [12] also reported that having the best vermicomposting potential due to its individual capability and better adaptability to the local temperate conditions.

Conclusion

The results indicated that the *Eisenia foetida* isolated from Shalimar proved to be having the best vermicomposting potential due to its individual capability and better adaptability to the local temperature conditions as compared to standard *Eisenia foetida* and other local isolates. Among the sixteen treatments and earthworms used for vermicomposting, waste combination of 50% cow dung + 50% organic

waste, treated with *Eisenia foetida* (Shalimar) proved to be the most efficient treatment for vermiculture.

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