INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Performance Evaluation of a Novel Two-Stage Biodegradation Technique for Composting of Diverse Biodegradable Wastes: Batch-Scale to Large-Scale Application

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SHORT ABSTRACT

Organic waste management has emerged as a critical challenge in contemporary times, given the detrimental environmental repercussions associated with inefficient treatment strategies. With an estimated 2 billion tons of organic waste generated annually worldwide, the need for sustainable and effective waste management solutions has never been more pressing. Traditional methods often fall short in adequately addressing the sheer volume and composition of organic waste, leading to accumulation, unregulated decomposition, and contamination hazards. However, a pioneering study proposes a holistic approach to organic waste treatment, encompassing rotary drum composting and vermicomposting, to overcome existing impediments and revolutionize waste management practices.

The Challenge of Organic Waste Management:

Organic waste, primarily consisting of biodegradable materials such as food scraps, agricultural residues, and sewage sludge, poses significant challenges due to its high-water content and diverse composition. Conventional treatment methods struggle to efficiently process organic waste, leading to management hurdles, increased costs, and resource depletion. The magnitude of the issue is underscored by statistics revealing substantial food wastage globally and the urgent need for sustainable waste management solutions to mitigate environmental risks.

Proposed Solution: Rotary Drum Composting and Vermicomposting

The study introduces a novel approach to organic waste management, combining rotary drum composting and vermicomposting to enhance the efficiency and sustainability of waste

treatment processes. Rotary drum composting accelerates the decomposition of organic waste by creating optimal conditions for microbial activity, while vermicomposting further enriches the resulting compost by utilizing earthworms to break down organic matter. This two-stage biodegradation process not only reduces waste volume but also produces nutrient-rich vermicompost with significant potential as a soil conditioner.

Phase I: Assessing Biodegradation Effectiveness

The effectiveness of the proposed biodegradation process was evaluated through a series of experiments utilizing rotary drum composters and vermicomposters. These experiments demonstrated the rapid decomposition of organic waste, with significant reductions in biodegradation periods achieved. The resulting compost exhibited high nutrient content, particularly in nitrogen, making it suitable for soil amendment purposes. Moreover, the biodegradation process proved reliable in stabilizing challenging waste materials, including sewage sludge and tough biomasses like terrestrial and aquatic weeds.

Phase II: Ensuring Safety and Efficacy

To ensure the safety and efficacy of the vermicompost produced through the biodegradation process, phytotoxicity tests were conducted using pot studies. These tests confirmed the suitability of the vermicompost as a soil conditioner, with seed germination rates exceeding 95% and healthy plant growth observed. The results provided further validation of the effectiveness of the two-stage biodegradation process in managing diverse organic wastes while producing a high-quality soil amendment.

Phase III: Scaling Up the Process

Building upon the success of the initial phases, the study progressed to pilot-scale trials to assess the scalability of the biodegradation process. Pilot-scale rotary drum composters and vermicomposting techniques were employed to process larger volumes of organic waste, including challenging substrates such as vegetable waste and water hyacinth. The results demonstrated the effectiveness of the process on a larger scale, with significant reductions in waste volume achieved and nutrient-rich vermicompost produced. Moreover, the study identified the stack vermicomposting method as particularly efficient in terms of land requirements and operational ease.

Phase IV: Field Evaluation and Impact Assessment

In the final phase of the study, field evaluations were conducted to assess the impact of vermicompost amendment on soil health and plant growth under natural conditions. The results revealed significant improvements in soil organic carbon content, plant growth, and yield in areas treated with vermicompost compared to untreated soil. The findings underscored the potential of vermicompost as a sustainable soil amendment, capable of enhancing soil fertility and crop productivity.

Conclusion:

The comprehensive study presents a paradigm shift in organic waste management, offering a sustainable solution to the growing challenges associated with waste treatment. By integrating rotary drum composting and vermicomposting, the study demonstrates the potential to reduce waste volume, produce nutrient-rich compost, and improve soil health. With further research and implementation, the proposed approach has the capacity to revolutionize waste management practices not only in India but also globally, paving the way for a more sustainable and environmentally conscious future.