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Macronutrients of Vermicompost Produced by Locally Isolated Earthworms from Temperate Kashmir Region

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Abstract The experiment was laid in completely randomized design which comprised of 16 treatments of 4 waste combinations including cow dung and mixture of organic wastes (kitchen wastes, municipal waste, crop residues, sheep/ poultry manure and apple pomace) cow dung (24 kg) and organic waste (60 kg). 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). The macro nutrients nitrogen (N), phosphorus (P), Potassium (K), calcium (Ca) magnesium (Mg) and sulfate (S) were significantly maximum in vermicompost obtained from treatment T_6 (50% cow dung + 50% organic waste) by *Eisenia foetida* (Shalimar) as compared to other treatments. The results indicated that the *Eisentia foetida* isolated from shalimar proved to be having the best vermicromposting potential due to its individual capability and better adaptability to the local temperate conditions as compared to standard *Eisenia foetida* and other local isolates.

Keywords *Eisenia foetida, Apporectodea rosea, Apporectodea caliginosa,* Vermicompost.

Introduction

Vermicomposting is a mesophilic process and is the process of ingestion, digestion and absorption of organic waste carried out by earthworms followed by excretion of castings through the worm's metabolic system, during which their biological activities enhance the levels of plant-nutrients of organic waste [1]. Compost and vermicompost are the end products of aerobic composting process, the later with using earthworms. Vermicompost possessed higher and more soluble level of major nutrients like nitrogen, phosphorus, potassium, calcium and magnesium [2] compared to the substrate or underlying soil and normal compost. Vermicomposting tech-

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nology has been recently applied to waste corn pulp blended with cow dung manure as feedstock as a solid waste management [3]. Vermicasts produced from vermicomposting are reported to be rich in nitrogen (N), phosphorus (P), postassium (K) and heavy metals [4]. Furthermore, another by-product from the vermicomposting process, which is the leachate, has also been reported to be rich in NPK composition [5]. *Eisenia foetida,* a temperate species of earthworm is most commonly used for the management of organic wastes by vermicomposting. Although *Eisenia foetida* has adapted to the temperate conditions of Kashmir valley, its vermicomposting ability gets drastically reduced during winter months. Therefore, it is important to look for local worms that can tolerate low temperature and perform better under such conditions. The local earthworms are supposed to adapt to the low temperatures because during winter months, vermicomposting process gets drastically slow due to the unfavorable temperatures. Also there is scanty work done to study the chemical composition of the vermicompost produced by locally available worms under temperate conditions. Keeping in view these facts, the present study is done to see the micro and macronutrients of vermicompost produced by locally isolated 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 1589 meters) ASL with atmospheric temperature of (-05 to + 35°C), Shalimar (altitude of 1680 meters) ASL with atmospheric temperature of (-10 to + 35°C) and Gulmarg (altitude of 2650 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 *Approectodea caliginosa* were identified from Shalimar and *Eisenia foetida* and *Approectodea caliginosa* were identified 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 *Approrectodea caliginosa* from Wadura, Shalimar and Gulmarg respectively were selected for vermicomposting process.

Details of layout

The experiment comprised of 16 treatments (Table 1) which included waste combinations and diffent earthworm species . Earthworm species used are S_1 : *Aporrectodea rosea,* S_2 : *Eisenia foetida,* S_3 : *Aporrectodea caliginosa* and S_4 : *Eisenia foetida* (standard isolate). Waste combination used are C_1 =0 : 1 (0 % cowdung) + 100% organic waste), C_2 = 1 : 1 (50% cowdung + 50% organic waste), C_3 = 1 : 2 (33% cowdung + 67% organic waste) and C_4 = 1 : 3 (25% cowdung + 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 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 the procedure outlined by Hopp [6]. 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.

During 45-90 days, worms convered 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

Table 1. Details of treatments and waste combinations.

Treat-ments	Combi-nations	Compo-sition
T_1	S_1C_1	S_1 *Aporrectodea rosea* (Wadura isolate) C_1 (0% cow dung + 100 organic waste)
T_2	S_1C_2	S_1 *Aporrectodea rosea* (Wadura isolate) C_2 (50% cow dung + 50 organic waste)
T_3	S_1C_3	S_1 *Aporrectodea rosea* (Wadura isolate) C_3 (33% cow dung + 67% organic waste)
T_4	S_1C_4	S_1 *Aporrectodea rosea* (Wadura isolate) C_4 (25% cow dung + 75% oganic waste)
T_5	S_2C_1	S_2 *Eisenia foetida* (Shalimar isolate) C_1 (0% cow dung+ 100% organic waste)
T_6	S_2C_2	S_2 *Eisenia foetida* (Shalimar isolate) C_2 (50% cow dung + 50% organic waste)
T_7	S_2C_3	S_2 *Eisenia foetida* (Shalimar isolate) C_3 (33% cow dung + 67% organic waste)
T_8	S_2C_4	S_2 *Eisenia foetida* (Shalimar isolate) C_4 (25% cow dung + 75% organic waste)
T_9	S_3C_1	S_3 *Aporrectodea caliginosa* (Gulmarg isolate) C_1 (0% cow dung + 100% organic waste)
T_{10}	S_3C_2	S_3 *Aporrectodea caliginosa* (Gulmarg isolate) C_2 (50% cow dung + 50% organic waste)
T_{11}	S_3C_3	S_3 *Aporrectodea caliginosa* (Gulmarg isolate) C_3 (33% cow dung +67% organic waste)
T_{12}	S_3C_4	S_3 *Aporrectodea caliginosa* (Gulmarg isolate) C_4 (25 % cow dung + 75% organic waste)
T_{13}	S_4C_1	S_4 *Eisenia foetida* (standard isolate) C_1 (0 % cow dung + 100% organic waste)
T_{14}	S_4C_2	S_4 *Eisenia foetida* (standard isolate) C_2 (50% cow dung + 50% organic waste)
T_{15}	S_4C_3	S_4 *Eisenia foetida* (standard isolate) C_3 (33% cow dung + 67% organic waste)
T_{16}	S_4C_4	S_4 *Eisenia foetida* (standard isolate) C_4 (25% cow dung + 75% organic waste)

6 to 8 h , 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 throughly, sieved and samples were drawn from each treatment in air tight poly bags for analysis of microbial composition.

Determination of macronutrients of vermicompost

Chemical properties for all the wastes used in various treatment combinations were determined . Organic carbon was determined by rapid titration method described by walkley and Black [7]. For determination of total nitrogen, organic waste samples were digested in digestion mixture of potassium sulfate, ferrous sulfate, copper sulfate and sellinium powder, with the addition of concentrated sulfuric acid. Then nitrogen determination was carried out by Kjeldhal's method described by Jackson [8]. Phosphorus in the extract was estimated by Vanado molybdate method. Potassium was determined by iuse of flame photometer (Digital FPM-125). Total calcium was determined from diacid digestion extract by use of Atomic Absorption Spectrophotometer (AAS) as described by Lindsay and Norwell[9].

Magnessium was determined from diacid digestion extract by use of AAS (Atomic Absorption spectrophotometer) as described by Lindsay and Norwell [9]. Sulfur was determined from diacid digestion sample with the addition of buffer solution, gum acacia and barium chloride and determination was carried out with the help of spectrophotometer at 420 nm wavelength described by Chesnien and Yien [10].

Results and Discussion

Treatment combination of *Eisenia foetida* (Shalimar) and cow dung + organic waste (1 : 1) produced maximum N content, P content in vermicompost and were significantly more than other worms. Minimum P was recorded in *Apporectodea caliginosa* (Table 2). Similar findings in vermicompost produced by different feed substrates have been recorded earlier by [11—13]. Suthar and Singh [14] also find maximum P content in vermicompost by *Eisenia foetida* while studying the effect of different feed substrates on P during vermicomposting . Moreover, *Eisenia foetida* (Shalimar), treatment of which produced maximum N content and maximum available nitrogen, might be due to its individual capability and better adaptability to the local temperate conditions.

Eisenia foetida (Shalimar) on waste combination of cow dung + organic waste recorded maximum K and Ca content in vermicompost and was significantly more than other worms. Minimum K and Ca content was recorded in *Apporectodea caliginosa* in waste combination of cow dung + organic waste 0 : 1 and 1 : 3 (Table 3). The most probable reason for the presence of significantly higher quantity of Ca in waste combination of 50% cowdung

Table 2. Effect of different waste combinations and earthworm isolates on N, P and K of vermicompost. 0 : 1 = (0% cowdung + 100% organic waste), 1 : 1 = (50% cowdung + 50% organic waste), 1 : 2 = (33% cowdung + 67% organic waste), 1 : 3 = (25% cowdung + 75% organic waste).

		Vermicompost														
Earthworm	Isolates	N (%)					P (%)					K (%)				
isolates (S)	from	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
Apporectodea rosea	Wadura	1.40	1.44	1.42	1.41	1.41	1.04	1.06	1.05	1.05	1.05	4.50	4.68	4.62	4.52	4.58
Eisenia foetida	Shalimar	1.48	1.54	1.52	1.51	1.51	1.08	1.26	1.25	1.08	1.14	4.70	5.05	5.01	4.72	4.87
Apporectodea caliginosa	Gulmarg	1.23	1.30	1.27	1.25	1.26	1.02	1.03	1.03	1.02	1.03	4.00	4.31	4.30	4.10	4.17
Eisenia foetida	Standard	0.87	0.98	0.97	0.88	0.92	1.05	1.24	1.10	1.06	1.11	4.66	5.01	5.00	4.70	4.84
Mean		1.24	1.31	1.29	1.26		1.05	1.15	1.08	1.05		4.46	4.76	4.73	4.51	
		CD (p<0.05)					CD (p<0.05)					CD (p<0.05)				
		Isolates (S)			= 0.030		Isolates (S)			=0.130		Isolates (S)			=0.980	
		Combinations (C)			=0.020		Combinations (C)			=0.055		Combinations (C)			=0.230	
		S × C			=0.230		S × C			=0.320		S × C			=2.260	

+ 50% organic waste, treated with *Eisenia foetida* (Shalimar) might be due to the additional supplement of kitchen waste and apple pomace which fortify the vermicompost with Ca. These results are in conformity with the findings of Shweta and Sharma [12] and Zargar et al. [13].

Use of *Apporectodea rosea* and *Eisenia foetida* (Shalimar) on waste combination of cow dung + organic waste (1 : 1) recorded maximum Mg content in vermicompost and was significantly more than other worms. Minimum of Mg was recorded in *Apporectodea caliginosa* in waste combination of cow dung + organic waste 0 : 1 (Table 3). The most probable reason for the presence of significantly higher quantity of magnesium in waste combination 0f 50% cow dung + 50% organic waste treated with *Eisenia foetida* (Shalimar) might be due the additional supplement of magnesium through organic waste. The results are in conformity with the findings of Shweta and Sharma [12]. *Eisenia foetida* (Shalimar) on waste combination of cow dung + or-

Table 3. Effect of different waste combinations and earthworm isolates on Ca, Mg and S (%) of vermicompost. 0 : 1 = (0% cowdung + 100% organic waste), 1 : 1 = (50% cowdung + 50% organic waste), 1 : 2 = (33% cowdung + 67% organic waste), 1 : 3 = (25% cowdung + 75% organic waste).

		Vermicompost														
Earthworm	Isolates	Ca (%)					Mg (%)					S (%)				
isolates (S)	from	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
Apporectodea rosea	Wadura	0.55	0.82	0.80	0.72	0.72	0.30	0.40	0.32	0.30	0.33	2.00	2.20	2.05	2.02	2.07
Eisenia foetida	Shalimar	0.90	1.05	1.00	0.92	0.73	0.40	0.50	0.42	0.42	0.44	2.30	2.51	2.42	2.30	2.38
Apporectodea caliginosa	Gulmarg	0.30	0.42	0.35	0.30	0.34	0.20	0.25	0.20	0.20	0.21	1.75	1.93	1.90	1.80	1.85
Eisenia foetida	Standard	0.87	0.08	0.98	0.89	0.71	0.38	0.49	0.40	0.40	0.42	2.28	2.49	2.40	2.28	2.36
	Mean	0.66	0.36	0.78	0.71		0.32	0.41	0.34	0.33		2.08	2.28	2.19	2.10	
		CD (p<0.05)					CD (p<0.05)					CD (p<0.05)				
		Isolate (S)			=0.59		Isolates (S)			=0.24		Isolates (S)			=0.52	
		Combinations (C)			=0.12		Combinations (C)			=0.05		Combinations (C)			=0.15	
		S × C			=0.20		S × C			=0.30		S + C			=0.01	

ganic waste (1 : 1) recorded maximum S content in vermicompost and was significantly more than other worms, and minimum of S was recorded in *Apporectodea rosea* in waste combination of cow dung + organic waste 0 : 1 (Table 3). The results are in accordance with the findings of Shweta and Sharma [12]. Moreover, *Eisenia foetida* (Shalimar), treatment of which producted maximum total and available sulfur content might be due to its individual capability and better adaptability to the local temperate conditions [14].

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