INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY AND CURRENT RESEARCH

ORIGINAL RESEARCH ARTICLE

Imvermicomposting Technology for Effective Solid Waste Management

Dr. D. P. Gupta and Dr. Arvind Dewangan

[a]HCTM Technical Campus, Ambala Road – Kaithal, Haryana INDIA

Abstract

Vermicomposting, also known as worm composting, is a process that saves you money, recycles your organic wastes, and is also eco-friendly. This natural way of composting organic wastes is a process that involves the use of worms, and of other beneficial microbes[1]. These worms then turn your organic scraps into a quality-made, and nutrient-filled compost (this by-product is also known as worm castings or worm manure). Worm castings help your plants and soil be at their best conditions, as these worm castings can be made into an organic fertilizer for your garden (it has an earthy smell to it); and as a soil conditioner for improving soil structure (water retention will improve)[10].

Key Words: *1. Vermicomposting 2. Worms 3. Soil 4. Disposal 5. Solid waste 5.Biomass 6. Compostable.*

Introduction

Vermicomposting : Earthworms are known to man ever since the man used to soil his hands. They are the "Intestines of the earth", and these slowly invertebrate are the "friends of farmers". Earthworms have an unique capacity to made qualitative and quantitative changes in their enzyme system to adapt to changed situations. They are very widely spread and resistant to stresses (Veeresh. 1986). The microflora harboring in the intestine of the earth-worm in conjunction with soil microflora reduce organics into simpler forms. Earthworms accelerate the process of mineralization of organic materials present in its environment. It is considered that the major part of mineralization takes place in the worm gut (within its digestive system) during its passage through it. Organic mineralization is thus found to be more in worm infested soils than in those without worms. Nitrogen (N) gets converted to nucleic acid, ammonia, urea and nitrates during mineralization. Microbes use carbon(C) for cell synthesis as well as a source of energy. Acids get condensed to numec acid while microbes convert organic phosphorous (P_o) into its inorganic form (P_i) (Krishnamurthy, 1986). Vermicomposting is set up by first placing a basal layer of vermibed comprising of broken bricks or pebbles (3-4 cm.) followed by a layer of coarse sand to a total thickness of 6-7 cm. to ensure proper drainage. This is followed by a 15 cm. moist layer of loamy soil into this soil are inoculated about 100 locally collected earthworms (about 50 surfaces and 50 subsurface varieties) small lumps of cattledung (fresh or dry) or dry leaves are then scattered over the soil and covered with a 10 cm layer of hay. Water is spread till the entire setup is moist but not wet. Less water kills the worms and too much chases them away. The unit is kept covered with leaves, old jute bags can also be used for covering. Watering the unit is continued and the unit is monitored for 30 days. The appearance of juvenile earth worms by this time is a healthy sign[2].

The passage soil or waste through the gut of the worm greatly enhances bacteria growth creates a favourable environment. Actinomycetes species, had been found to thrive in the presence of earthworm. The content of Actinomycetes in earthworm casting is six to seven times more than in the original waste (Bridgens, 1981). This accelerate the decomposition of organics into stabilized humus. An increase in the total viable count and in the number of nitrifying bacterial had also been observed (Jambhekar, 1991). Sixteen types of micro fungi were isolated from earthworm (infested soil and the gut of pheretima postuma (Srinivasulu, 1986).

Suitable Earthworm Species for Vermicomposting: The Indian subcontinent provides most environmental conditions for a rich and diverse earthworm fauna comprises of about 365 species belonging to 10 famiies and 58 genera (Julka, 1986). Depending upon their habitats, earthworms are classified as (Jhulka, 1986) Epiges (litter or dung dwellers), Endoges (dwellers on top soil rich in organics) and Aneciques (deep soil dwellers). For a successful vermicomposting operation it is essential that suitable species of earthworms are selected on the basis (Dash and Senapati, 1986; Julkla, 1986) of their : (1) ability to inhabit and feed upon high percentage of organic matter, (2) adaptability of human disturbances, and fluctuations in physic-chemical and environment parameters, (3) high fertility rate (that is high cocoon production rate with low incubation period and short life cycle), (4) high growth, consumption, digestion and assimilation rates, and (5) lease vermistabiity (period of inactivity after initial incubation of organic waste)[3]. Epiges (litter and dung dwellers) are very much tolerant to disturbance, have high rate of cocoon production and short life cycle. They are most suitable for vermicomposting. Some Endoges species with tolerance to disturbances, moderate to high rate of cocoon production and moderately short life cylcle are also found to be suitable (Jhulka , 1986).

Why should schools vermicompost?

Using worms to decompose food waste offers several advantages:

- It can reduce garbage disposal costs.
- It produces fewer odors and attracts fewer pests than putting food wastes into a garbage container.
- It saves water and electricity that sinks and garbage disposals use.
- It produces a free, high-quality soil-amendment.
- It is a good way to teach students about minimizing waste.
- Schools can earn money by selling the valuable compost and extra worms produced[10].

Vermicomposting Process: The degradation of organic waste by earth wormic consumption is known as vermicamposting. Vermiculture is the production of a stock of earth worms (Hartenstein 1981). It can be described as the scientific method of breeding and rearing earthworms in controlled condition. It aims at creating favourable conditions, for the multiplication and growth of earthworms (Bhole, 1992).

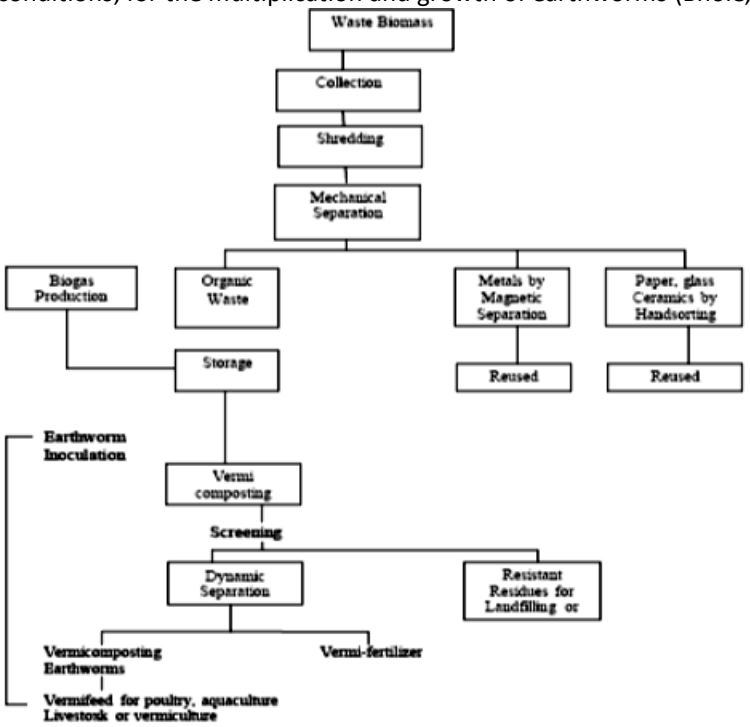

Figure 1: shows the Vermicomposting flowchart

MSW was collected from

1) Panch Kandil Area

2) June Dhule Area
3) Deopur Area
4) Vegetable Market, Dhule
5) Residential Area (Pratap Mills)

About 5-10 kg of waste was collected from each point and mixed well to obtain a composite sample representative of the Dhule municipal waste. The MSW collected was sundried and segregated into organic and non-organic matter. It was then chopped (shredded) into 2-3 cm size.Earthworms were hatched and growth in the laboratory from polyculture seeds obtained from Maharashtra Agriculture Bioteks, Pune[4]. The species include E. Foetida and P.Elogeta. Earthworms eggs present in casting were hatched in earthen pots for about 30 days with moisture content not exceeding 60% and at PH of around 7.dry leaves were given as initial organic matter for us by the young worms. Regular monitoring or moisture content and pH were done every third day. Watering was done as per the requirement to maintain moisture content 50-60%. The necessity for pH adjustment did not arise as the pH was found to be more or less constant. The young worms were then transferred into 2.0 liter glass beakers along with casting (in which they were hatched) forming the bottom 5-6 cm layer to acclimatize the worms into the new environment[5].
Acclimatization was completed in 10 day and worm were ready for transfer subsequently into the experimental setup.

Experimental Setup of the Vermireactor (VR)

An earthen pot of dimension 36x21x15 cm was used as the reactor for vermicomposting. This reactor was called vermireactor (VR). A perforated irons sheet was attached to the reactor as a cover to protect them from external interferences like birds, lizards, and rats. The bottom most layer of 2.5 cm depth in the vermireactor consisted of ordinary sandy soil. On the top of this the acclimatized worms with soil were added as a 1.5 cm layer. Chopped MS (1.5 kg with a moisture content of 31.5 %) was added as the top 3.0 cm layer schematic diagram of the reactor is given in figure . The total number of earthworms added were 150-175 nos, forming a total earthworm biomass of 75 cm (Worms were washed with successive 250 ml. of tap water and then transferred to filter paper before weighting)[6]. The reactor was watered with such amount of water so as to get moisture content of 50-60%. Watering was done every time after collection of sample once in a week. Figure 2 shows the schematic diagram of vermireactor and Figure 3, shows the photograph of the experimental setup for vermicomposting of municipal solid waste[7]

ANALYSIS OF VERMICOMPOSTING EXPERIMENT

The samples collected from the top of Municipal Solid Waste portion of Vermireactor (VR) were analyzed parameter and results are presented below:-
Total Compostable Matter and Organic Carbon: following table shows the weekly variation of total compostable matter and organic carbon for seven weeks duration. Total compostable matter and organic carbon showed a declining trend in the vermireactor. In the vermicomposting unit, the total compostable matter was found to decrease by 91.73% over a period of 7 weeks when analysis was done for vermireactor.
The degradation of organic carbon was found to be in the same range as that of total compostable matter[8].
Result shows the variation of total compostable matter and organic carbon graphically respectively. The curves of TCM and OC shows that the vermicomposting process was completed within 4-5 weeks as a flat line is obtained after 5 weeks.

Table : TOTAL COMPOSTABLE MATTER (TCM) IN SAMPLESFROM THE VERMIREACTOR FOR DHULE CITY

Time in week	TCM in Vermireactor (%)	% of Reduction in TCM over the intial value
0	54.25	0.0
1	23.95	55.87
2	15.20	72.09
3	11.19	79.48
4	8.55	84.59
5	4.88	91.37
6	4.50	91.65
7	4.39	91.69

Nitrogen and Carbon / Nitrogen Ratio: The nitro content (Total Kjeldahl Nitrogen) was found out for samples and results are shown in Table and Figure 6 almost all the samples showed in initial fall in nitrogen content followed by a gradual increase as shown in Figure[9] The Nitrogen content increased by 56.61% over the 7 weeks period. C/N ratio decreased from an initial value of 40.50 to a final value of 2.30 in vermireactor. The results on variation of C/N ratio are given in Table 4 and are shown in Figure 7. A very low C/N ratio signifies the usefulness of the compost as an organic fertilizer. A C/N ratio below 20 signifies that direct absorption of nutrients from the compost by plans is possible (Dash, M.C. And Senapati B.K. 1986)

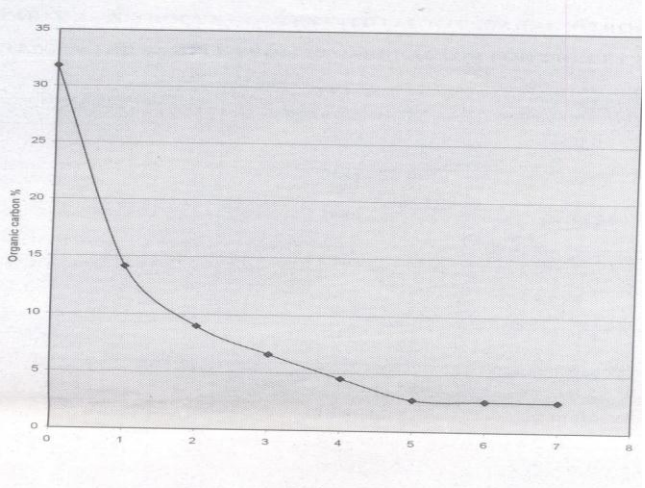

FIGURE - 5 : VARIATION OF ORGANIC CARBON CONTENT IN VERMIREACTOR

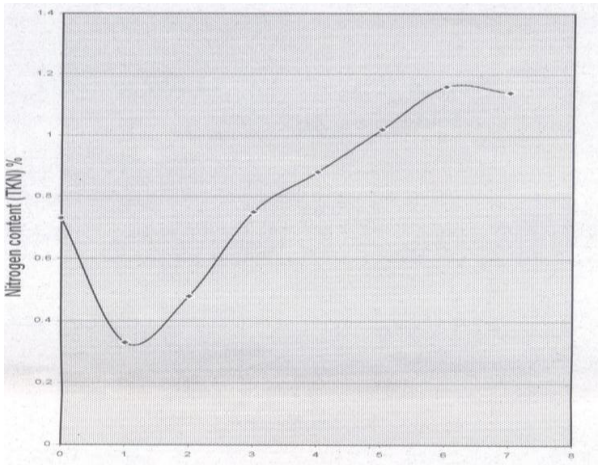

FIGURE 6 :VARIATION OF NITROGEN CONTENT IN VERMIREATOR -

Table : C/N RATIO IN SAMPLES FROM VERMIREACTOR FOR DHULE CITY

Times in Weeks	C/N Ratio
0	40.35
1	34.82
2	18.7
3	8.78
4	5.17
5	2.7
6	2.3
7	2.3

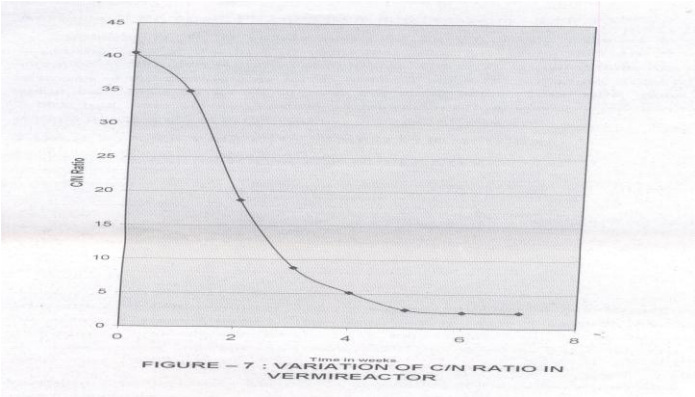

FIGURE – 7 : VARIATION OF C/N RATIO IN VERMIREACTOR

CONCLUSIONS

As a processing system, the vermicomposting of organic waste is very simple. Worms ingest the waste material - break it up in their rudimentary gizzards - consume the digestible/putrefiable portion, and then excrete a stable, humus-like material that can be immediately marketed and has a variety of documented benefits to the consumer.Vermitechnology can be a promising technique that has shown its potential in certainchallenging areas like augmentation of food production, waste recycling, management ofsolid wastes etc. There is no doubt that in India, where on side pollution is increasing due to accumulation of organic wastes and on the other side there is shortage of organic manure, which could increase the fertility and productivity of the land and produce nutritive and safe food. So the scope for vermicomposting is The present study establishes the vermicomposting technology as an efficient method for MSW recycling. MSW vermicomposting technology holds great potential in all developing countries in general and India in particular because of the presence of high compostable matter in its municipal solid waste and abundance of earthworm fauna. It is not only produces enriched and cost effective organic fertilizer, but provided direct and indirect employment opportunities also. It is more lucrative as the technique is not energy, capital or equipment intensive. With the continued awareness against artificial fertilizer, vermifertilizer can be seen as a better alternative with a lot of promise. However the sophistication and time required for nitrogen determination makes C/N ratio parameter unattractive. The gut enzymes produced in the earthworm are supposed to play a major role in the decomposition of organic matter during its passage through the gut. Various enzymes, like amylase, chitinasea, cellulose, protease and urease were reported to be present in the gut (Dash and Snapati, 1986).

REFERENCES

[1] Albanell, E., Plaixats, J. & Cabrero, T. (1988): Chemical changes during vermicomposting (*E. fetida*) of sheep manure mixed with cotton industries waste. – Biology and Fertility of Soils 6(3): 266–269.
[2] Allee, W.C., Torvik, M.M., Lahr, J.P. & Hollister, P.L. (1930): Influence of soil reaction on earthworms. – Physiol. Zoology 3(2): 164–200.
[3] Aranda, E., Barois, I., Arellano, P., Irisson, S., Salazar, T., Rodriguez, J., & Patron, J.C. (1999): Vermicomposting in the Tropics. – In: Lavelle, P., Brussaard, L. & Hendrix, P. (eds.): Earthworm management in tropical agroecosystems. CAB International, pp. 253–287.
[4] Arrhenius, O. (1921): Influence of soil reaction on earthworms. – Ecology 2: 255–257.
[5] Atiyeh, R.M., Dominguez, J., Subler, S. & Edwards, C.A. (2000): Changes in biochemical properties of cow manure during processing by earthworms (*Eisenia andrei* Bouche) and the effects on seedling growth. – Pedobiologia 44: 709–724.
[6] Bansal, S. & Kapoor, K.K. (2000): Vermicomposting of crop residues and cattle dung with Eisenia foetida. – Bioresource Technology 73: 95–98.
[7] Bhawalkar, U.S. (1995): Vermiculture bioconversion of organic residues. – Ph.D. Thesis, I.I.T. Mumbai, India
[8] Camp, Dresser, McKee Inc. (1980): Compendium on solid waste management by vermicomposting. Cincinnati, OH, Municipal Environmental Research Lab, EPA.
[9] Rynk, R.M., Kamp, V.D., Willson, G.G., Singley, M.E., Richard, T.L., Kolega, J.J., Gouin, F.R., Laliberty, L. Jr., Kay, D., Murphy, D. H., Hoitink, A.J. & Brinton, W.F. (1992): On-farm composting handbook. – In: Rynk, R. (ed.): NRAES-54, Natural resource, agriculture and engineering service. 186 pp.
[10]. www.idem.IN.gov/greensteps-2013

ABOUT AUTHORS

Dr. D.P. Gupta is working as a Director of HCTM TECHNICAL CAMPUS, Kaithal, Haryana, INDIA. His research paper have been published in various National and International Journals like- IJITEE- Head office: 12320 Burbank Blvd Apt#300, Valley village, CA 91607,USA, Phone: +14082509035, Email: editor.ijcet@inpressco.com, IE[India], IeJMAE, IJCTEE[US]; IJMTAH, JERAD, ENGINEERING TECHNOLOGY IN INDIA, IJERIA and Research India Publication- Journal[IJAER etc.] in various civil engineering fields.

Young, dynamic and enterprising technocrat, Dr. Durga Parsad Gupta, attained the Degree in Bachelor of Engineering in the year 1984 from the Maulana Azad College of Technology, Bhopal. He enriched his qualification by acquiring the Master's Degree (M.Tech) from the same College of repute. His zest for learning did not end here which prompted him to pursue further higher studies in Engineering, resulting in the award of Ph.D Degree by the Maulana Azad National Institution of Technology, Bhopal under the Barkattulah University, Bhopal (M.P.). He is also deeply and emotionally involved in various projects related to R & D. Eversince his joining the College, he is diverting all his energies towards creation, development and upgradation. In recognition of his academic and administrative achievements, Dr. D.P. Gupta has been the recipient of the BEST PRINCIPAL AWARD by the INDIAN ACHIEVERS FORUM, New Delhi. He also received the EMINENT EDUCATIONIST AWARD from the National and International Compendium, New Delhi.

Dr. Arvind Dewangan, Associate Professor in Department of Civil Engineering, Haryana College of Technology & Management, Technical Campus KAITHAL. His highest academic qualification is PhD in Mining & Geological Engineering. He has 12years of experience in teaching and research. He has published 37 papers in International and National journals and won more than 15 times NATIONAL LEVEL ESSAY COMPETITION.

Co- Author: At present **Dr. Arvind Dewangan** is working as an Associate Professor in Civil Engineering Department in HCTM TECHNICAL CAMPUS, Kaithal; Haryana, INDIA since July 2008. Various articles about Technical & Higher education have been published in national level competition magazine like – Competition Success Review, i-SUCCEED, Civil Services Chronicle, Pratiyogita Sahitya, Pratiyogita Vikas, and Pratiyogita Darpan, and various research paper have been published in National and International Journals like- CSVTU RESEARCH, Bhilai, IE[India], IeJMAE, IJCTEE[US]; IJMTAH, JERAD, Stress Distribution Analysis of the Kaolinite Layer at the Kaolinite – Geotextile. He has 13 years teaching experience in Engineering Educationand about 4 years Field experience in Geo- hydrological field. He has also achieved 2-years administration experiences as Deputy director in Career Plus Institute affiliated with Gurughasidas University[at present – A Central University] Bilaspur Chhattisgarh. At present **Dr. Arvind Dewangan** is working as an Associate Professor in Civil Engineering Department in HCTM TECHNICAL CAMPUS, Kaithal; Haryana, INDIA since July 2008. Various articles about Technical & Higher education have been published in national level competition magazine like – Competition Success Review, i-SUCCEED, Civil Services Chronicle, Pratiyogita Sahitya, Pratiyogita Vikas, and Pratiyogita Darpan, and various research paper have been published in National and International Journals like- CSVTU RESEARCH, Bhilai, IJITEE- Head office: 12320 Burbank Blvd Apt#300, Valley village, **CA 91607,USA,** Phone: +14082509035, Email: editor.ijcet@inpressco.com IE[India], IeJMAE, IJCTEE[US]; IJMTAH, JERAD, ENGINEERING TECHNOLOGY IN INDIA, Research India Publication- Journal[IJAER etc.] in various civil engineering fields.