Journal of Research & Development, Vol. 10 (2010) ISSN 0972-5407

Vermicomposting of Different Wastes with Cow Dung Using Earthworm Species *Eisenia foetida*.

Suhaib A. Bandh, U.K. Chuhan[1], Azra N. Kamili, B.A. Ganai[2] and A.Q. Mir[3]
P.G. Department of Environmental science/Centre of Research for Development, University of Kashmir, Hazratbal, Srinagar
[1] School of Environmental Biology, Awadhes Pratap Singh University, Rewa (M.P)
[2] P. G Department of Biochemistry, University of Kashmir, Hazratbal, Srinagar
[3] Govt. Degree College, Dooru

ABSTRACT

In present study different waste combinations like cow dung, cow dung + rice straw, cow dung + kitchen wastes, cow dung + mustard stove and cow dung + legume crop waste were vermicomposted during a 60 day composting experiment with *Eisenia foetida*. The pre-decomposed wastes and the post-decomposed wastes (vermicompost) obtained were chemically characterized for the nutrients like organic carbon, nitrogen, potassium, phosphorus, available nitrogen, available phosphorus, available potassium, available calcium, available magnesium and available sulphur. Vermicomposting resulted in a considerable reduction in the C:N ratio and organic carbon with an increase in mineral Nitrogen. On comparing the results obtained, they showed an increase in the values of total phosphorus and total potassium. The amount of available nitrogen, phosphorus, potassium, calcium, magnesium and sulphur was found in higher range in the vermicompost obtained from the combination of cow dung and kitchen wastes. A considerable variation was also found in earthworm population in the vermicompost obtained from different waste combination with the higher number of earthworms in cow dung + kitchen waste combination. A significant increase in earthworm population from the initial load of 50 worms was registered with a maximum increase in waste combination cow dung + kitchen waste and minimum in cow dung only. Various feed substrates are also having a great deal of effect on the maturation rate of the vermicompost.

Key words: Cow dung, earthworms, *Eisenia foetida*, vermicomposting

INTRODUCTION

Vermicomposting, a modified and specialized method of composting using earthworms to eat and digest different types of wastes to turn into high quality compost has become increasingly popular because of its use in agricultural and other sectors. Vermicomposting in recent years has gained importance because of its more economic value over traditional methods of composting. *Eisenia foetida* is one of such worms which have the potential for converting organic wastes into nutrient rich vermicompost. It is well distributed throughout India, found in sewage dumps, sludge tanks, filters, etc. and has been marked under different names like red worm, pink worm, purple worm, tiger worm, branding worm or even vermiculture or vermicomposting worm. It is a suitable species for management of wastes which are utilized successfully in vermicomposting (Edwards and Gunadi, 2003). Hence degradation of organic wastes by earthworms is one of the recent developments in biological sciences. They are also responsible for the breakdown of complex organic residues into simpler water-soluble substances. The vermicompost, chiefly the fecal matter of earthworm, is rich in plant nutrients, plant growth promoters and beneficial microflora.

In order to avoid environmental hazards by dumping of sewage, agro based and industrial wastes, the use of certain elite earthworms especially *Eisenia foetida* for effective disposal of these wastes can be considered. The invasive weeds in the water bodies of Kashmir Valley, could be converted to resources through vermicomposting by using this earthworm species (Najar and Khan, 2010). Vermitechnology could successfully be used to clean the environment as it uses wastes as raw material to change polluted and costly chemical farming to sustainable agriculture (Lal *et al.*, 2003). Although a lot of work has been done in the world as well as in India, however in Kashmir, use of earthworms for effective degradation and decomposition of organic wastes had not yet been worked. Therefore, the present study entitled, "Vermicomposting of different Wastes with Cow dung Using Earthworm species *Eisenia foetida*" was endeavored to meet the following objectives:

- To evaluate different wastes for vermicomposting.
- To produce nutrient rich vermicompost.

MATERIAL AND METHODS

The materials used, experimental procedures and methods followed during the present investigation are described as follows:

Experimental details

Vermibeds of dimensions 0.5×0.5×0.12 m (L×W×H) for vermicomposting of different wastes were made with different treatments (Table 1).

Initial status of wastes

Initial status of organic carbon, nitrogen, phosphorus and potassium for all the wastes used in various treatment combinations shown in Table 1 were determined as per the following methods:

1. Organic Carbon: Titration method (Walkley and Black 1934).
2. Nitrogen: Kjeldhal's digestion method (Jackson, 1973).
3. Phosphorus: Acid-digestion method (Bhargava and Raghupatti, 1993).
4. Potassium: Flame photometric method (Jackson, 1973).

Table 1. Treatment details of various waste combinations

Treatment No.	Treatment name	Ratio
T_1	Cow dung alone	
T_2	Cow dung +Rice straw	10:3
T_3	Cow dung + Kitchen waste	10:3
T_4	Cow dung +Mustard stove	10:3
T_5	Cow dung +Legume crop waste	10:3

Preparation of waste samples

Waste samples were first washed with running tape water to remove soil and other foreign materials followed by dipping in dilute HCl (0.1N) and again washed with double distilled water. The samples were then dried on filter paper followed by oven drying at 60±5°C for 24 hours. The dry matter weight for each sample was recorded before crushing. The crushed material was sieved through 2mm mesh size sieve and taken for chemical analysis.

Analysis of Vermicompost:

1. Organic Carbon: Chromic acid digestion method (Walkley and Black, 1934).
2. Nitrogen: Kjeldhal's method (Thangavel, 2000).
3. Available Nitrogen: Kjeldhal's method (Subbiah and Asija, 1956).
4. Available Phosphorus: Procedure by Olsen *et al.* (1954).
5. Available Potassium: Flame photometric method (Merwin and Peech, 1950).
6. Total Phosphorus: Colorimetric method (Thangavel, 2000).
7. Total Potassium: Flame photometric method (Thangavel, 2000).
8. Available Calcium: Titration method (Thangavel, 2000).

9. Available Magnesium: Titration method (Thangavel, 2000).
10. Available Sulphur: Spectrophotometric method (Thangavel, 2000).
11. Population of Earthworms: By manual counting.

RESULTS AND DISCUSSION

The data obtained on the chemical analysis of the pre-decomposed waste and final vermicompost (Table 2) reveals that the organic carbon was found in the range of 17.60% in T_1 and 27.76% in T_2 in vermicompost compared to 24.66% in T_1 and 42.13% in T_2 in pre-decomposed waste respectively. Lower Organic Carbon in vermicompost is possibly due to incorporation into earthworm tissues as well as leaching of the nutrients into the bedding material. Thus the Organic Carbon shows a declining trend during vermicomposting. However, similar findings were reported by Chauhan *et al.* (2010), Hervas *et al.* (1989), Micthell (1997) and Shewata *et al.* (2005a). Nitrogen was found in the range of 0.46% in T_1 to 0.91% in T_3 in pre-decomposed wastes compared to 0.89% in T_1 and 1.53% in T_3 in vermicompost respectively. The nitrogen values showed increasing trend in vermicomposting. Losses of organic carbon might be responsible for nitrogen addition in the form of mucous nitrogenous excretory substances, growth stimulatory hormones and enzymes from the gut of earthworms (Tripathi and Bhardwaj, 2004). The higher values of nitrogen in T_3 can be attributed to presence of nitrogen supplements in the form of kitchen wastes compared to T1 without any other nitrogen supplement. Alawdeen and Ismail (1986) and Sheweta *et al.* (2005b) also revealed the similar findings in nitrogen values of vermicompost. C: N in pre-decomposed waste was found maximum in T_1 53.60% and minimum in T_3 46.42%, where as in vermicompost maximum was found in T_3 17.9%. C: N ratio one of the most widely used indicators of vermicompost maturation, decreases sharply during vermicomposting process (Suther, 2008). Earthworms lower the C: N ratio by combustion of carbon during respiration (Bansal and Kapoor, 2000). Similar findings were reported by Chauhan *et al.* (2010).

Table 2. **Effects of various feed substrates on Organic carbon, Nitrogen, C: N ratio, total nitrogen and total phosphorus in predecomposed wastes (A) and vermicompost (B)**

Treatment no.	Treatment details	Organic Carbon (%)		Nitrogen (%)		C:N ratio		Total Potassium (%)		Total phosphorus (%)	
		A	B	A	B	A	B	A	B	A	B
T_1	Cow dung alone	24.66	17.60	0.46	0.89	53.68	19.78	0.05	0.18	0.13	0.33
T_2	Cow dung+ Rice straw	42.03	27.76	0.89	1.52	47.22	18.26	0.38	0.61	0.22	0.47
T_3	Cow dung+ Kitchen waste	42.13	27.40	0.91	1.53	46.49	17.90	0.53	0.69	0.27	0.94
T_4	Cow dung+ Mustard stove	38.98	26.57	0.83	1.42	46.93	18.71	0.36	0.51	0.21	0.45
T_5	Cow dung + Legume crop waste	37.14	25.99	0.80	1.37	46.42	18.97	0.38	0.52	0.3	0.72

Total Potassium status of vermicompost was found maximum in T_3 (0.69%) and minimum in T_1 (0.18%) compared to potassium content of pre-decomposed wastes where maximum was found in T_3 (0.53%) and minimum in T_1 (0.05%). High potassium content in vermicomposting can be attributed to high organic matter. The initial status of feed substrates and pH was also found effective for potassium content in vermicompost. In general potassium content did not vary much in vermicompost and organic substrates. Similar results were also reported by Singh *et al.* (1986).

Total phosphorus content in vermicompost was found maximum in T_3 (0.94%) and minimum in T_1 (0.33%) compared to the maximum of 0.3% in T_5 and minimum of 0.13% in T_1 in pre-decomposed wastes. The higher range of phosphorus is because of organic carbon and protein content of earthworm tissues in vermicompost which enhanced phosphorus content during decomposition. These results are in confirmation to the studies of Krishanamourty and Vajranabhaiah (1986) and Bhawalker (1989) who studied the effect of different wastes on phosphorus during Vermicomposting.

The available Nitrogen, Phosphorus and Potassium content as shown in Table 3 was found in the range of 559ppm in T_1 to 771ppm in T_2, 14.67ppm in T_1 to

20.76ppm in T_4 and 5027 ppm in T5 to 7311ppm in T3 respectively. The higher values of nitrogen in vermicompost are a result of enhanced microbial activity. The higher content of available nitrogen in T_2 followed by T_3 and T_4 could be attributed to the sources of nitrogenous organic substrates like rice straw, kitchen wastes and mustard stove. Results confirmed by the findings of Muthukumaravel *et al.* (2008). Available phosphorus found in T_4 followed by T_5 and T_3 was high because of additional supplement of phosphorus in the form of mustard stove, legume crop wastes and kitchen wastes. Results corroborated with the findings of Datar *et al.* (1997) and Bhawalkar (1989). The highest content of available potassium in vermicompost could be attributed to the dominance of mineral composition as well as high presence of organic matter in the feed substrates. The available potassium in T_3 followed by T_4 and T_2 was because of the additional supplement of potassium through kitchen wastes, mustard stove and rice straw. These results also corroborated with the findings of Singh *et al.* (1986) and Shewata *et al.* (2005a).

Table 3. Effects of various feed substrates on available nitrogen, available phosphorus, available potassium, available calcium, available magnesium and available sulpher in vermicompost

Treatment no.	Treatment details	available nitrogen (ppm)	available phosphorus (ppm)	available potassium (ppm)	available calcium (ppm)	available magnesium (ppm)	available sulpher (ppm)
T_1	Cow dung alone	559	14.67	5030	733	186	1025
T_2	Cow dung +Rice straw	771	15.00	5920	733	320	1016
T_3	Cow dung + Kitchen waste	752	15.38	7311	2268	180	1865
T_4	Cow dung +Mustard stove	732	20.76	6008	933	180	1408
T_5	Cow dung +Legume crop waste	685	15.66	5027	600	334	1034

Available calcium, magnesium and sulphur content shown in Table 3 was found in the range of 600 ppm in T_5 to 2260 ppm in T_3, 180 ppm in T_3 and T_4 to 334 ppm in T_5 and 1016 ppm in T_2 to 2865ppm in T_3 respectively. The high range of calcium could be attributed to the calcareous nature of the organic substrates used as feed to earthworms. The highest content of available calcium in T_3 was possibly due to additional supplement of calcium in the form of egg shells in the kitchen wastes. Magnesium has chemical association with calcium hence attributed the similar cause in vermicompost. However the highest content of sulpher in T_3

was because of the additional sulpher supplement in the form of kitchen wastes. Results were in confirmation to the findings of Sheweta *et al.* (2005,a) and Garg *et al.* (2006).

The maximum number of adult earthworms was recorded in T_3 (310) and minimum in T_1 (180), the juvenile number was maximum in T_3 (108) and minimum in T_1 (78). However maximum cocoons were found in T_3 (168) and minimum in T_2 (101). This variation may be due to nutritional composition, microbial content and palatability of the substrates (Table 4 and Fig. 1). T_3 was the best treatment combination and could be considered as excellent nutrition and palatable diet for earthworm population or vermiculture. Viljoen and Reinacke (1988) stated the nature of the food substrate influences the cocoon production. Our results are confirmed by the findings of Huhta and Haimi (1988). Shewata *et al.* (2005b) pointed out that *Eisenia foetida* thrives well in household wastes and fruit wastes. The different combination of cattle dung, agro and kitchen wastes caused a significant growth in the *Eisenia foetida* (Nath *et al.*, 2009).

Table 4. Effects of various feed substrates on earthworm population

Treatment no.	Treatment details	Earthworms				
		Initials	Cocoons	Adults	Juveniles	Total
T_1	Cow dung alone	50	157	107	78	185
T_2	Cow dung + Rice straw	50	101	197	89	286
T_3	Cow dung + Kitchen waste	50	168	202	108	310
T_4	Cow dung + Mustard stove	50	138	178	82	260
T_5	Cow dung + Legume crop waste	50	148	136	97	233

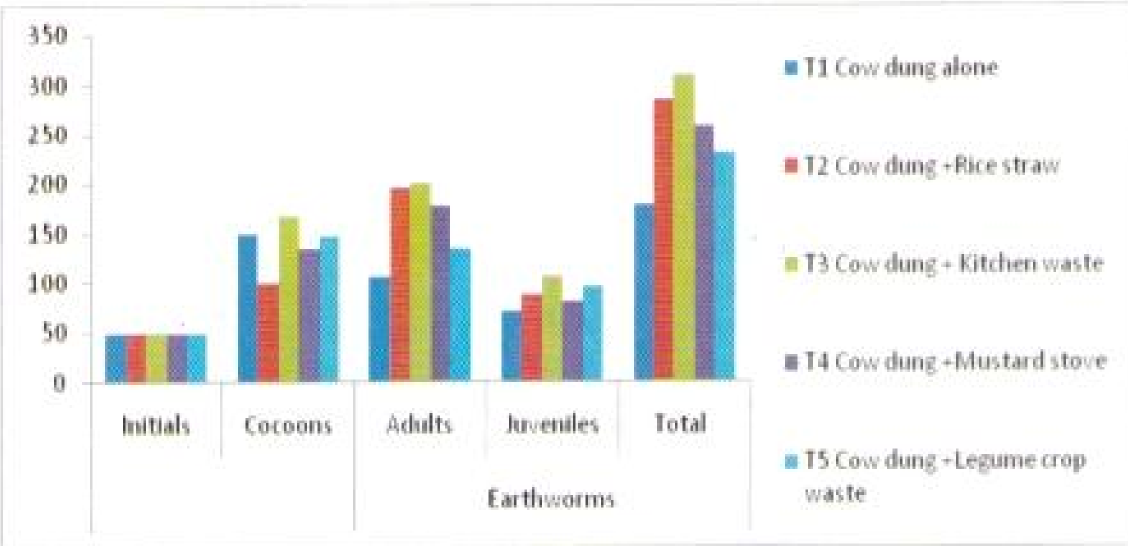

Fig. 1. Graphical representation of the results shown in table 4.

Duration of vermicomposting is very important and is used as an index of vermicompost (Table 5). Treatment combination T_3 took 40-45 days to get converted into vermicompost followed by T_1, T_2, T_4 and T_5 which took 45-50 days for it. Earlier maturation of T_3 could be possibly due to the palatable nature of the waste mixture. Edwards and Lofty (1976) stated the earthworms prefer soft and palatable nature of food and get their conversion early into vermicompost. Hervas *et al*. (1980) also reported the early maturation of food substrates which suit the earthworms.

Table 5. Effects of various feed substrates on maturation of vermicompost

Treatment no	Treatment details	Maturation days
T_3	Cow dung + Kitchen waste	40-45
T_1	Cow dung alone	45-50
T_2	Cow dung +Rice straw	-do-
T_4	Cow dung +Mustard stove	-do-
T_5	Cow dung +Legume crop waste	-do-

CONCLUSIONS

All organic residues are suitable as feed substrates. However cow dung, kitchen wastes and mustard stove are most suitable. Treatment combination T_3 (cow dung + kitchen wastes) was the best for rearing of earthworms and preparation of vermicompost.

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