International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

Vermitechnology: A Sustainable Approach to Manage Organic Waste in Urban Areas

Leena Shakya[1], Ram Babu[2], Archana Singh[3], Srishti Dhiman[4], Sunil Kumar Dhiman[5]
[1,3]Assistant Professor, Department of Botany, Kirori Mal College, University of Delhi, Delhi. 110007
[2,5]Associate Professor, Department of Botany, Kirori Mal College, University of Delhi, Delhi. 110007
[4] Student, B.Sc.(H) Zoology III year, Department of Zoology, Kirori Mal College, University of Delhi, Delhi. 110007

ABSTRACT: Vermicomposting is the natural process of compost formation by converting organic wastes into organic fertiliser utilising earth worms and cow dung. It is being widely used for solid waste management. Many species of earthworms are utilised in this process such *as Eisenia fetida, Eudrilus eugeniae, Eisenia andrei, Lampito rubellus* and *Drawida willis.* They feed on the organic waste to produce vermicompost, vermiwash and more earthworms as resultant products. Composting process with this technique takes around 28-120 days and it depends upon the type of worms and organic waste used. Kirori Mal College of the University of Delhi is pioneer in adopting the vermicomposting on a large scale. It has put 15 beds in place in its nursery. This set of fifteen composting beds is able to utilise about 1.7 tons of dry leaves in a single cycle and converts them into very nutritious fertilizer. As we could run four such cycles in a year, the Kirori Mal College has the potential of consuming about seven tons of dry leaves annually and put it to a better use, which otherwise, would have been a responsibility of the Municipal Corporation of Delhi. Along with the vermicompost, the process also produces vermiwash, a concentrated liquid fertilizer, which is stored and is being utilized after dilution. The vermicomposting also leads to rapid multiplication of earthworms, which can be sold in the market and the spare ones can be utilised for the next cycle. Vermicomposting for the disposal of the dry organic waste is very cost effective and energy efficient.

KEYWORDS: Cost effective, Eco-friendly, Energy saving, Solid waste disposal and management, Vermicompost, Vermiwash.

INTRODUCTION

Solid wastes generated due to various activities are a universal problem which is faced by most of the countries. These wastes are generated due to several human activities as well as natural adversity (Chalmin and Gaillochet, 2009). Different types of solid wastes in the educational institutions are generated in large scale and their collection and management are very challenging. Right approach towards Solid Waste management plays a significant role for eco-friendly institutions.

In order to adopt a sustainable approach towards environment, implementation of 3R programs (reduce, reuse and recycle) has been regarded as an alternative approach to old-style waste management practices (Shekdar, 2009). It is estimated that in India nearly 700 million tons of organic waste is generated annually that comprises leaves, husk, sawdust, steam bark, flowers etc. which is either burned or land filled (Kulkarni et al., 2020). When these are left as such on soil surface in excess quantity, they cause problems such as bad smell and are the breeding grounds of mosquitoes that eventually lead to fast spreading of the infectious diseases.

Vermicomposting is an environmental friendly process of using earthworms to transform organic, biodegradable waste into a nutrient-rich fertilizer (Vasanthi et al., 2013). Vermicompost contains many essential nutrients along with macro and micro nutrient (Aalok et al., 2010) which are more soluble and readily absorbed by the plants along with plant growth regulators and microbes (Bhoyar and Bhide, 1996). It also contains beneficial soil microbes like nitrogen fixing bacteria and Mycorrhizal fungi which are excellent growth promoters (Gopi 2017). The main objective of Vermicomposting is to produce organic manure of exceptionally good quality for the organically starved soil by using the waste generated by institutions, and also contributing towards improvement of the environment as the process itself is eco- friendly. Vermicomposting has attracted a lot of interest in recent years due to increasing environmental concerns and use of sustainable fertilizers (Hosseinzadeh et al., 2018).

Earthworms consume various types of organic wastes such as sewage sludge, animal wastes, crop residues and industrial refuse and reduce its volume by 40-60% (Mitchell et al., 1980; Chan and Griaths, 1988; Hartenstein and Bisesi, 1989). More than 350 species of earthworms are used but *Eisenia fetida*, which is an epigeic (surface dwelling) species of earthworms (Edwards et al., 2010)

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

commonly known as red worm, has been proved to be the best species (Sandeep et al., 2017) in the prevalent environmental conditions in the north India.

Fallen leaves are one of the types of organic waste which can be decomposed through earthworms. Several researchers have succeeded in converting leaf litter into vermicompost and used it either alone or with biofertilizers or inorganic fertilizers on several crops. Pozo et al. (1998) worked on decomposition of *Eucalyptus globulus* leaf and found that addition of leaf waste minimises the maturation time of vermicompost. During vermicomposting process leaf litter is usually mixed with different proportions of cattle dung.

In present investigation the vermicomposting process was explored, that followed different stages such as establishment of vermicompost unit; collection of fallen leaves of the diverse plant species in the institution; procuring the cow dung and the earthworms (*Eisenia foetida*); putting all the constituents in a proper order within the vermicomposting units for the production of vermicompost. In the present experiment, quantum of different components required for the vermicomposting in the 15 beds and the final output of the procedure were measured and their relevance to the environment were analysed.

OBJECTIVES

The vermicompost produce proves to be of significant value to the end users like gardeners and farmers as it replaces chemical fertilizers and getting better prices for the organic produce using such composting material locally available at much lower cost. The main objectives of vermicomposting are as follows:

1. To reduce the bulk waste of college campus generated by plants/trees of the college.
2. To utilise earthworms in an eco-friendly manner to obtain vermicompost as a valuable fertiliser.
3. To replace the use of synthetic fertilizer by the vermicompost in college garden.
4. To manage and increase the long term fertility of soil by using vermicompost.
5. Spreading awareness about the use of naturally produced fertiliser.

MATERIALS AND METHOD

Kirori Mal College is one of the leading institutions of higher learning and is a constituent of University of Delhi for all academic and administrative purposes. It is located in the North Campus of Delhi University, in New Delhi, India. Gardens and the green over of Kirori Mal College were planned in a beautiful manner. It has various well managed lawns. It has great density of trees. This vegetation not only adds beauty to the College campus but also provides valuable study material for botany students. For maintaining many of these plants, sufficient amount of nutrients are needed. Keeping in mind the costly nature of chemical fertilisers and its adverse effect on environment, Kirori Mal College has started the project of vermicompost from organic solid waste. Since College campus has large number of trees, huge quantity of leaves falls down from them. These fallen leaves make bulk of biodegradable solid waste which can be used for making vermicompost. The method (Adhikary, 2012) minimizes the amount of wastes send to landfills along with the generation of vermicompost and various useful products for plants and supports the sustainable pattern in an environmental friendly manner.

I. Collection of Leaves, Cow Dung and Earthworms

In the experiment fallen leaf waste of institution's campus was collected. The leaf waste made the solid substrate for the growth of the earthworms as organic matter upon which they survive. It was open dried for 30 days and weighed before filling 15 vermicompost beds. Cattle dung (about twenty tons) was procured locally from the animal farms in Mangolpuri. The epigeic earthworms (*Eisenia foetida*) were obtained from Sidkom Plantex farms, Ballabgarh Haryana India.

II. Process of Vermicomposting

The biodegradable fallen leaf waste is degraded by composting process using earthworms. It comprises placing and setting up of Vermicompost beds on the levelled surface of the earth having a slight inclination. The inclination provides a draining mechanism, utilising the gravitational force, for collecting vermiwash produced during vermicomposting. The Vermicompost beds of 12x4x2 ft. were procured from Hygiene Enterprise, Gujarat. The whole set of 15 Vermi beds are housed inside a shed made up of plastic fibre sheets that is open from all sides so as to provide the shade to vermibeds and protect worms from direct heat of the sun while maintaining proper aeration.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

Cow dung and leaf waste were placed in layers so as to make a heap of about 6 inches of leaf at the base followed by about 4 inches of the cow dung. This layering was repeated till the Vermibed was completely filled. The amount of dry leaves and the cow dung used to fill each bed were measured and the values are mentioned in the **Table I**. After 15 days the active and healthy earthworms (*E. foetida*) were introduced to the pre-decomposed waste (Singh et al., 2004) and were covered by jute bags. Approximately 3 Kg of worms were used to inoculate each bed. Moisture (40-50%) and temperature (20–35° C) was maintained by the regular sprinkling of water over the beds.

Carefully and thoroughly intermittent mixing of the layers was done to provide proper aeration. This Process is monitored till maturation (45 days). The range of humidity level was 80 and 100% and the pH was in the range of 5.0–7.0 that stabilized to near neutral on the 60th day. When the surface appeared black granular, the vermicomposting process is considered to be almost completed. At this stage watering was stopped and the beds were kept undisturbed for few days before harvesting the vermicompost. After the stopping the sprinkling of water, upper layers in the vermicompost beds became dried due to which the worms gradually move downwards. Now the vermicompost can be harvested from the upper layers. As the upper layers of vermicompost are removed, lower layers become exposed. These exposed layers also get dried in few days leading to movement of worms further downwards. These steps are repeated during the harvesting until the earthworms have moved and settled to the bottom. The bottom layers are spared and not harvested so as to keep the worms alive for the use in next cycle of vermicomposting.

The harvested vermicompost was filtered through moderate sieve in order to get fine uniform vermicompost as explained in flowchart and Figure 1. The Vermicompost preparation is completely ready to the filtering stage after 2-3 months. The moisture level which is a very important factor even after the filtration of the prepared compost was checked and found to be 90-92%.

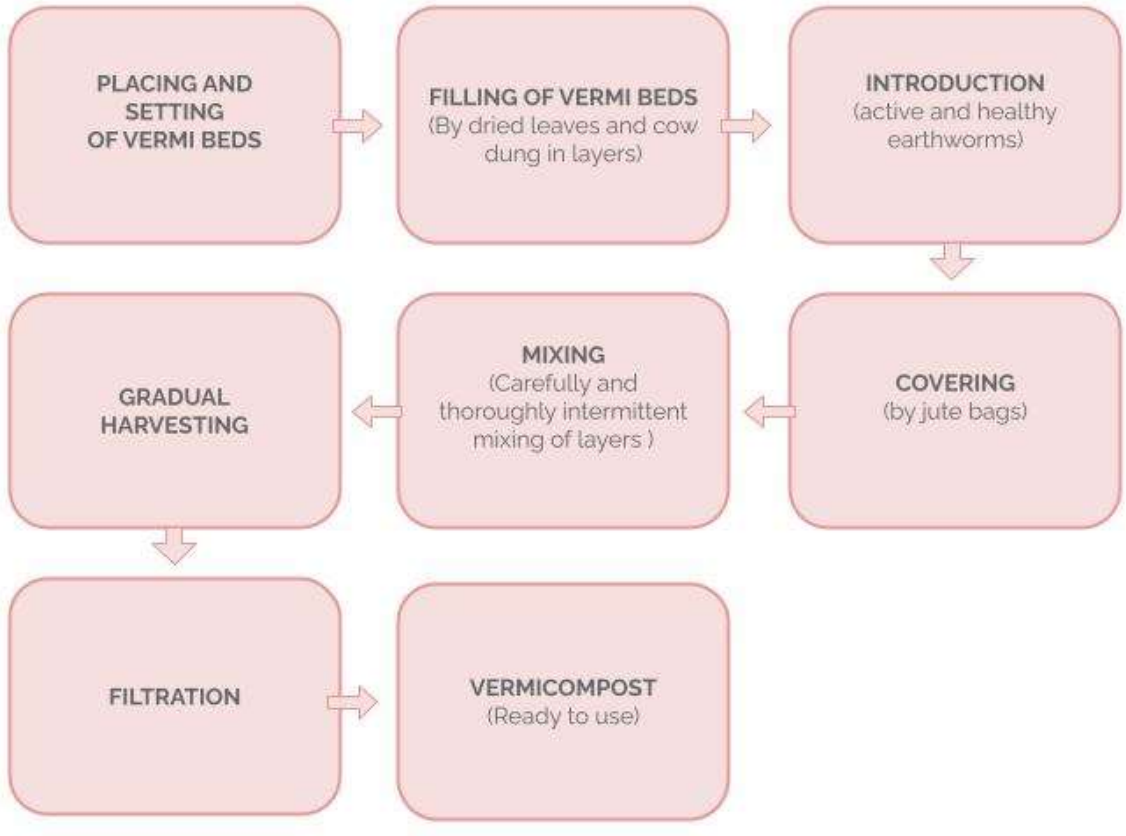

Figure 1. Steps involved in the Process of Vermicomposting

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

Figure 2. (A) Series of vermicompost beds with well-ventilated shed for preventing direct sunlight and rain water.
(B) Newly filled vermicompost beds showing the top layer of dried leaves.
(C) Red worms (*Eisenia fetida*)
(D) Vermicompost - The ready to use vermicompost after the final step of sieving.
(E) Vermiwash - It is a by-product of the vermicomposting process, produced periodically, after the watering of vermicompost beds.

RESULTS AND DISCUSSION

The data collected in the vermicompost set up established in the Kirori Mal College related to single cycle of vermicomposting process. The single cycle consumed 1.683 tons of the dry leaves and 18.030 tons of cow dung (Table I). In addition, about 3Kgs of earthworm inoculum was added to each bag for initiating the vermicomposting process. Introduced earthworms worked for about 60 days within the beds so as to convert the raw material (19.713 tons) into vermicompost (14.784 tons). This end product is about 74.99% by weight, of the raw materials added. A single cycle of the vermicomposting in the Kirori Mal College took about 3 months to complete. Therefore, with the present set up, we can run four such cycles of composting a year. This essentially means that, Kirori

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

Mal College can consume about 78.852 tons of dry organic waste annually and put it to the production of very useful product. So, using Vermicomposting method we are able to reduce the biodegradable waste generated by the college in an environment friendly and healthy manner.

Table I- The Amount of Vermicompost produced (Kg) in College Campus in 15 Vermi Beds from the Waste generated in College Campus

Bag No	*Total Leaf Used (Kg)*	*Cow Dung Used (Kg)*	*Vermicompost Produced (Kg)*
1.	114.400	1245.900	1020.23
2.	110.500	1240.800	1013.48
3.	110.000	1025.950	851.96
4.	111.700	1251.600	1022.48
5.	112.870	1245.900	1019.08
6.	112.340	1250.800	1022.36
7.	112.150	1025.950	853.58
8.	111.970	1245.900	1018.40
9.	111.790	1250.800	1021.94
10.	112.800	1225.950	1004.06
11.	110.750	1251.600	1021.76
12.	113.230	1246.500	1019.80
13.	112.850	1245.900	1019.06
14.	112.650	1250.800	1022.59
15.	112.850	1025.950	854.10
Total	**1682.85 (1.683 tons)**	**18030.300 (18.030 tons)**	**14784.86 (14.784 tons)**

Vermicomposting procedure adopted by the Kirori Mal College is on one side contributing in helping the organisations which are involved in the solid waste handling. Municipal Corporation of Delhi (MCD) is the organisation that has the responsibility of collection of the solid waste from all over Delhi, including our institution. Installation of the vermicompost set up in KMC, has a remarkable positive impact on MCD. First of all, there is the reduction of lifting off the solid waste, about 78.852 tons annually, from our institution, which otherwise had been a responsibility of MCD over the years. This is significant, as this leads to savings of the MCD in the form of reduction of the transportation cost. Furthermore, it also reduces the amount of work to be done by MCD for a proper management and disposal of the solid waste from College campus.

On the other hand, this process is also proves to be very valuable for the Kirori Mal College. The technique provides a very good opportunity to consume our own solid waste, produced in the college campus. The solid waste consumed in the process, is transformed into a superior quality bio-fertilizer, which is much better than that of chemical fertilizers. Vermicompost not only provides the macronutrients and micronutrients to the plants, but also the much needed organic matter to the soil used to grow these plants. The organic content improves soil texture and the health of the soil. Apart from the final end product, that is, the vermicompost, the composting procedure also produces a liquid fertilizer which is known as vermiwash. The vermiwash is the by-product, produced periodically, as a result of watering the vermicompost chambers. As mentioned in the materials and methods, to maintain the adequate moisture within the chambers, for proper growth and development of the earthworms, the chambers are watered as and when required. The water added to the chambers is usually more than sufficient, for maintaining the moisture. So, the extra water drains out of the chambers, through the drainage system installed during the initial setting up of the vermicompost chambers. This water that drains out at each watering is collected and stored as it carries a lot of nutrients along with it from the compost bags, and accordingly has been named as vermiwash. As the vermiwash is quite concentrated, it is diluted before its use as liquid fertilizer.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

Earthworms which were added as the initial inoculum for vermicomposting can also be an asset to the institution. The 3 kg earthworms added in the beginning of the procedure reproduce very fast and within a week can be seen throughout the vermicompost chamber. During the period of 10 weeks, about 30 Kgs of earthworms can be harvested from each chamber. So, a total of about 450 kg of earthworms are produced in a single cycle from the whole set up in the Kirori Mal College that may lead to the production of about 1800 kg (1.8 tons) of earthworms annually. If 400 kg of the earthworms are used as recurring inoculum, even then we have about 1.4 tons of spare earthworms. These earthworms can be sold in the market which can accrue an income of about Rs 4, 20,000/- to the institution (at the rate of Rs 300/- per Kg) annually.

We are able to generate more Earthworms (inoculum) almost 10 times that are used initially (30 Kg along with the eggs). These resultantearthworms can be used in next cycle of vermicomposting. We have produced fine superior quality vermicompost as a bio-fertiliser and liquid fertilizer known as vermiwash, containing the nutrients in concentrated form. We can use vermiwash in hydroponics also and can create a conducive and healthy environment for the plants which required minimal amount of nutrients in dissolved form. After harvesting of the vermicomposting, we are able to obtain an appreciable number of earthworms in living and healthy condition, which we can use further in next cycle of Vermicomposting.

This methodology of solid waste management utilises the natural life-cycle of the earthworms, where they feed upon the cow dung and the dry leaves, live their life and reproduce. Earthworm castings are the main products of the overall process that takes the form of compost. The inputs required for the technique are dry leaves and cow dung. Energy in the form electricity or in any form is not needed for running the system. So, with a minimal cost we derive maximum output that decreases the expenses for solid waste disposal. It is a cost-effective method and in terms of energy it's a very useful energy saving method where input in terms of ambient temperature, humidity and the availability of water is natural and there is no need to add extra money to maintain the process It is a onetime investment where only vermibed, earthworms and cow dung are to be purchased. Later on, for the second cycle, only cow-dung is to be purchased and the other materials are provided by the products of the first cycle. Interestingly, no chemicals are required in this process and even there is no requirement for any sophisticated and costly instruments. It minimises the recurring maintenance cost of running the process. Since the water, temperature, humidity and other resources required to run this process is almost natural and readily available so with the use of minimum input this technique provides best results with maximum output.

CONCLUSION

By adopting the way of decomposition done by earthworms in a healthy biodegradable manner we are able to produce vermicompost, more earthworms and vermiwash. These products are free from any toxic chemicals and just by using minimal required components we are able to achieve all these content in sustainable manner which we can further use to increase or promote the growth of number of plants. Moreover the vermiwash obtained during this process can give a better option for complete eradication of synthetic fertilisers. The continuous availability of vermiwash during vermicomposting provides a thorough availability of natural fertiliser.

REFERENCES

1. Aalok, A. and Tripathi, A.K. 2010. Composting-Vermicomposting of different types of leaves using earthworm species *Eisenia fetida*. Dynamic Soil, Dynamic Plant 4 (Special issue 1): 139-144.
2. Adhikary, S. 2012. Vermicompost, the story of organic gold: A review.
3. Bhiday, M. 1994. Earthworms in agriculture. Indian Farming 43(12): 31-34.
4. Bhoyar, R.V. and Bhide, A.D. 1996. Vermicomposting of organic (vegetable) solid wastes. International conference on Environmental
5. Chalmin, P. and Gaillochet, C. 2009. From waste to resource: An abstract of World waste survey. Cyclope Veolia Environmental Services. Edition Economica, France.
6. Chan, P.L.S. and Griaths, D.A. 1988. The vermicomposting of pre-treated pig manure. Biological Wastes 24: 57-69.
7. Dash, M.C. 1993. Fundamentals of Ecology. Tata McGraw-Hill, New Delhi, India, pp. 210.
8. Edwards, C.A. 2010. Introduction, history and potentials of vermicompost technology In: Edwards, C.A., Arancon, N., Sherman, R. (eds.).Vermiculture Technology-Earthworm,organic wastes and Environmental management. CRC Press, London. pp.1-10

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-05, Impact Factor: 6.789
IJCSRR @ 2023
www.ijcsrr.org

9. Gopi, P. 2017. Vermitechnology, a scenario of sustainable agriculture-a mini review. VISTAS 6(1): 51-56.
10. Hartenstein, R. and Bisesi, M.S. 1989. Use of earthworm biotechnology for the management of effluents from intensively housed livestock. Outlook on Agriculture 18: 3-7.
11. Hosseinzadeh, S. R. and Ahmadpour, R. 2018. Evaluation of vermicompost fertilizer application on growth, nutrient uptake and photosynthetic pigments of lentil (*Lens culinaris* Medik.) under moisture deficiency conditions. Journal of Plant Nutrition 41: 1276-1284.
12. Mitchell, M.J., Hornor, S.G. and Abrams, B.I. 1980. Decomposition of sewage sludge in drying beds and the potential role of the earthworm, *Eisenia fetida*. Journal of Environmental Quality 9: 37-378.
13. Planning and Management, VRCE, Nagpur, India.
14. Pozo, J., Basaguren, A., Arturo, E., Jon, M., Eric, F. and Eric, C. 1998. Afforestation with *Eucalyptus globulus* and leaf litter decomposition in streams of northern Spain. Hydrobiologia 373/374: 101-110.
15. Sandeep, S. D., and Yadav, J. Urmila 2017. Assessment of nutrient status of vermicompost of leaf litter using *Eisenia fetida*. Journal of Entomology and Zoology Studies, 5(2): 1135-1137.
16. Shekdar, A.V. 2009. Sustainable solid waste management: An integrated approach for Asian countries. Waste Management 29(4): 1438-1448.
17. Vasanthi, K., Chairman, K. and Ranjit Singh AJA 2013. Vermicomposting of leaf litter ensuing from the trees of Mango (*Mangifera indica*) and Guava (*Psidium guujuvu*) leaves. International Journal of Advanced Research 1(3): 33-38.
18. Williams, A.P., Roberts, P. and Avery, L.M. 2006. Earth worms as vectors of *Escherichia coli* O 157:H7 in soil and vermicompost. FEMS Microbiology Ecology 58: 54-64.

Cite this Article: Leena Shakya, Ram Babu, Archana Singh, Srishti Dhiman, Sunil Kumar Dhiman (2023). Vermitechnology: A Sustainable Approach to Manage Organic Waste in Urban Areas. International Journal of Current Science Research and Review, 6(8), 5373-5380