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An Overview of Vermicomposting as a Sustainable Waste Management Method

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Abstract

Solid waste management has become one of the most pressing issues of the modern world, driven by factors such as rapid population growth, industrialization, and evolving lifestyles. The growing volume of waste, especially in urban areas, has intensified the need for sustainable and effective waste management practices. Among the traditional methods of dealing with solid waste, landfilling has been the most widely used approach. However, the environmental impacts of landfills, including soil and water contamination, greenhouse gas emissions, and habitat destruction, have made it increasingly clear that this method is not a viable long-term solution.

As we move toward more sustainable solutions, it is crucial to examine the composition of solid waste. Organic waste constitutes a significant portion of the total waste, highlighting the importance of focusing on this fraction. One such eco-friendly and efficient method of waste management is composting, which decomposes organic materials into nutrient-rich humus. Composting reduces the volume of waste and minimizes the harmful environmental effects associated with landfilling and incineration. It helps mitigate greenhouse gas emissions, reduces disease spread, and enriches the soil by providing valuable organic matter.

There are two primary forms of composting: aerobic and anaerobic. Aerobic methods, such as windrow composting and vermicomposting, are particularly effective. Vermicomposting, which uses earthworms to break down organic waste, produces vermicompost, a high-quality organic fertilizer that enhances soil structure, water retention, and microbial activity. Vermicomposting is an environmentally friendly, low-cost alternative to traditional waste management methods and can significantly contribute to sustainable waste management. This article delves into the benefits, techniques, and potential of vermicomposting as a transformative solution to the global waste management crisis, emphasizing its role in fostering a green future.

Keywords: *Sustainable Waste Management, Safer Alternative, Reduces Harmful Emissions, Minimizes disease spread, Nutrient-rich fertilizer, Microbial Activity.*

Introduction

In today's modern habitat, Humans generate extreme amounts of solid waste. The situation is worsening daily due to population growth, industrialization, and changes in our way of life. An enormous amount of complicated solid waste has finally been produced due to the unchecked abuse of plentiful resources (Sarkar et al. 2023). Solid waste is causing environmental problems in the majority of Indian cities. During the rainy season, solid waste causes numerous issues by obstructing the water flow (Kumar et al., 2015; Motcha et al., 2017).

In the fiscal year 2022, India produced more than 170,300 metric tonnes of municipal solid trash every day. There was an approximate 6% gain compared to the prior year. That year, the South Asian nation's highest quantity of municipal solid trash was generated in the Indian state of Maharashtra (Alves, 2024). This situation makes us aware that, waste management is becoming acknowledged as an essential component of environmental preservation and sustainable development that calls for scientific study, public awareness initiatives, and appropriate management techniques. If this isn't done, there are more environmental risks and waste production (Singh et. al., 2024).

There are various approaches to handling this solid waste. To find out the proper solution to the problem we must be aware of the problem first. So, firstly we should be aware of the types of waste. Waste is separated into some categories, encompassing solid waste from municipalities, biomedical waste, industrial waste, and agricultural waste. Paper, plastic, metal, food scraps, glass, and other items make up solid garbage from municipalities, which is produced by both residential and commercial operations (Bhat et al., 2018; Verma et al., 2016).

Agricultural waste comes from numerous sources, such as animal waste, agricultural crop residue, agro-industrial byproducts, and garbage from tourism (Bhat et al., 2012). However, during manufacturing or other industrial processes, industrial waste is created in mines, mills, and factories. It is possible to recycle agricultural waste returning minerals and organic materials to the soil by employing techniques like Biogas creation, anaerobic digestion, and composting. However industrial waste might be harmful or non-toxic. (Asokan et al., 2006). Environmental pollution avoidance, recycling, and waste reduction strategies, including eco-design and closed-loop manufacturing systems, are all part of effective industrial waste management (Winkler, 2011).

More than 75% of trash is reportedly managed by landfilling worldwide. (Zuberi & Ali, 2015). However, landfill leachate contaminates groundwater and surface water. (Kinobe, 2015). Climate change is made worse by methane emissions from solid waste breakdown, which comprise around 5% of greenhouse gas emissions. (Rodic-Wiersma, 2013). Nevertheless, all solid waste pieces can be applied if they are transformed into usable goods using an appropriate scientific procedure. (Bhat et al., 2019).

That is why this evaluation article focuses on sustainable waste management methods to minimize waste's environmental impact. Vermicomposting is one of the best options for disposing of trash in an environmentally responsible way. (Zafar & Jamali, 2024).

The technology of vermicomposting is gaining popularity as a solid waste management method. (Manyuchi & Phiri 2013). The word "vermicomposting" was created to describe the entire process by which earthworms use biodegradable material. (Ahmad et al., 2021). Traditional composting and Vermicomposting are two different aspects. Because the earthworms' digestive systems break down the organic material, vermicomposting differs from traditional composting. The earthworms aggressively contribute to the breakdown of organic substances via means of biochemical and physical processes, and the digested casts can enhance soil physical characteristics and fertility. (Motcha et al., 2017).

In the mesophilic, bio-oxidative process of vermicomposting, Microorganisms, and earthworms work together to mineralize organic waste substrates and turn them into organic manure which is rich in nutrients. (Pramanik & Chung, 2011; Sharma & Garg, 2019). Vermicompost Fertilizer is the best alternative to chemical fertilizer. Vermicompost fertilizer is an environmentally friendly, pure, organic fertilizer that is very nutrient-dense and utilized for soil maintenance and crop production. (Celik et al., 2020).

This review Article highlights the importance of Vermicomposting due to its eco-friendly approach.

Worldwide use of Vermicompost

Vermiculture, the massive production of earthworms from waste materials, is a developing waste-free business that includes end products and by-products that are safe for the environment. It began in Holland in 1970 and has since expanded to Canada, France, England, Korea, the United States, Italy, the Philippines, Thailand, China, Japan, Australia, Israel, and Brazil. (Bhat et al., 2018; Edwards, 2004). In 1978–79, the American Earthworms Technology Company generated about 500 tonnes of vermicompost monthly. (Edwards, 2004). According to Collier, Hartenstein, and Bisesi, Vermiculture was used to remediate sewage sludge in the United States. The USA shipped three thousand tonnes of earthworms to Japan between 1985 and 1987 to break down cellulose waste. (Collier, 1978; Hartenstein & Bisesi,1989). Additionally, Edwards mentioned using paper waste, rice straw, and municipal sludge sawdust for vermicomposting, which produces two to three thousand tonnes of vermicompost monthly. (Edwards, 2004).

Sinha reported vermicomposting sites with a daily capacity of 100 tonnes in Bangalore and Pune. The largest earthworm-based vermiculation facility in India is the Earthworm Research Institute of Bhawalkar (BERI)., located in Pune. (Bhat et al., 2018; Sinha, 1996) Earthworms were used to remediate cellulosic wastes, coir wastes, and sericulture wastes, according to Senapati, Gunathilagraj, and Ramesh. (Gunathilagraj & Ramesh, 1996; Senapati, 1992).

Earthworms

According to Aristotle, earthworms are the "intestine of the earth" and the "unheralded soldiers of mankind" by Charles Darwin because they can break down a variety of organic compounds. (Vijayshankar et al., 2024; Darwin & Seward, 1903; Martin, 1976). Earthworms are vertebrates pertaining to the class Oligochaeta and phylum Annelida. They participate in the breakdown of cellulose, the formation of soil, and the building of humus. (Jambhekar, 1992).

Earthworms come in more than 3000 species worldwide. It is estimated that India is home to roughly 384 species., and detailed taxonomic research has already been completed on them. (Julka, 1983; Adhikary, 2012). Bouche (1977). Based on their biological characteristics, and kind of feeding habitat, earthworms are divided into three types.: epigeic, anecic, and endogeic.

Epigeic: These earthworms reside above the mineral soil's surface. They are uniformly coloured and modest in size. Because they cannot delve into the soil, epigeics are phytophagous and do not influence the soil's surface (Singh et al., 2020; Lee 1985; Ismail 1997). Because they can turn leaf debris into manure, they are suitable for vermicomposting.

Examples: Drawida modesta, Eudrilus eugeniae, Eisenia fetida, Eisenia andrei, and Perionyx excavatus

Anecic: These are the species that burrow beneath mineral soil layers but emerge to consume decaying leaves. To enhance soil aeration, vertical tunnels were constructed because of their up-and-down movement. They are geo-phytophagous, meaning they consume both soil and plant matter. (Singh et al., 2020; Ismail 1997).

Examples: Lampito mauritii, Lumbricus terrestris, Aporrectodea trapezoids and Aporrectodea longa.

Endogeic: They push their waste to the soil's bottom surface and reside six feet below the surface. They dig tunnels beneath the soil and feed primarily on organic matter. This encourages crop roots to have access to sunlight, water drainage, and aeration. (Singh et al., 2020; Lee 1985; Ismail 1997).
Examples: Drawida barwelli, Allolobophora rosea, Octochaetona thurstoni, and Allolobophora caliginosa.

In India, vermicomposting is done with exotic epigeic species such as Eisenia fetida (Kaviraj & Sharma, 2003; Hartenstein et al., 1979), Parionyx excavatus (Kaviraj & Sharma, 2003; Kale et al., 1982), and Eudrilus euginae (Kaviraj & Sharma, 2003; Ashok, 1994). E. fetida has high fecundity, broad temperature tolerance, and capacity to survive in a variety of organic wastes. (Robatjazi, 2023; Badhwar et al., 2020; Edwards, 2004).

Vermicomposting

Vermicomposting is an effective method for reducing trash in large quantities and producing pathogen-free vermicompost. (Rakkini et al., 2017; Nair et al., 2006). As per Neher et al., 2013 this method takes 60-90 days. Vermicomposting makes use of microorganisms and earthworms that thrive at temperatures between 10°C and 32°C. (Adhikary, 2012).

Vermicomposting can be done in a number of ways, but the most popular ones are bed and pit methods.

Bed method: Composting is done on the ground by establishing an organic mixed bed. This approach is simple to use and maintain.

Pit method: The cement pits are used for composting. Materials that are accessible locally are used to cover the unit. higher production costs, Poor aeration, and water logging at the bottom make this method unfavorable. A cold, damp, and shaded location is ideal for a vermicomposting unit.

Procedure of Vermicomposting

- Chopped dried leafy materials and cow dung are combined in a 3:1 ratio and allowed to partially take 15 to 20 days to break down.
- As bedding material, place a layer of chopped dried leaves or grasses at the bottom of the bed, about 15 to 20 cm deep.
- Beds of partially decomposed material should be constructed.
- The number of beds can be adjusted based on the need and availability of raw materials.
- The top layer of the bed should be used to release earthworms.
- As soon as the worms are released, water should be sprinkled.
- Water should be sprayed on beds every day to keep them moist, and they should be covered with Polythene and gunny bags.
- To ensure enough aeration, the bed should be turned once every 30 days for disintegration.

End Products and its Benefits

Vermiculture is the process by which earthworms are produced as byproducts of vermicomposting. Additionally, vermiwash is created along with vermicompost, also known as vermicasts. Vermiwash and vermicompost can be used as biofertilizers. (Manyuchi & Phiri 2013). Vermicompost is a dark brown, odorless biofertilizer. The granular byproduct compost is enhanced with different soil nutrients. (Aalok et al., 2008; Chaudhuri et al., 2000). It can be the best alternative to chemical fertilizer and will also help to promote an eco-friendly approach to farming.

Conclusion

Looking towards waste management with the eco-friendly approach, we can say that, using biological agents to handle solid waste is a viable substitute. In that way, Vermicomposting is a very successful method of waste management. The complex action of Earthworms gives a useful end product, which can easily take the position of chemical fertilizer. The process will reduce the current limitations of waste management and provide useful byproducts.

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Conflicts of Interest
The authors declare that there are no conflicts of interest regarding the publication of this paper.

References:

1. Adhikary, S. (2012). Vermicompost, the story of organic gold: A review. *Agricultural Sciences, 3* (7), 905-917. https://doi.org/10.4236/as.2012.37110
2. Ahmad, A., Aslam, Z., Bellitürk, K., Iqbal, N., Idrees, M., Nawaz, M., Nawaz, M. Y., Munir, M. K., Kamal, A., Ullah, E., Jamil, M. A., Akram, Y., Abbas, T., & Aziz, M. M. (2021). Earthworms and vermicomposting: A review on the story of black gold. *Journal of Innovative Sciences, 7* (1), 167-173. https://doi.org/10.17582/journal.jis/2021/7.1.167.173
3. Aalok, A., Tripathi, A. K., & Soni, P. (2008). Vermicomposting: A better option for organic solid waste management. *Journal of Human Ecology, 24* (1), 59-64.

4. Alves, B. (2024, July 29). Municipal solid waste generation per day in India FY 2019-2022. Statista. https://www.statista.com/statistics/1448775/municipal-solid-waste-generated-india-timeline/
5. Ashok, K. C. (1994). State of art report on vermicomposting in India. Council for Advancement of People Action and Rural Technology (CPART).
6. Badhwar, V. K., Singh, S., & Singh, B. (2020). Biotransformation of paper mill sludge and tea waste with cow dung using vermicomposting. *Bioresource Technology, 318*, 124097. https://doi.org/10.1016/j.biortech.2020.124097
7. Bhat, R. A., Dar, S. A., Dar, D. A., & Dar, G. H. (2018). Municipal solid waste generation and current scenario of its management in India. *International Journal of Advanced Research in Science and Engineering, 7*(2), 419–431.
8. Bhat, R. A., Dar, G. H., Jehangir, A., Bhat, B. A., & Yousuf, A. R. (2012). Municipal solid waste generation and present scenario of waste management during Yatra season in Pahalgam: A tourist health resort of Kashmir valley. *International Journal of Current Research, 4*(10), 004–009.
9. Bhat, S. A., Singh, S., Singh, J., Kumar, S., & Vig, A. P. (2018). Bioremediation and detoxification of industrial wastes by earthworms: Vermicompost as a powerful crop nutrient in sustainable agriculture. *Bioresource Technology, 252*, 172-179. https://doi.org/10.1016/j.biortech.2018.01.104
10. Bouche, M. B. (1977). Strategies lombriciennes. In U. Lohmander & G. Persson (Eds.), *Soil organisms as components of ecosystems* (pp. 122-132). Biological Bulletin (Stockholm), 25.
11. Chaudhuri, P. S., Pal, T. K., Bhattacharjee, G., & Dey, S. K. (2000). Chemical changes during vermicomposting (Perionnyx excavatus) of kitchen waste. *Tropical Ecology, 41*(1), 107-110.
12. Collier, J. (1978). Use of earthworms in sludge lagoons. In *Utilization of Soil Organisms in Sludge Management* (pp. 133-137).
13. Darwin, F., & Seward, A. C. (Eds.). (1903). *More letters of Charles Darwin: A record of his work in a series of hitherto unpublished letters.* John Murray.
14. Edwards, C. A. (2004). *Earthworm ecology.* CRC Press.
15. Hartenstein, R., & Bisesi, M. S. (1989). Use of earthworm biotechnology for the management of effluents from intensively housed livestock. *Outlook on Agriculture, 18*(2), 72-76. https://doi.org/10.1177/003072708901800205
16. Hartenstein, R., Neuhauser, E. F., & Kaplan, D. L. (1979). Reproductive potential of earthworms Eisenia fetida. *Oecologia, 43*, 329-340.
17. Ismail, S. A. (1997). *Vermicology: Biology of earthworms.* Orient Longman Ltd.
18. Jambhekar, H. (1992). Use of earthworm as a potential source of decomposing organic wastes. In *Proceedings of the National Seminar on Organic Farming* (pp. 52-53). Coimbatore.
19. Julka, J. M. (1983). A new genus and species of earthworm (Octochaetidae: Oligochaeta) from South India. *Geobioscience New Reports, 2*, 48-50.
20. Kale, R. D., Bano, K., & Krishnamoorthy, R. V. (1982). Potential of *Perionyx excavatus* for utilizing organic wastes. *Pedobiologia, 23*, 419-425.
21. Kaviraj, A., & Sharma, S. (2003). Municipal solid waste management through vermicomposting employing exotic and local species of earthworms. *Bioresource Technology, 90*(2), 169-173.
22. Kinobe, J. R. (2015). *Assessment of urban solid waste logistics systems: The case of Kampala, Uganda* (Vol. 2015, No. 2015: 94).
23. Kumar, K. U., Henock, & Tsegay. (2015). Conversion of solid waste into bio-fertilizer by vermicomposting: A case study of Padmanadapuram. *International Journal of Innovative Research in Science, Engineering and Technology, 4*, 3801–3808.
24. Lee, K. E. (1985). *Earthworms: Their ecology and relationship with soil and land use.* Academic Press.
25. Martin, J. P. (1976). *Darwin on earthworms: The formation of vegetable moulds.* Bookworm Publishing.
26. Manyuchi, M. M., & Phiri, A. (2013). Vermicomposting in solid waste management: A review. *International Journal of Scientific Engineering and Technology, 2*(12), 1234–1242.
27. Motcha, V. R., Vincent, S., Kumar, A. S., & Baskar, K. (2017). Review article: An overview of organic waste management by earthworm. *Journal of Civil Engineering and Environmental Sciences.* Received April 11, 2017; Accepted April 27, 2017; Published April 28, 2017.
28. Nair, J., Sekiozoic, V., & Anda, M. (2006). Effect of pre-composting on vermicomposting of kitchen waste. *Bioresource Technology, 97*, 2091–2095. https://doi.org/10.1016/j.biortech.2005.08.013
29. Neher, D. A., Weicht, T. R., Bates, S. T., Leff, J. W., & Fierer, N. (2013). Changes in bacterial and fungal communities across compost recipes, preparation methods, and composting times. *PLOS ONE, 8*(11), e79512. https://doi.org/10.1371/journal.pone.0079512
30. Pramanik, P., & Chung, Y. R. (2011). Changes in fungal population of fly ash and vinasse mixture during vermicomposting by *Eudrilus eugeniae* and *Eisenia fetida*: Documentation of cellulase isozymes in vermicompost. *Waste Management, 31*(6), 1169-1175. https://doi.org/10.1016/j.wasman.2011.01.020
31. Rakkini, V. M., Vincent, S., Kumar, A. S., & Baskar, K. (2017). An overview: Organic waste management by earthworm. *Journal of Civil Engineering and Environmental Science, 3*(1), 013-017. https://doi.org/10.17352/2455-488X.000015
32. Rodic-Wiersma, L. (2013). *Guidelines for national waste management strategies: Moving from challenges to opportunities.* United Nations Environment Programme (UNEP).
33. Robatjazi, J. (2023). An overview on vermicompost environmental impacts (from past to future). *Journal of Agricultural Science and Food Research, 14*, 161.

34. Sarkar, J. D., Sarkar, A. K., & Lal, S. P. (2023). A critical review of vermi-composting in urban and peri-urban waste management apropos robust environment. *Journal of Agricultural Extension Management, 24*(2).
35. Sharma, K., & Garg, V. K. (2019). Vermicomposting of waste. In *Sustainable resource recovery and zero waste approaches* (pp. 133–164). https://doi.org/10.1016/b978-0-444-64200-4.00010-4
36. Senapati, B. K. (1992). Vermitechnology as an option for recycling of cellulose waste in India. In *New trends in biotechnology* (pp. 347-358).
37. Sinha, R. K. (1996). Vermiculture biotechnology for waste management and sustainable agriculture. *Environmental Crisis*.
38. Singh, P. K., Singh, A., Fatima, N., & Singh, K. (2024). Vermicomposting: An ecofriendly approach towards solid waste management. *Mun. Ent. Zool., 19*(2).
39. Singh, S., Singh, J., Kandoria, A., Quadar, J., Bhat, S. A., Chowdhary, A. B., & Vig, A. P. (2020). Bioconversion of different organic waste into fortified vermicompost with the help of earthworm: A comprehensive review. *International Journal of Recycling of Organic Waste in Agriculture, 9*(4), 423-439. https://doi.org/10.30486/IJROWA.2020.1893367.1037
40. Verma, R. L., Borongan, G., & Memon, M. A. (2016). Municipal solid waste management in Ho Chi Minh City, Vietnam: Current practices and future recommendations. *Procedia Environmental Sciences, 35*, 127–139.
41. Vikaspedia. (n.d.). Vermicompost production and practices, from https://static.vikaspedia.in/media/files_en/agriculture/farm-based-enterprises/vermicompost-production-and-practices.pdf
42. Winkler, H. (2011). Closed-loop production systems: A sustainable supply chain approach. *CIRP Journal of Manufacturing Science and Technology, 4*(3), 243–246.
43. Zafar, A., & Jamali, M. S. (2024). The role of components in sustainable waste management: A comprehensive review in the context of Pakistan. *Pak-Euro Journal of Medical and Life Sciences, 7*(2), 317–326.
44. Zuberi, M. J. S., & Ali, S. (2015). Greenhouse effect reduction by recovering energy from waste landfills in Pakistan. *Renewable & Sustainable Energy Reviews, 44*, 117–131.