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Vermicomposting: An effective tool for recycling organic wastes using *Eisenia foetida* and *Eudrilus eugeniae*

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Abstract
An investigation was undertaken to explore the potential use of epigeic earthworm species *viz*. *Eudrilus eugeniae* and *Eisenia foetida* for effective management of Jackfruit leaf litter, Coconut leaf litter, Arecanut leaf litter and Sapota leaf litter. The experiment was conducted during 2021-2021 laid in Factorial Randomized Block Design (FRBD) with eight treatments and four replications. The result indicated that organic carbon content and C:N ratio of final vermicompost product get decreased with the enhancement of composting period. The total micronutrient content was found higher in treatment S_1 (jackfruit leaf litter) comprises 1618.07 ppm Fe, 109.93 ppm Mn, 26.58 ppm Zn and 7.43 ppm Cu. The minimum number of days (94.57 days) were required for maturation of material of treatment S_1 *i.e*, jackfruit leaf litter and maximum no. of days (113.75 days) were required for maturation of material of treatment S_2 *i.e.*, coconut leaf litter.

Keywords: *Eudrilus eugeniae*, *Eisenia foetida*, jackfruit leaf litter, coconut leaf litter, arecanut leaf litter and sapota leaf litter, vermicompost, micronutrient

1. Introduction
Leaf litter improves the soil quality through adding the organic matter and nutrients to the soil. Leaf litter is the main and fastest source of organic matter and other nutrients as compared to other wastes. Direct composting is probably the oldest and most effective method for efficient management of organic wastes but like all other methods of composting, it also too has its limitations. The main one is that it takes a long time to decompose unless of chopping everything in small pieces. Also it emits an unpleasant smell, sometimes the loss of nitrogen also takes place, it occupies more land and sometimes may get affected by adverse weather conditions. Thus, vermicomposting is one of the better option to manage the organic wastes.
Vermicomposting is the process of producing organic fertilizers or vermicompost from biodegradable materials with inoculation of earthworms and produce the better end product. Vermicomposting uses worms for such decomposition where they decomposes the buried waste material under moistened condition (80-85% moisture content) and at about temperature range of 20-25^0 C. The bedding is mainly made from shredded paper, dead leaves or straw. Vermicompost is a finely divided peat-like material which exhibit an excellent structure, porosity, aeration, drainage and moisture holding capacity (Ismail 2005; Edwards *et al*. 2011) [6, 4]. Vermicompost is nutrient rich, microbiologically active organic amendment with somewhat low C:N ratio with readily available forms of nutrients for plant uptake. There are nearly 3600 types of earthworms found in the world and are represented every soil type of globe (Verma and Prasad, 2005) [11] which are divided into burrowing and non- burrowing types. Epigeic species live in the organic horizon, or near the soil horizon and they mainly feed on decaying organic matter. *E. foetida* is especially adapted to living in a decaying environment, especially ones such as rotting vegetables, manures and actual composts, which makes it a very good choice for vermicomposting. *Eudrilus eugeniae* (African night crawler) was finds to have higher feeding, growth and bio-degradation capacity.
In the present study different substrates such as Jackfruit leaf litter, Coconut leaf litter, Arecanut leaf litter and Sapota leaf litter used for preparing the vermicompost which further analysed for its nutritive value.

2. Material and Methods

2.1 Experimental site

The experiment was conducted at Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during September 2020 to February 2021.

2.2 Substrate used

The dry leaf litter of different horticultural crops such as Jackfruit (*Artocarpus heterophyllus*), Coconut (*Cocos nucifera*), Arecanut (*Areca catechu)* and Sapota (*Manilkara zapota*) were used in experiment as substrates.

2.3 Collection and pre-treatment of substrates

The substrate samples *i.e,* fallen dry leaves of Jackfruit, Coconut, Areca-nut and Sapota were collected from the orchad of respective plants present in college campus, which comes under Department of Horticulture, Dapoli. After that, samples were kept for proper drying, then chopped in small fractions of about 2-3 inch sizes. The chopped leaf samples were spreaded on ground, sprinkled with decomposing culture and kept in shady areas for about 15 days by covering them with polythene sheets for pre-decomposition. Apart from this, the fresh cow dung was used for the preparation of slurry by using water in 1: 1 proportion and was sprinkled it over substrate material.

2.4 Earthworm Species

The experimental study was carried out by using epigeic species of earthworms namely *Eudrilus eugeniae* and *Eisenia foetida.* The both earthworm species were brought from M/s. Institute on National Organic Agriculture, Pune.

2.5 Filling of pots and layering of substrates

Thirty- two small earthen pots (60 cm diameter and 60 cm height) were used for vermicomposting of leaf litters. Bottom of the pots was covered with a layer of small pieces of bricks (2-3 inches). A layer of 5 cm thick mixture of sieved garden soil and powdered cow dung in proportion 1:1 was prepared over bricks which served as bedding material. Above that, 25 earthworms were introduced as per treatment and combination along with the partially decomposed leaf substrates (3 kg in each pot). The added organic residues were watered regularly throughout the experimental study *i.e.,* up to 90 days to maintain an optimum moisture level of 50%.

2.6 Inoculation of Earthworms

Half-decomposed leaf litters were incubated with two different earthworm species namely *Eudrilus eugeniae* and *Eisenia foetida* as per treatments. Each pot was filled with 25 earthworms. The optimum conditions for earthworms activities *i.e.,* moisture level of up to 50% and relative humidity was maintained. The material in the pot was turned over manually at an interval of one month.

Table 1: Total treatment combinations

Tr. No.	Treatment Combination
T_1	Jackfruit leaf litter + *Eudrilus eugeniae*
T_2	Jackfruit leaf litter + *Eisenia foetida*
T_3	Coconut leaf litter + *Eudrilus eugeniae*
T_4	Coconut leaf litter + *Eisenia foetida*
T_5	Arecanut leaf litter + *Eudrilus eugeniae*
T_6	Arecanut leaf litter + *Eisenia foetida*
T_7	Sapota leaf litter + *Eudrilus eugeniae*
T_8	Sapota leaf litter + *Eisenia foetida*

The vermicompost samples from three randomly and well distributed spots in each treatment combinations were collected with the help of augur without disturbing the live worms. The sampling was done thrice during experiment *i.e.*, at 30 DAI, 60 DAI and 90 DAI of vermicomposting and treatment wise composite vermicompost sample was prepared by mixing. The chemical properties *viz.* Organic carbon, C:N ratio, total micronutrients, No. of days required for maturation of compost were analysed from air dried vermicompost samples.

2.7 Nutrient analysis

Organic carbon of vermicompost samples was determined by preparing ash in muffle furnace at constant temperature of 550º-600 ^{0}C. The organic carbon was calculated by multiplying the percent loss on ignition by 0.58. (Piper, 2010) [8]. C:N ratio of vermicompost samples was determined by dividing organic carbon by total nitrogen. Total micronutrients of vermicompost samples were determined of vermicompost samples was determined from di-acid extract by AAS Method. (Lindsey and Norvell, 1978) [7]. The total number of days required to complete the process of composting *i.e.,* starting from the day of setting the windrow with substrate were recorded as duration of vermicomposting which is 90 days.

3. Results and Discussion

3.1 Organic carbon of vermicompost

The data given in Table 2 revealed that the higher organic carbon content were found in treatment S_1 (jackfruit leaf litter) *i.e,* 39.98%, 36.86% and 21.59% on 30, 60 and 90 DAI of vermicomposting respectively. As the composting period increased, the organic carbon content of final vermicompost product get decreased. Edwards and Boglen (1996) [3] reported that the respiratory activity of earthworms and microorganisms responsible for the reduction in organic carbon.

3.2 C:N ratio of vermicompost

From the data presented in Table 3 it is observed that the C:N ratio showed decreasing trend with increase in period of composting. The C:N ratio varied as maximum to minimum from 43.67 to 38.31, 32. 32.08 to 28.38 and 21.13 to 16.37 on 30, 60 and90 DAI of composting; respectively. The treatment S_2 containing coconut leaf litter showed highest C:N ratio followed by co-arecanut leaf litter, sapota leaf litter and jackfruit leaf litter. The activity of earthworms alters the physical and chemical status of wastes which reduces C/N ratio of cow vermicompost post, making it an odorless, finely divided peat like material with high porosity and water holding capacity along with enhanced nutrient contents. (Dominguez and Edwards 2004) [5].

3.3 Total iron content of vermicompost

The data depicted in Table 4 revealed that, on 30 DAI of composting, the maximum total iron content was obtained in treatment S_1 containing jackfruit leaf litter (958.58 ppm) followed by sapota leaf litter (939.13 ppm), arecanut leaf litter (892.22 ppm) and coconut leaf litter (857.59 ppm). On 60 and 90 DAI of composting, the maximum total iron content was observed in treatment S_1 (jackfruit leaf litter) *i.e,* 1254.77 ppm and 1618.07 ppm respectively while minimum total iron content were observed in treatment S_2 containing coconut leaf litter *i.e,* 1143.93 ppm and 1517.24 ppm respectively.

Chowdappa *et al.* (1999) [2] showed that the waste conversion of Arecanut and cocoa garden waste into vermicompost resulted in higher micronutrient iron content than the other normal compost WITI.

3.4 Total manganese content of vermicompost

From the data given in Table 5, it is observed that, On 30, 60 and 90 DAI of composting, the maximum total amount of manganese (84.40 ppm, 105.24 ppm and 109109.93 ppm respectively) was obtained from in treatment S_1 containing jackfruit leaf litter while minimum total manganese content (77.93 ppm, 90.31 ppm and 94.44 ppm) was found in treatment S_2 containing coconut leaf litter. Agarwal (1999) [1] observed that there were significant increase in total manganese content of vermicompost as compared to aerobic compost and anaerobic compost.

3.5 Total zinc content of vermicompost

The data given in Table 6, presented that, On 30, 60 and 90 DAI of composting, the maximum total amount of zinc (18.57 ppm, 21.60 ppm and 26.58 ppm respectively) was obtained from treatment S_1 containing jackfruit leaf litter. Sannigrahi (2005) [9] reported that enhancement in the earthworm population in compost bed decreased the period of vermicomposting and also simultaneously responsible for increases in the total zinc content.

3.6 Total copper content of vermicompost

The data of table 7 indicated that, On 30 DAI of composting the maximum copper content was obtained from treatment S_1 containing jackfruit leaf litter (4.42 ppm) followed by treatment S_4 containing sapota leaf litter (3.66 ppm) followed by treatment S_3 having arecanut leaf litter (3.42 ppm) and the lowest total copper content was obtained in treatment S_2 containing coconut leaf litter (3.42 ppm).

3.7 Number of days required for maturation of vermicompost

From the data presented in Table 8 it is observed that the days required for maturation of vermicomposting substrates were minimum for treatment S_1 containing jackfruit leaf litter (94.57 days) and maximum for treatment S_2 *i.e*, coconut leaf litter (113.75 days) point out that degradation of organic wastes was mainly dependent on the lignin content of leaf wastes and the C:N ratio of the mixture being composed. Talashilkar *et al.* (1996) [10] studied the changes in different properties during humification of solid material carried out in the pit method for the period of 150 days and concluded that after the inoculation of earthworm species such *E. foetida* and *E. eugeniae*, composting period get reduced from 135 to 120 days in case of mango leaves and from 90 to 60 days in case of kitchen garbage.

Table 2: Changes in Organic carbon content (%) of vermicompost during composting of organic residues

Treatment effect		30 DAI			60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	Jackfruit leaf litter	41.08	38.88	39.98	39.31	34.41	36.86	22.55	20.64	21.59
S_2	Coconut leaf litter	33.66	30.89	32.27	31.39	29.68	30.53	19.40	17.84	18.62
S_3	Arecanut leaf litter	37.08	33.84	35.46	34.11	31.61	32.86	20.44	18.53	19.48
S_4	Sapota leaf litter	38.45	36.74	37.59	36.58	30.90	33.74	22.21	19.68	20.94
Mean		37.57	35.09	35.82	35.35	31.65	33.49	21.15	19.17	20.16
		S	E	S×E	S	E	S×E	S	E	S×E
S.E. ±		0.37	0.26	0.53	0.29	0.20	0.41	0.17	0.12	0.25
C.D. at 5%		1.11	0.79	NS	0.87	0.61	1.23	0.52	0.36	NS

Table 3: Changes in total iron content (ppm) of vermicompost during composting of organic residues

Treatment effect		30 DAI			60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	Jackfruit leaf litter	995.21	921.96	958.58	1296.31	1213.24	1254.77	1662.55	1573.6	1618.07
S_2	Coconut leaf litter	871.78	843.40	857.59	1175.84	1112.02	1143.93	1583.98	1450.51	1517.24
S_3	Arecant leaf litter	902.66	875.78	889.22	1238.25	1184.34	1211.29	1590.42	1475.31	1532.86
S_4	Sapota leaf litter	970.57	907.69	939.13	1267.21	1209.8	1238.50	1620.31	1518.22	1569.26
Mean		935.05	887.20	911.12	1244.40	1179.85	1212.12	1614.31	1504.41	1559.36
		S	E	S×E	S	E	S×E	S	E	S×E
S.E. ±		1.97	1.39	2.79	3.97	2.81	5.62	6.94	4.90	9.81
C.D. at 5%		5.80	4.10	8.21	11.70	8.27	NS	20.41	14.43	NS

Table 4: Changes in total Manganese content (ppm) of vermicompost during composting of organic residues

Treatment effect		30 DAI			60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	Jackfruit leaf litter	85.13	83.68	84.40	107.57	102.91	105.24	113.59	106.28	109.93
S_2	Coconut leaf litter	79.17	76.68	77.93	92.99	87.62	90.31	95.70	93.19	94.44
S_3	Arecanut leaf litter	80.96	79.18	80.07	96.12	90.01	93.06	97.87	95.43	96.65
S_4	Sapota leaf litter	82.91	82.10	82.51	104.84	99.44	102.14	111.89	103.99	107.94
Mean		82.04	80.41	81.22	100.38	95.00	97.68	104.76	99.72	102.24
		S	E	S×E	S	E	S×E	S	E	S×E
S.E. ±		0.11	0.08	0.16	0.16	0.11	0.23	0.15	0.11	0.22
C.D. at 5%		0.34	0.24	0.49	0.49	0.34	0.69	0.46	0.33	0.66

Table 5: Changes in total zinc content (ppm) of vermicompst during composting of organic residues

Treatment effect		30 DAI			60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	Jackfruit leaf litter	19.56	17.58	18.57	23.11	20.08	21.60	27.90	25.25	26.58
S_2	Coconut leaf litter	15.74	13.31	17.66	17.97	16.88	17.42	22.58	21.01	21.79
S_3	Arecanut leaf litter	17.00	16.01	16.50	18.84	17.36	18.10	23.94	21.98	22.96
S_4	Sapota leaf litter	18.34	16.64	17.49	21.13	18.71	19.92	26.66	24.60	25.63
Mean		17.66	15.88	16.77	20.26	18.26	19.26	25.27	23.21	24.24
		S	E	S×E	S	E	S×E	S	E	S×E
S.E. ±		0.17	0.12	0.24	0.10	0.07	0.14	0.07	0.05	0.11
C.D. at 5%		0.51	0.36	NS	0.31	0.22	0.44	0.23	0.16	0.33

S – Substrate effect E – Earthworm effect NS – Non - Significant
E_1 – *Eudrilus eugeniae* E_2 – *Eisenia foetida*

Table 6: Changes in total copper content (ppm) during composting of organic residues

Treatment effect		30 DAI			60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	Jackfruit leaf litter	4.91	3.93	4.42	5.90	5.21	5.56	7.92	6.95	7.43
S_2	Coconut leaf litter	2.90	2.37	2.63	4.11	3.46	3.78	5.17	4.98	5.07
S_3	Arecanut leaf litter	3.10	3.73	3.42	4.89	3.93	4.41	6.01	5.94	5.98
S_4	Sapota leaf litter	4.16	3.15	3.66	5.14	4.82	4.98	7.20	6.18	6.69
Mean		3.77	3.30	3.53	5.01	4.36	4.68	6.57	6.01	6.29
		S	E	S×E	S	E	S×E	S	E	S×E
S.E. ±		0.04	0.03	0.06	0.03	0.02	0.04	0.01	0.01	0.02
C.D. at 5%		0.14	0.10	0.20	0.10	0.07	0.14	0.04	0.03	0.06

Table 7: Changes in C:N ratio during composting of organic residues

Treatment effect		30 DAI			60 DAI			90 DAI		
		E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	Jackfruit leaf litter	40.52	36.09	38.31	28.01	28.76	28.38	16.65	16.08	16.37
S_2	Coconut leaf litter	45.81	41.54	43.67	31.11	31.57	31.34	25.54	19.73	21.13
S_3	Arecanut leaf litter	42.04	37.42	39.73	27.98	29.78	28.88	19.93	18.48	19.20
S_4	Sapota leaf litter	41.09	39.13	40.11	31.42	32.75	32.08	18.61	16.47	17.54
Mean		42.37	38.55	40.45	29.63	30.71	30.17	19.43	17.69	18.56
		S	E	S×E	S	E	S×E	S	E	S×E
S.E. ±		0.68	0.48	0.97	0.57	0.40	0.81	0.41	0.29	0.58
C.D. at 5%		2.04	1.44	NS	1.71	NS	NS	1.23	0.87	NS

S – Substrate effect E – Earthworm effect NS – Non - Significant
E_1 – *Eudrilus eugeniae* E_2 – *Eisenia foetida*

Table 8: No. of days required for composting of organic residues

Treatment effects		No. of days		
		E_1	E_2	Mean
S_1	Jackfruit leaf litter	90.75	98.75	94.57
S_2	Coconut leaf litter	109.00	118.50	113.75
S_3	Arecanut leaf litter	105.75	113.00	109.37
S_4	Sapota leaf litter	95.25	103.75	99.50
Mean		100.18	108.50	104.29
		S	E	S×E
S.E. ±		0.17	0.12	0.25
C.D. at 5%		0.53	0.37	0.75

4. Conclusion

On the basis of data obtained from present investigation, it can be concluded that, amongst the different sources (leaf litter) used for the preparation of vermicompost jackfruit leaf litter was found to be the best source for rapid composting with higher concentration of micronutrients. Amongst two different epigeic species of earthworms, *Eudrilus eugeniae* was found superior than *Eisenia foetida* for enhancing the composting process and quality of composting material.

5. References

1. Agarwal S. Study of Vermicomposting of Domestic waste and the effect of vermicompost on growth of some vegetable crops, Ph. D Thesis submitted to R. A. U., Jaipur, India. 1999.
2. Chowdappa P, Bidappa CC, Sujatha S. Efficient recycling of organic wastes in Arecanut (*Areca catechu*) and Cocoa (*Theobroma cacao*) plantation through vermicomposting. Indian J Agril. Sci. 1999;69(8):563-566.
3. Edwards CA, Boglen PJ. Biology and ecology of earthworms. Third edition. Chapman and Hal London, England. 1996.
4. Edwards CA, Subler S, Arancon N. Vermiculture technology: earthworms, organic waste and environmental management. CRC Press, Boca Raton. 2011, 287-301.
5. Dominguez J, Edwards CA. Vermicomposting Organic Wastes: A Review. In S. S. Hanna & W. Z. A Mikha TI, Soil Zoology for the sustainable development in the 21st Century. 2004.
6. Ismail A. The earthworm book. Other India Press, Mapusa. 2005, 101.
7. Lindsay WI, Norwell WA. Development of DTPA soil test for zinc, iron, manganese and copper, Soil Science, Society of American Journal. 1978;42:421-428.
8. Piper CS. Soil and Plant analysis, Hands publisher, Bombay. 2010.

9. Sannigrahi AK. Efficiency of *Perionyx excavatus* in vermicomposting of Thatched grass in comparison to *Eisenia foetida* in Assam. Journal of Indian Society of Soil Science. 2005;13:23-27.
10. Talashikar SC, Bhangarath PP, Mehta VB. Changes of chemical properties during composting of organic residues as influenced by earthworm activity. Journal Indian Society of Soil Science. 1996;47(1):50-53.
11. Verma P, Prasad A. Vermicomposting: A Potential Technology of Solid Waste Management. Agrobios Newsletter. 2005;4(5):33-35.