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POULTRY WASTE MANAGEMENT THROUGH VERMICOMPOSTING EMPLOYING EXOTIC AND INDIGENOUS SPECIES OF EARTHWORMS

BEOHAR P.A.[1*] AND SRIVASTAVA R.K.[2]
[1]Environmental Engineering Laboratory, Hitkarini College of Engineering & Technology, Hitkarini Hills, Dumna Road, Tembhar, P.O.-Khamaria, Jabalpur, 482005, MP, India
*[2]Environmental Research Laboratory, P.G. Department of Environmental Science, Government Model Science College (Autonomous), Centre For Excellence, Jabalpur, MP,482001, India
*Corresponding author. E-mail: Purnim78@yahoo.com

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Abstract - A comparative studies was conducted between exotic and indigenous (epigeic *Eisenia foetida* (exotic) and anaecic species *Lampito mauritii* (indigenous) respectively). We use two species of earthworms for the evaluation of their efficacy in vermicomposting of poultry waste. Vermicomposting of poultry waste takes 90 days of time, resulted in significance difference between the two species in their performance and compost quality in respect to pH, Electrical conductivity, organic carbon %,Organic matter%, available nitrogen%, available phosphorus% available Potassium%, Ca, Mg and weight loss of poultry waste.
Keywords- Poultry waste, *Eisenia foetida, Lampito maurittii*, vermicomposting

Introduction

A rapidly increasing population and high rate of industrialization has increased the problem of solid waste management. The problem has further increased in cities because of shortage of the dumping sites and strict environmental legislation, so scientists are seeking for management alternatives, which should be ecofriendly, cost effective and fast. Now days we are facing major problem with Poultry waste because it is highly organic in nature, so vermicomposting has become an appropriate alternative for the safe hygienic and cost effective disposal of it. Earthworms feed on the organics and convert material into casting, which is rich in plant nutrients. The action of the earthworms in the process of vermicomposting of waste is physical and biochemical. The physical process includes substrate aeration, mixing as well as actual grinding while the biochemical process is influenced by the microbial decomposition of substrate in the intestine of the earthworms (Hand *et al*., 1998) Various studies have shown that vermicomposting of organic waste accelerates organic matter stabilization (Neuhauser *et al.*, 1998; Frederickson *et al.*, 1997)and gives chelating and phytoharmonal elements (Tomati *et al.*, 1995) which have a higher content of microbial matter and stabilized humid substances. In India the exotic epigeic species, like *Eudrilus euginae* (Ashok,1994) *Parionyx excavatus*(Kale *et al*., 1982) and *Eisenia foetida* (Harrtenstein *et al*., 1978)are being used for vermicomposting. Selection of the worms depends upon the waste for vermiprocessing. Species like *E. foetida* (Harrtenstein *et al*., 1979) and *E.eugineae* (Kale and Bano 1988) have been used the converting organic waste into vermicompost. We have selected two species for present study because their available literature and they can survive in the climatic conditions of the Jabalpur. By the use of above two species we can solve our above 3 problems and we can evaluate their efficacy in vermicomposting of poultry waste.

In the present era we are facing 3 major problems:
1. Pollution created by the solid waste.
2. Pollution created by the fertilizers.
3. We have to change chemical based farming into organic sustainable for the quality betterment of grains as well as field area.

MATERIALS AND METHODS

COLLECTION OF THE WASTE MATERIAL

Poultry waste is the collected from the poultry farm. As we aware through the literature on the Earthworm that for the survival and better result of composting, the pH, moisture and the organic content of the feed given to them (earthworms) are very important and the pH must be neutral or alkaline (7 to 9) but in case of poultry waste it was found that it was highly acidic (4.9 pH), where as organic content and moisture were suitable. Therefore during the inoculation of the earthworms on pure poultry waste, no response was given by the any earthworms variety and their mortality rate was very high and this was mainly because of high acidic pH. To neutralize the acidic pH of poultry waste $CaCO_3$ was used.

RATIO OF POULTRY WASTE AND COW DUNG

The ratio of poultry waste and cow dung was taken according to dry matter weight. According to dry weight analysis, 5 different combinations of fresh poultry waste and fresh cow dung were prepared. As we know that cow dung is a great source of the microbes. That's why we use Cow dung to reduce the time of the semidecomposition. In these combinations, $CaCO_3$ was mixed according to the weight of the dry poultry waste.

According to dry weight analysis, 5 different combinations of fresh poultry waste and fresh cow dung were prepared.T1, T2, T3, T4 and T5 are different treatment combinations.

T-1 (4:1) (i.e.) 4 parts of poultry waste and 1 part of cow dung

T -2 (2:1) (i.e.) 2 parts of poultry waste and 1 part of cow dung

T-3 (1: 1) (i.e.) 1 parts of poultry waste and 1 part of cow dung

T -4 (1 :0) (i.e.) 1 parts of poultry waste and 0 part of cow dung

T -5 (0:1) (i.e.) 0 parts of poultry waste and 1 part of cow dung

PREPERATION OF PITS FOR SEMIDECOMPOSITION OF WASTE

For the semidecomposition of any organic waste, usually two methods are used, these are:

Pit method

Heap method

For the present study, pit method was selected because it is very safe and moisture level can easily be maintained. For semidecomposition of poultry waste and cow dung (of different combinations), five pits were prepared of size 5 ft length x 2 ft width x 5 ft depth. (5 x 2 x 5)

These five combinations were put in prepared pits and named as T1, T2, T3, T4 and T5 for decomposition and every week, pH of these combinations was measured and after 45 days, i.e. on 7th week, the desired pH value of the combination was achieved and material was semidecomposed which is easily accepted by worms.

ECOBINS

To inoculate earthworms in semidecomposed materials, 45 earthenware pots of spherical shape were taken without any hole. The experimental design was factorial and according to design, coding on pots was made. For each species of earthworm, four replicates in each treatment were taken as A1, A2 ------upto J4 And K,L,M,N,O for controls..

VARIETIES OF EARTHWORMS

For the experiment 2 different varieties of earthworms were taken these are:

1. S-1 *Eisenia foetida* (exotic species)
2. S-2 *Lampitto mauritti* (indigenous species)

Now total no of earthworm species 2

Total no. of treatments 5

And total 4 replicates of all 5 combination were taken.

S= species

S1 Earthworms species *Eisenia foetida*

S2 Earthworms species *Lampito mauritti*

T= Treatments

T1 4:1(poultry :cow dung)

T2 2:1 (poultry :cow dung)

T3 1:1 (poultry :cow dung)

T4 1:0 (poultry :cow dung)

T5 0:1(poultry :cow dung)

R= Replicates

R1 Replicates

R2 Replicates

R3 Replicates

R4 Replicates

METHODS OF CHEMICAL ANALYSIS OF ALL SAMPLES (RAW WASTE MATERIAL, SEMIDECOMPOSED MATERIAL AND PREPARED VERMICOMPOST)

Sample codes used during analysis

For raw materials

Pure poultry waste RM-1

Cow dung RM-2

For semidecomposed material

Treatment T-1 SD-1

Treatment T-2 SD-2

Treatment T-3 SD-3

Treatment T-4 SD-4

Treatment T-5 SD-5

For prepared compost

A1, A2, A3, A4,B1, B2, B3, B4,C1, C2, C3, C4 ,D1, D2, D3, D4,E1, E2, E3, E4,F1, F2, F3, F4,G1,G2,G3,G4, H1,H2,H3,H4, I1, I2, I3, I4, J1, J2, J3, J4, K, L, M, N, O.

FOLLOWING CHEMICAL PARAMETERS WERE ANALYSED FOR ALL SAMPLES (RAW WASTE MATERIAL, SEMIDECOMPOSED MATERIAL AND PREPARED VERMICOMPOST)

1. pH
2. Electrical Conductivity
3. Organic Carbon %
4. Organic Matter %
5. Total Nitrogen %
6. Available Nitrogen %
7. Total phosphorus %
8. Available Phosphorus %
9. Total Potassium %
10. Available Potassium %
11. Ca
12. Mg

The above analysis was done according to the standard procedure of Jackson (1973).

1. pH and Electrical Conductivity: Potentiometric method (1:2.5 soil water suspension) by pH and EC meter.
2. Organic Carbon Content: Titrimetric determination (Wakley and Black,1934).
Organic matter was derived from the organic carbon content.
3. Available Nitrogen: Alkaline potassium permanganate method (Subbiah and Asija, 1956). Total Nitrogen was derived from available Nitrogen.
4. Available Phosphorus: Olsen's method (Olsen's et al. 1954). Total Phosphorus was derived from available Phosphorus.
5. Available Potassium: Ammonium Acetate Extract Method. Total Potassium was derived from available Potassium.
6. Estimation of Calcium and Magnesium : Complexometric Titration Method.

CHEMICAL ANALYSIS

pH

In all the five combinations of compost prepared by both species, the pH value was around 8 (alkaline) as compared to pH of fresh poultry waste which was 4.9 (acidic).

Electrical Conductivity

In comparison with pure poultry waste, electrical conductivity was decreased . It was around 0.2 in all the compost prepared by both species in all five combinations.

Organic Carbon

In pure poultry waste, organic carbon was 22.52, but after vermicomposting the organic carbon decreased considerablely to around 2.0 . In case of T 4 combination i.e. pure poultry waste, organic carbon of the vermicompost was 2.2 and 2.3 of S1 and S2 species respectively whereas in case of S2 species, its value was 1.726. Chowdappa *et al*. (1999) found the same result of decrease of organic carbon contents in their studies of recycling of organic waste.

Total % Nitrogen

Total % N also decreased considerably. It decreased from their original value of pure poultry waste. There was not noticeable difference with all combinations of the compost.

Total % Phosphorus

The value of % phosphorus of final compost between 0.03 to 0.6, which is less in comparison with pure poultry waste and it is around 1.33%.

Total % Potassium The total % of K in all the compost was in between 0.021 to 0.4 which is less then its initial value of poultry waste.

RESULTS AND DISCUSSION

After inoculation of different species of earthworms in various combinations, it was found that species S-I (*Eisenia foetida*) and species S-II (*Lampito mauritti*) started making vermicompost on the third day. During this period, moisture and temperature was regulated by regular watering.

PHOTOGRAPHS SHOWING VERMICOMPOSTING AND HOW WE MAINTAIN THE MOISTURE AND TEMPERATURE

After 45 days, it was found that S -I and S-II species completely converted the semidecomposed material into vermicompost and these pots were now filled with sweet smelling spongy vermicompost.
After completion of composting, earthworms were removed from the compost by drying it on a cemented floor, directly in sunlight. By this process earthworms gathered at the bottom of the compost and then bunches of earthworms were separated from the vermicompost.

PHOTOGRAPHS SHOWING DRYING OF COMPOST AND SAPERATION OF EARTHWORMS

PHOTOGRAPHS SHOWING SAPERATION OF EARTHWORMS

After removing earthworms from the compost chemical analysis of the vermicompost was done. The result is summarized in the form of tabular form:

DISCUSSION

Thus the poultry waste (which was considered as non utilizable solid waste) can be effectively used for conversion to useful vermicompost by utilization of different earthworms species and different combination of cow dung. On the basis of the chemical analysis, the observations indicated the *E.foetida* to be superior in performance over *L. mauritii* in terms of loss of TOC, reduction in carbon to nitrogen ratio, incease in EC and TK , though *E.foetida* are capable of working hard to convert all the organic waste into manure, they are no significant value in modifying structure of soil. *L. mauritii* however are capable of both organic waste consumption as well as modifying the soil structure.

CONCLUSION

According to Dr. Radha D. Kale book "Earthworms Cinderella of Organic Forming " Page No. 62. " Any animal waste axcept the poultry droppings can be used for composting. If poultry waste has to be used for composting it should be slurry derieved fom the biogas plant." But here in present study, pure poultry waste has been converted in to vermicompost by keeping the pH between 7 to 9 i.e. alkaline. The vermicompost prepared from pure poultry waste is superior and of good quality in comparison with vermicompost prepared from other organic waste in term of organic carbon and potassium, whereas in term of nitrogen and phosphorus it is of medium quality.

From the present study we can conclude that:

1. Pure poultry waste can be converted into useful vermicompost.
2. Total 45 days are required for the semidecompsition for all combinations.
3. Total composting time for S1 and S2 species is 45 days.
4. The best combination for S2 species that can be used to convert poultry waste into vermicompost is T2 combination (2: 1)i.e. two parts of poultry waste and one part of cow dung.
5. The best combination for S1 Species i.e. *Eisenia foetida* is T3 combination (1 : 1)i.e. 1 part of poultry waste and 1 part of cow dung.
6. The best compost of S1 species i.e. *Eisenia foetida* was formed in T3 combination (1:1) i.e. 1 parts poultry waste and 1 part cow dung.
7. The best compost of S2 species i.e. *Lampito mauritii* formed in T3 combination (1:1) i.e. 1 parts poultry waste and 1 part cow dung.
8. The best compost was formed by S1 Species i.e. *Eisenia foetida* in T3 combination (1 : 1) i.e. 1 part of poultry waste and 1 part of cow dung.
9. The best species for converting T4 combination (1 : 0) i. e. pure poultry waste into vermicompost is S1 species i.e. *Eisenia foetida* and prepared compost was also of good quality.

PRECAUTION DURING THE EXPERIMENTS

Moisture level in the vermipit should be between 40-50%.Excess water reduces the activity of the earthworms. Worms should not injured while handling. Worms should be protected by the predators like white ants, red ants, centipedes, toads , lizards and rats etc. the harvesting and the providing of the feed mix should be attended in the time, otherwise accumulation of the vermicomposting and reproduction of the worms would be reduced.

During rainy season, temporary shelter over the pit and proper drainage around the pit should be provided to avoid water entry inside of the pit. Semidecomposed material helps faster formation of the vermicomost.

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Table 1- Chemical properties and nutrient contents of various compost samples prepared by s - 1 species

COMPOST SAMPLE CODE		pH (1:2.5)	EC (mS/cm.)	Organic Carbon (%)	Organic Matter (%)	Avaialable nutrients (%)			Exchangeable Cations (me/100g)		Total N %	Total P %	Total K %
						N	P	K	Ca	Mg			
T1	A-1	8.020	0.130	2.400	4.140	0.021	0.0210	0.0320	34.270	6.370	0.210	0.210	0.320
	A-2	7.930	0.290	2.370	4.090	0.020	0.0230	0.0450	30.330	12.780	0.200	0.230	0.450
	A-3	8.030	0.123	2.500	4.280	0.021	0.0200	0.0380	34.470	6.580	0.210	0.200	0.380
	A-4	8.025	0.285	2.385	4.058	0.021	0.0210	0.0410	30.335	12.741	0.210	0.210	0.410
	AVERAGE	**8.001**	**0.207**	**2.414**	**4.142**	**0.021**	**0.0213**	**0.0390**	**32.351**	**9.618**	**0.208**	**0.213**	**0.390**
T2	B-1	7.940	0.290	2.550	4.390	0.022	0.0150	0.0420	19.500	5.070	0.220	0.150	0.420
	B-2	7.870	0.210	2.580	4.450	0.022	0.0140	0.0070	22.460	7.820	0.220	0.140	0.070
	B-3	7.800	0.159	2.740	4.720	0.024	0.0150	0.0060	20.790	14.520	0.240	0.150	0.060
	B-4	7.861	0.214	2.547	4.435	0.025	0.0160	0.0060	22.425	8.546	0.250	0.160	0.060
	AVERAGE	**7.868**	**0.218**	**2.604**	**4.499**	**0.023**	**0.0150**	**0.0153**	**21.294**	**8.989**	**0.233**	**0.150**	**0.153**
T3	C-1	7.720	0.182	2.690	4.640	0.023	0.0350	0.0460	28.560	13.520	0.230	0.350	0.460
	C-2	7.750	0.098	2.420	4.180	0.021	0.0340	0.0340	24.430	9.480	0.210	0.340	0.340
	C-3	7.680	0.290	2.020	3.480	0.170	0.0480	0.0290	21.280	7.720	1.700	0.480	0.290
	C-4	7.741	0.094	2.412	4.164	0.021	0.0320	0.0310	24.254	9.579	0.210	0.320	0.310
	AVERAGE	**7.723**	**0.166**	**2.386**	**4.116**	**0.059**	**0.0373**	**0.0350**	**24.631**	**10.075**	**0.588**	**0.373**	**0.350**
T4	D-1	8.220	0.098	1.270	2.190	0.011	0.0590	0.0360	23.120	17.430	0.110	0.590	0.360
	D-2	8.210	0.290	1.830	3.160	0.016	0.0550	0.0310	24.320	10.220	0.160	0.550	0.310
	D-3	8.330	0.139	1.950	3.370	0.017	0.0530	0.0320	24.300	10.470	0.170	0.530	0.320
	D-4	8.231	0.125	1.854	3.165	0.016	0.0560	0.0350	24.312	10.351	0.160	0.560	0.350
	AVERAGE	**8.248**	**0.163**	**1.726**	**2.971**	**0.015**	**0.0558**	**0.0335**	**24.013**	**12.118**	**0.150**	**0.558**	**0.335**
T5	E-1	8.010	0.145	1.990	3.430	0.017	0.0370	0.0460	25.410	14.590	0.170	0.370	0.460
	E-2	7.870	0.156	1.520	2.620	0.130	0.0380	0.0420	22.260	9.890	1.300	0.380	0.420
	E-3	7.824	0.154	1.536	2.652	0.125	0.0350	0.0410	22.312	9.254	1.250	0.350	0.410
	E-4	7.770	0.116	1.270	2.200	0.011	0.0370	0.0070	22.660	7.960	0.110	0.370	0.070
	AVERAGE	**7.869**	**0.143**	**1.579**	**2.726**	**0.071**	**0.0368**	**0.0340**	**23.161**	**10.424**	**0.708**	**0.368**	**0.340**

CHEMICAL PROPERTIES AND NUTRIENT CONTENTS OF VERIOUS COMPOST SAMPLES PREPARED BY S - 2 SPECIES													
COMPOST SAMPLE CODE		pH (1:2.5)	EC (mS/cm.)	Organic Carbon (%)	Organic Matter (%)	Available nutrients (%)			Exchangeable Cations (me/100g)		Total N %	Total P %	Total K %
						N	P	K	Ca	Mg			
T 1	F-1	8.180	0.115	1.030	1.770	0.009	0.0530	0.0290	26.790	13.220	0.090	0.530	0.290
	F-2	7.740	0.209	1.120	1.930	0.010	0.0520	0.0300	25.020	17.270	0.100	0.520	0.300
	F-3	7.960	0.214	1.740	3.200	0.015	0.0530	0.0270	24.430	10.120	0.150	0.530	0.270
	F-4	7.725	0.204	1.125	2.365	0.012	0.0520	0.0260	26.125	15.254	0.120	0.520	0.260
	AVER AGE	**7.901**	**0.186**	**1.254**	**2.316**	**0.012**	**0.0525**	**0.0280**	**25.591**	**13.966**	**0.115**	**0.525**	**0.280**
T 2	G-1	7.700	0.196	1.710	2.950	0.015	0.0510	0.0270	21.280	8.330	0.150	0.510	0.270
	G-2	7.610	0.192	0.810	1.390	0.007	0.0420	0.0250	18.320	16.430	0.070	0.420	0.250
	G-3	7.610	0.272	1.390	2.360	0.012	0.0380	0.0250	21.670	8.820	0.120	0.380	0.250
	G-4	7.612	0.195	1.352	1.385	0.025	0.0410	0.0260	19.652	15.220	0.250	0.410	0.260
	AVER AGE	**7.633**	**0.214**	**1.316**	**2.021**	**0.015**	**0.0430**	**0.0258**	**20.231**	**12.200**	**0.148**	**0.430**	**0.258**
T 3	H-1	7.790	0.280	1.770	3.060	0.015	0.0370	0.0240	18.520	30.600	0.150	0.370	0.240
	H-2	7.890	0.199	1.870	3.220	0.016	0.0350	0.0230	18.320	16.670	0.016	0.035	0.023
	H-3	7.850	0.338	2.890	4.980	0.025	0.0330	0.0280	16.940	15.300	0.025	0.033	0.028
	H-4	7.254	0.020	1.815	3.320	0.021	0.0360	0.0240	17.326	16.250	0.026	0.034	0.021
	AVER AGE	**7.696**	**0.209**	**2.086**	**3.645**	**0.019**	**0.0353**	**0.0248**	**17.777**	**19.705**	**0.054**	**0.118**	**0.078**
T 4	I-1	7.870	0.274	2.300	3.970	0.020	0.0450	0.0280	23.050	17.100	0.026	0.034	0.021
	I-2	7.960	0.275	2.300	3.960	0.020	0.0490	0.0300	21.280	8.920	0.026	0.034	0.021
	I-3	7.940	0.145	2.110	3.640	0.018	0.0460	0.0300	23.840	17.370	0.026	0.034	0.021
	I-4	7.854	0.247	2.321	3.914	0.024	0.0430	0.0310	22.281	9.126	0.026	0.034	0.021
	AVER AGE	**7.906**	**0.235**	**2.258**	**3.871**	**0.021**	**0.0458**	**0.0298**	**22.613**	**13.129**	**0.026**	**0.034**	**0.021**
T 5	J-1	7.800	0.116	2.270	3.910	0.020	0.0380	0.0330	23.440	10.270	0.026	0.034	0.021
	J-2	7.720	0.260	1.730	2.890	0.015	0.0360	0.0280	23.050	10.210	0.026	0.034	0.021
	J-3	7.780	0.262	2.230	3.840	0.019	0.0300	0.0330	22.260	8.980	0.026	0.034	0.021
	J-4	7.712	0.261	2.211	2.892	0.015	0.0230	0.0290	24.056	10.215	0.026	0.034	0.021
	AVER AGE	**7.753**	**0.225**	**2.110**	**3.383**	**0.017**	**0.0318**	**0.0308**	**23.202**	**9.919**	**0.026**	**0.034**	**0.021**

CHEMICAL PROPERTIES AND NUTRIENT CONTENTS OF VERIOUS SEMIDECOMPOSED MATERIALS												
COMPOS T SAMPLE CODE	pH (1:2.5)	EC (mS/cm .)	Organic Carbon (%)	Organic Matter (%)	Avaialable nutrients (%)			Exchangeable Cations (me/100g)		Total N %	Total P %	Total K %
					N	P	K	Ca	Mg			
SD-1	8.140	0.109	2.740	4.720	0.024	0.049	0.038	24.030	10.210	0.024	0.049	0.038
SD-2	7.810	0.263	2.110	3.640	0.018	0.040	0.034	22.460	8.920	0.018	0.040	0.034
SD-3	7.700	0.123	2.150	3.700	0.019	0.036	0.037	24.230	10.090	0.019	0.036	0.037

SD-4	8.590	0.321	2.110	3.640	0.018	0.024	0.038	27.380	12.890	0.018	0.024	0.038
SD-5	7.950	0.272	1.270	2.190	0.011	0.032	0.036	24.430	17.320	0.011	0.032	0.036

meq of Ca or mg / 100 g soil

Heading change in Exchangeable Cations (me/100 g)

meq = me milliun equivalent unit

CHEMICAL ANALYSIS OF DRY RAW MATERALS

S. NO	PARAMETER	RM-1 (Poultry Waste)	RM-2 (Cow Dung)
1	Water Holding Capacity (%)	48.80	50.60
2	pH (1:2.5)	4.9 (acidic)	9.8 (Alkaline)
3	EC (mS/cm)	1.93	1.03
4	Organic Carbon (%)	22.52	27.60
5	Organic Matter (%)	38.82	47.58
6	Nitrogen: Total N %	1.94	2.38
	Available N %	0.19	0.24
7	Phosphorus : Total %	1.33	1.85
	Available %	0.13	0.19
8	Potassium : Total %	3.64	5.36
	Available %	0.36	0.54
9	Calcium : Total %	1.58	0.89
	Available %	0.16	0.09

Also the vermicompost prepared from pure poultry waste is of good quality by comparing it with Jackson (1973) standards we can say that:

VARIABLES	JACKSON STANDARD	S-1 SPECIES	S-2 SPECIES
OC%	<0.5 Low 0.5 to 7.5 medium >0.75 high	1.726 high	2.258 high
N Kg/ ha	<272 low 273 to 544 medium >544 high	375.00 medium	493.75 medium
P Kg/ha	<9.82 low 9.82 to 24.45 medium > 24.45 high	15.90 medium	16.00 medium
K Kg/ ha	< 113.3 low 113.3 to 281.5 medium > 281.5 high	341.70 high	391.68 high