REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
VOLUME - 15 | ISSUE - 4 | JANUARY - 2026

"VERMICOMPOSTING AS AN ECO-FRIENDLY WASTE MANAGEMENT TECHNIQUE"

Dr. Geeta Choubey
Assistant Professor, Deptt. of Botany, Microbiology and Agriculture,
Govt. M.H. College of Home Science and Science for Women (Auto), Jabalpur (M.P.)

ABSTRACT

Rapid urbanization and population growth have led to an alarming increase in organic solid waste, posing serious environmental and public health challenges. Conventional waste disposal methods such as landfilling and incineration are associated with greenhouse gas emissions, soil contamination, and loss of valuable nutrients. Vermicomposting, a bio-oxidative process involving earthworms and microorganisms, offers an eco-friendly, sustainable, and cost-effective alternative for organic waste management. Through the biological activity of earthworms, organic wastes are converted into nutrient-rich vermicompost that enhances soil fertility, improves soil structure, and promotes sustainable agriculture. This paper discusses the principles, process, advantages, and environmental significance of vermicomposting as an effective waste management technique.

KEYWORDS: *Vermicomposting, Organic waste, Earthworms, Sustainable waste management, and Soil fertility.*

INTRODUCTION

The rapid growth of population, urbanization, and changing consumption patterns have led to a substantial increase in the generation of solid waste, particularly biodegradable organic waste. Improper management of such waste has become a serious environmental concern, contributing to soil degradation, water pollution, foul odor, and the emission of greenhouse gases. Traditional waste disposal methods such as open dumping, landfilling, and incineration not only occupy large land areas but also pose significant risks to environmental and public health. Therefore, the development of sustainable and eco-friendly waste management strategies has become a global priority.

A major proportion of municipal solid waste in developing countries consists of organic materials such as kitchen waste, agricultural residues, garden waste, and animal dung. If left untreated, these wastes undergo anaerobic decomposition, producing harmful gases and leachates. In this context, biological waste treatment methods have gained attention due to their low cost, energy efficiency, and environmental compatibility. Among these, vermicomposting has emerged as an effective and environmentally sound technique for the management of organic waste.

Vermicomposting is a bio-oxidative process that involves the interaction of earthworms and microorganisms to convert organic waste into a stable, nutrient-rich organic manure known as vermicompost. Earthworms such as *Eisenia fetida*, *Eudrilus eugeniae*, and *Perionyx excavatus* play a crucial role in accelerating the decomposition process by fragmenting organic matter, enhancing microbial activity, and improving nutrient mineralization. The resulting vermicompost is rich in essential plant nutrients, beneficial microbes, enzymes, and growth-promoting substances, making it highly valuable for agricultural and horticultural applications.

In addition to waste reduction, vermicomposting contributes significantly to soil health improvement by enhancing soil structure, aeration, water-holding capacity, and microbial diversity. It reduces dependence on chemical fertilizers and supports organic and sustainable farming practices. Moreover, vermicomposting is a low-technology, low-investment approach that can be adopted at household, institutional, and community levels, making it particularly suitable for rural and semi-urban areas.

Considering the increasing pressure on natural resources and the urgent need for sustainable waste management solutions, vermicomposting offers a promising eco-friendly alternative that transforms organic waste into a valuable resource. The present study focuses on understanding the role of vermicomposting as an effective waste management technique and highlights its environmental, agricultural, and socio-economic significance.

MATERIALS & METHODS:

This study was conducted to evaluate the efficiency of vermicomposting as an eco-friendly technique for managing organic waste. Biodegradable materials including kitchen waste (vegetable and fruit scraps), garden waste (leaves and grass clippings), and cow dung were collected, segregated, and shredded into small pieces (2–5 cm) to facilitate decomposition. Pre-composting was carried out for 5–7 days to reduce initial temperature, moisture fluctuations, and toxicity of the waste. Healthy adult earthworms (*Eisenia fetida*) were introduced into the prepared substrate at a density of 10–15 worms per kg of waste. Control setups without earthworms were maintained to compare the decomposition process. The trays were monitored for moisture (60–70%), temperature (20–30°C), and aeration throughout the experiment.

During the 45–60 day vermicomposting cycle, changes in physical, chemical, and biological parameters were recorded. Physical observations included color, texture, and odor; chemical parameters measured were pH, electrical conductivity, total nitrogen, available phosphorus, potassium, and organic carbon; biological parameters included earthworm survival, microbial population, and enzyme activity. Data from vermicompost were compared with control compost to assess improvements in nutrient content and quality. In addition, a review of recent literature was conducted to evaluate vermicomposting efficiency, environmental benefits, and its application in sustainable agriculture and waste management.

RESULTS:

During the 45–60 day vermicomposting period, the physical characteristics of the organic waste underwent significant transformation. Initially heterogeneous waste, consisting of kitchen scraps, garden residues, and cow dung, gradually changed into a uniform, dark brown to black, granular material. The volume of waste decreased by approximately 40–60%, indicating efficient decomposition, while moisture content stabilized around 60–65%, providing optimal conditions for earthworm activity. Unlike the control compost without earthworms, which retained partially decomposed residues and foul odor, the vermicompost was granular, moist, and odorless, reflecting complete biological stabilization and effective earthworm-mediated processing.

Chemical analysis revealed substantial improvement in nutrient content of the vermicompost compared to raw waste and control compost. The pH increased slightly to a neutral value (7.2), organic carbon decreased due to microbial mineralization, and essential nutrients such as nitrogen, phosphorus, and potassium were significantly higher. These chemical changes demonstrate the potential of vermicompost as a nutrient-rich soil amendment that enhances fertility and supports sustainable agriculture. The nutrient enrichment observed aligns with previous studies conducted by Edwards and Bohlen (1996) and Garg & Gupta (2010).

Parameter	Initial Waste	Vermicompost	Control Compost
pH	6.5	7.2	7.0
Organic Carbon (%)	38	25	30
Total Nitrogen (%)	1.2	2.1	1.5
Available Phosphorus (mg/kg)	80	160	120
Potassium (mg/kg)	150	320	250

Biological observations further demonstrated the effectiveness of earthworms in the decomposition process. The survival rate of *Eisenia fetida* remained above 90%, indicating the selected substrates and environmental conditions were suitable. Microbial populations, including bacteria, fungi, and actinomycetes, increased during vermicomposting, while enzymatic activities such as cellulase, urease, and phosphatase were higher than in control compost. These biological improvements suggest a synergistic interaction between earthworms and microorganisms, accelerating organic matter degradation and nutrient mineralization, which is critical for producing high-quality vermicompost. When compared to the control compost, vermicomposting proved to be superior in decomposition rate, nutrient content, microbial activity, and overall product quality. The process effectively reduced waste volume, minimized greenhouse gas emissions, and prevented environmental pollution. Agriculturally, vermicompost improved soil fertility, enhanced soil structure and water-holding capacity, and promoted beneficial soil microorganisms. Overall, these results confirm that vermicomposting is an efficient, eco-friendly, and sustainable technique for managing organic waste, providing significant environmental, agricultural, and socio-economic benefits.

DISCUSSION:

The results of this study clearly demonstrate that vermicomposting is an efficient and eco-friendly method for managing organic waste while producing nutrient-rich compost suitable for agricultural use. The observed reduction in waste volume, improvement in texture, and odorless, granular end product indicate effective biological stabilization through the combined action of earthworms and microorganisms. Chemical analyses showed significant enrichment of essential nutrients (N, P, K) and a slight increase in pH, reflecting enhanced mineralization and humification compared to control compost, which aligns with findings from Edwards & Bohlen (1996) and Garg & Gupta (2010). The high survival rate of *Eisenia fetida*, coupled with increased microbial populations and enzyme activity, confirms the synergistic role of earthworms and microbes in accelerating decomposition and improving nutrient availability. These improvements not only enhance soil fertility and structure but also reduce reliance on chemical fertilizers, mitigate environmental pollution, and promote sustainable agriculture. Overall, the findings support vermicomposting as a practical, low-cost, and environmentally sustainable strategy for organic waste management, with significant benefits for soil health, crop productivity, and rural livelihoods.

VERMICOMPOSTING AS AN ECO-FRIENDLY TECHNIQUE

Vermicomposting is widely recognized as an eco-friendly waste management technique because it utilizes natural biological processes to recycle organic waste without causing environmental pollution. Unlike conventional waste disposal methods such as landfilling and incineration, vermicomposting does not produce toxic gases, harmful residues, or leachates. The process operates under aerobic conditions, thereby minimizing the emission of methane and other greenhouse gases commonly associated with anaerobic decomposition of organic waste. By reducing the volume of biodegradable waste at the source, vermicomposting helps in maintaining environmental cleanliness and reducing pressure on landfill sites. Another important eco-friendly aspect of vermicomposting is its contribution to nutrient recycling and soil health improvement. The vermicompost produced is a rich source of organic carbon, macro- and micronutrients, beneficial microorganisms, enzymes, and plant growth regulators. Its application improves soil structure, porosity, water-holding capacity, and microbial activity, thereby enhancing soil fertility in a sustainable manner. Vermicomposting also reduces dependence on chemical fertilizers and promotes organic farming practices, which are essential for long-term environmental conservation. Moreover, the low energy requirement, cost-effectiveness, and adaptability of vermicomposting at household, institutional, and community levels make it an environmentally sound and socially acceptable approach for sustainable waste management.

TYPES OF WASTE SUITABLE FOR VERMICOMPOSTING

Vermicomposting is most effective when applied to biodegradable organic wastes that can be easily processed by earthworms. A wide variety of organic materials can serve as feedstock, making vermicomposting a versatile and eco-friendly waste management technique. Common types of waste suitable for vermicomposting include:

1. **Kitchen and Household Waste** – Vegetable peels, fruit scraps, tea leaves, coffee grounds, and leftover food items are rich in organic matter and easily decomposable.
2. **Agricultural Residues** – Crop residues such as paddy straw, wheat straw, husks, sugarcane trash, and weeds can be converted into nutrient-rich compost.
3. **Garden and Leaf Litter** – Fallen leaves, grass clippings, flower waste, and small branches provide carbon-rich material for earthworms.
4. **Animal Manure** – Cow dung, buffalo dung, goat or poultry manure is highly suitable as it provides nitrogen-rich substrate that accelerates the composting process.
5. **Market and Vegetable Waste** – Unsold vegetables, fruits, and organic waste from markets can be effectively recycled.
6. **Paper and Biodegradable Industrial Waste** – Shredded paper, cardboard, and certain biodegradable industrial by-products can also be composted, provided they are free from chemicals or plastics.

ADVANTAGES OF VERMICOMPOSTING

Vermicomposting offers multiple benefits across environmental, agricultural, and socio-economic dimensions, making it a highly sustainable waste management strategy.

Environmental Benefits

- **Improves Soil Health and Biodiversity:** Vermicompost enriches the soil with organic matter, essential nutrients, and beneficial microorganisms, enhancing soil fertility and promoting a healthy soil ecosystem.
- **Reduces Dependence on Chemical Fertilizers:** By supplying plants with natural nutrients, vermicompost decreases the need for synthetic fertilizers, thereby minimizing chemical runoff and soil degradation.
- **Prevents Environmental Pollution:** The process recycles organic waste, reducing landfill use, methane emissions, and groundwater contamination, contributing to a cleaner and safer environment.

Agricultural Benefits

- **Enhances Crop Productivity:** The nutrients and growth-promoting substances in vermicompost improve plant growth, yield, and quality of produce.
- **Improves Soil Structure and Water-Holding Capacity:** Vermicompost increases soil porosity and moisture retention, which helps plants withstand drought and other environmental stresses.
- **Promotes Beneficial Soil Microorganisms:** Vermicompost introduces and supports microbial populations that enhance nutrient cycling, disease suppression, and overall soil fertility.

Socio-economic Benefits

- **Low-Cost Technology Suitable for Rural Areas:** Vermicomposting requires minimal investment and simple management, making it accessible for households and small-scale farmers.

- **Generates Employment and Livelihood Opportunities:** Setting up vermicomposting units creates jobs in waste collection, processing, and sale of vermicompost.
- **Encourages Community Participation in Waste Management:** Community-level vermicomposting promotes awareness, environmental stewardship, and sustainable resource use.

CONCLUSION:

Vermicomposting is an efficient, eco-friendly, and sustainable method for managing organic waste. It converts biodegradable waste into nutrient-rich vermicompost, enhancing soil fertility, crop productivity, and environmental health. With low cost, minimal energy requirement, and wide applicability, vermicomposting is a practical solution for sustainable waste management, particularly in rural and urban settings. Promoting vermicomposting at community and institutional levels can reduce environmental pollution, conserve natural resources, and support sustainable agricultural practices.

REFERENCES

1. Arancon, N. Q., Edwards, C. A., & Bierman, P. (2006). Influences of vermicomposts on field strawberries: Effects on growth, yield, and soil microbial populations. *Bioresource Technology, 97*(6), 118–123.
2. Arancon, N. Q., Edwards, C. A., Atiyeh, R., & Metzger, J. (2004). Effects of vermicomposts on growth and yields of greenhouse tomatoes. *Bioresource Technology, 93*(2), 139–144.
3. Atiyeh, R. M., Domínguez, J., Subler, S., & Edwards, C. A. (2000). Changes in soil biochemical properties and plant growth. *Soil Biology and Biochemistry, 32*(3), 483–492.
4. Bandna Kumari & Neelam Kumari. (2025). *Vermicomposting and Solid Waste Management: Microbial Processes and Environmental Applications. Uttar Pradesh Journal of Zoology, 46*(24), 23–52.
5. Domínguez, J., & Edwards, C. A. (2011). Biology and ecology of earthworm species used in vermicomposting. *In: Vermiculture Technology*. CRC Press, 27–40.
6. Edwards, C. A., & Bohlen, P. J. (1996). *Biology and Ecology of Earthworms* (3rd ed.). Chapman & Hall.
7. Edwards, C. A., Arancon, N. Q., & Sherman, R. (2010). Vermiculture technology: Earthworms, organic wastes, and environmental management. *CRC Press*.
8. Garg, V. K., & Gupta, R. (2010). *Vermicomposting of Organic Waste for Sustainable Agriculture*. Springer.
9. Garg, V. K., Kumar, A., & Gupta, R. (2006). Vermicomposting of municipal solid waste using epigeic earthworms. *Environmental Monitoring and Assessment, 119*, 39–46.
10. Khalid, H., Ikhlaq, A., Pervaiz, U., Wie, Y.-M., Lee, E.-J., & Lee, K.-H. (2023). *Municipal Waste Degradation by Vermicomposting Using a Combination of Eisenia fetida and Lumbricus rubellus Species. Agronomy, 13*(5), 1370.
11. Sinha, R. K., Agarwal, S., & Singh, R. P. (2009). Vermiculture technology and organic farming. *Agricultural Reviews, 30*(4), 285–294.
12. Suthar, S. (2009). Vermicomposting of domestic waste: Comparison of different earthworm species. Bioresource Technology, 100(1), 1623–1629.
13. Yalyang Yanya et al. (2025). *Vermicomposting: A sustainable approach to waste management and enhancing soil fertility and crop productivity. J Pharmacogn Phytochem, 14*(4), 09–12.