Organic Waste Composting Machine

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Abstract

This abstract presents an innovative approach to organic waste management through the design and implementation of an advanced organic waste composting machine. As the global population continues to grow, managing of organic waste becomes an innovative challenge. The proposed solution aims to address environmental concerns, promote sustainable agricultural practices, and contribute to the reduction of greenhouse gas emissions. Key features of the composting machine include automated temperature and moisture control, ensuring an optimal environment for microbial activity. The organic waste compost produced by the machine serves as a nutrient-rich soil conditioner, promoting soil health and fertility. The implementation of this composting technology contributes to circular economy principles by closing the organic waste loop and reducing dependence on chemical fertilizers. Additionally, the composting machine aligns with sustainable development goals by promoting resource efficiency and supporting local agriculture in waste reduction practices. This technology represents a step towards creating more resilient and environmentally conscious communities while supporting the transition to circular economies in the context of waste management.

Keywords: Organic waste, Composting machine, Temperature, Moisture.

1. Introduction:

Organic waste composting machines are becoming increasingly popular as people look for ways to reduce their environmental impact and create nutrient-rich fertilizer for their gardens. These handy machines take food scraps, yard waste, and other organic materials and turn them into compost, a dark, crumbly soil amendment that is packed with nutrients. The proposed idea for organic waste management and composting machine targets small-scale industries, particularly catering to the needs of farmers who frequently purchase organic manure. The system is designed to efficiently handle organic waste originating from households and agricultural farms. The cornerstone of this solution is the utilization of the Anaerobic Composting method. The process begins with the collection of organic waste, encompassing both food and agricultural residues, which is then stored in a dedicated storage tank. Upon the provision of power supply, the integrated grinder or shredder within the storage tank commences the decomposition process by crushing the collected waste into small pieces. Simultaneously, a heater incorporated into the storage tank is activated, elevating the temperature within the tank. This rise in temperature serves a dual purpose, facilitating the breakdown of organic matter and promoting the

evaporation of water content present in the waste. The functionality of the system is enhanced through the Integration of various sensors strategically placed within the tank. These sensors play a crucial role in analysing and monitoring key parameters such as temperature, moisture levels, and other essential factors. The data collected by these sensors enables a real-time assessment of the composting environment, allowing for precise adjustments and optimizations as needed. This sensor-driven approach ensures that the composting conditions remain within the ideal range, promoting optimal microbial activity and overall efficiency in the decomposition process.

1.1 Objective of the Project

- Design and implement an efficient organic waste composting machine.
- Integrate automation for temperature and moisture control in the composting machine.
- Incorporate sensor-based monitoring systems for real-time data collection.
- Produce nutrient-rich compost suitable for sustainable agriculture and soil health.
- Mitigate environmental impact by reducing methane emissions and promoting responsible waste disposal.

1.2 Existing Methodology

Method 1 – Animal Feed: Utilizing organic waste as animal feed represents an eco-friendly and sustainable approach to waste management. This process involves repurposing food processing by-products and other organic residues to create nutritionally rich feed for livestock. By converting organic waste into animal feed, not only is the volume of waste reduced, but valuable nutrients are also redirected into the agricultural cycle. This practice contributes to the circular economy by transforming waste into a resource, offering a cost-effective and environmentally friendly alternative to traditional disposal methods. Moreover, the nutritional content of the resulting animal feed enhances the well-being of livestock, supporting the overall sustainability of the agricultural system.

Method 2 – Automated Composting Machine: An automated composting machine streamlines the organic waste decomposition process by employing a systematic and efficient approach. Initially, the machine receives a diverse range of organic materials that undergo shredding or chopping stage, breaking down larger components into smaller pieces. Subsequently, the organic matter enters a controlled environment that regulates key factors such as temperature, moisture, and aeration. Microorganisms, including bacteria and fungi, thrive in this optimized setting, accelerating the decomposition process. The machine monitors and adjusts these environmental variables automatically to ensure an ideal composting environment. As the microorganisms break down the organic matter, the machine facilitates the transformation into nutrient-rich compost. The final product is a valuable soil amendment that can be utilized to enhance soil fertility and promote sustainable agriculture. Hardware design is shown in Figure 2.

2. Literature Survey

[1] In this paper, Conventional agro-waste disposal, a traditional method, is time-consuming and contributes to environmental pollution. This approach effectively converts tough-to-decompose solid wastes into smaller pieces, facilitating easier decomposition. Its application in the forest industry can transform large quantities of tree branches and leaves, including peels, into valuable fertilizer or vermicompost. [2] The paper aims to design a composting machine with specific parameters, focusing on design, process time, and user-friendly features such as ease of use, odor elimination, and power efficiency. In contrast, the existing manual operation-based system is time-consuming. The incorporation of a shredder machine is proposed to reduce noise, vibrations, and overall time consumption. For effective composting, maintaining an approximate carbon-nitrogen ratio of 30:1 in the input waste and ensuring a 50% moisture level are crucial factors. [3] In this paper, an Arduino Mega2560 is utilized to process data, connected to a 3900rpm motor and various sensors. The system displays the crushing process and composting condition on an LED monitor, which also shows the

trash can temperature via a temperature sensor and monitors garbage height using an LDR sensor. The average transformation time for composting is approximately 10 days. [4] This paper outlines a process where organic waste, upon addition, triggers the humidity sensor, activating the heater in the composting tank. This leads to water evaporation through the exhaust system, achieving a substantial 70-80% volume reduction due to the inherent water content in organic waste. The fully automatic and compact composting machine employs the microorganism "Acidulants" to expedite organic waste decomposition into compost within a 24-hour timeframe, despite the associated high process cost. [5] This design and mechanical study focus on tele managing composting parameters, transmitting data from the composter to a smartphone and computer through 4G and Wi-Fi. Moisture, temperature, airflow, drum rotation, and stoppage information are monitored and controlled remotely using a tele management on/off system, providing real-time management through a smartphone application. The product's output is achieved within a four-week timeframe. [6-10] This paper explains the traditional method of composting that last for 6-12 months includes four stages of composting. Mesophilic, where bacteria and fungi break down easily to a couple of weeks; Thermophilic, where heat-loving microorganisms break down lasting several weeks; Cooling Phase, where Mesophilic microorganisms return to break down remaining matter over a few months; and Curing Phase, where compost matures at ambient temperature, lasting several months.

3. Methods and Materials
3.1 Working

The automated composting machine described here employs the anaerobic composting method to efficiently decompose organic waste. The process begins with the collection of organic waste in a storage tank. When power is supplied, a grinder or shredder inside the tank breaks down the waste into smaller pieces. Simultaneously, a heater within the tank is activated, raising the temperature and facilitating the evaporation of water content in the waste. The system utilizes various sensors within the tank to analyse crucial parameters such as temperature, moisture, and other environmental conditions. To initiate the decomposition process, necessary microorganisms with the appropriate carbon-nitrogen ratio are introduced into the tank. Over a period of 2-3 days, the microorganisms work in conjunction with the optimized conditions inside the tank to transform the organic waste into nutrient-rich organic manure. Block diagrams are shown in Figure 1.
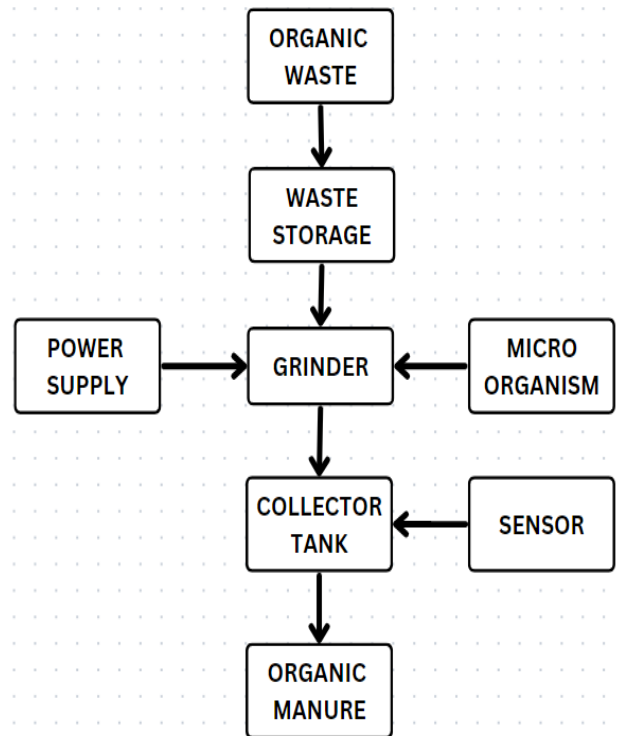
3.2 Block Diagram

Figure 1 Block Diagram

3.3 Components Used
1. Motor (¼ hp, 1500 rpm, 50Hz)
2. Storage Tank (20L Capacity)
3. Temperature Sensor (PT 100)
4. Soil Moisture Sensor (3.3-5V Analog)
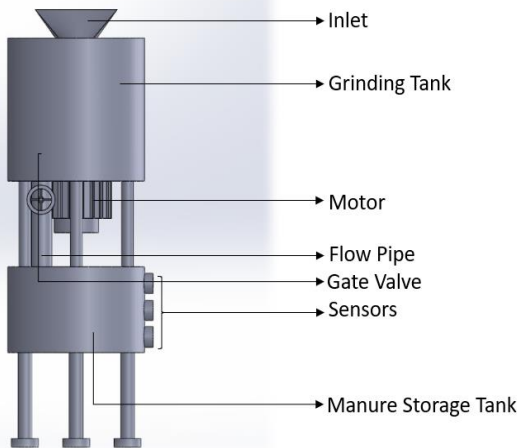5. Grinder with Blades Hydrolytic Bacteria (1kg for 5 kg of waste)

3.4 Hardware Design

Figure 2 Hardware Design

4. Simulation Analysis
4.1 Simulation

In this composting experiment, two bins were utilized to explore the impact of microorganisms on organic waste decomposition. Bin 1, the control group with only organic vegetable waste, exhibited a slower composting process over the five-day observation period. In contrast, Bin 2, incorporating microorganisms, displayed an impressive 95% effectiveness in accelerating the composting process, surpassing expected outcomes. The heightened efficiency in Bin 2 suggests that microorganisms play a crucial role in expediting the breakdown of organic materials, leading to a more rapid conversion into nutrient-rich compost. The delayed composting in Bin 1 underscores the significance of microorganisms in achieving desired compost maturity levels. This finding implies practical benefits for optimizing composting systems, emphasizing the advantageous role of microorganisms in transforming organic waste into valuable compost for agricultural and environmental purposes. Further investigation is recommended to assess the long-term effects and sustainability of this microorganism-enhanced composting approach. Simulation Readings are shown in Table 1.

4.2 Simulation Table

Table 1. Simulation Readings

DAY	BIN 1		BIN 2	
	Temperature (°C)	Moisture (%)	Temperature (°C)	Moisture (%)
Day 1	58.16	39.12	42.14	49.76
Day 2	61.72	40.12	57.44	56.70
Day 3	62.15	46.27	58.49	62.27
Day 4	64.30	60.20	61.49	69.70
Day 5	67.74	69.40	62.37	70.67
Day 6	72.56	70.17	62.78	71.36

4.3 Simulation Result

Figure 3 Comparison of Composting

*Bin 1: Organic Waste
*Bin 2: Organic Waste mixed with microorganism. A comparison of composting is shown in Figure 3.

5. Results and Discussion
5.1 Advantages

- Composting machines effectively convert organic waste into nutrient-rich compost, reducing overall waste volume and landfill usage.

- The produced compost serves as an eco-friendly soil conditioner and enhance fertility in agricultural lands.
- Compact size model enables use of composting machine in household and agricultural farms.
- Integration of automated controls and sensors ensures precise monitoring and optimize composting conditions.
- The composting process reduces the need for chemical fertilizers and promoting a circular economy approach to organic waste.
- The entire process typically requires a significant amount of 3-5 days.

5.2 Disadvantages

- Composting sometimes may generate an unpleasant smell during the decomposition process.
- Potential attraction of snakes, rats, and bugs due to the organic waste.
- Time-consuming for composting can be a drawback for some individuals or communities.

6. Results and Future Scope

The organic waste composting machine experiment yielded promising insights into composting efficiency. Specifically designed for organic waste, the machine demonstrated noteworthy performance, efficiently transforming waste into nutrient-rich compost. Recorded data, including temperature, moisture levels, and decomposition rates, provided valuable insights into the machine's effectiveness. Temperature trends indicated a well-managed process, creating an optimal environment for microbial activity, while maintained moisture levels supported crucial composting microbial actions. Decomposition rates highlighted the machine's ability to expedite the composting timeline, emphasizing its efficiency in creating favourable conditions. These results underscore the potential of well-designed composting machines in contributing significantly to sustainable waste management. By reducing waste volume and producing valuable compost for agriculture, such machines positively impact environmental conservation and resource utilization.

The future of waste management is poised for significant advancements with a growing emphasis on sustainability and environmental awareness. Innovations in processing various organic waste types are expected to take centre stage, paving the way for more efficient and eco-friendly solutions. The integration of advanced technologies will play a crucial role in enhancing overall efficiency, making waste management practices more streamlined and effective. Additionally, there will be a concerted effort to improve compost quality and simplify the composting process, ensuring user-friendly approaches to contribute to a greener and healthier planet.

References

[1]. Pare, M., & Aman, M. (2019). Design Of Organic Compost Machine. International Research Journal of Engineering and Technology, 6(12), 532-6.
[2]. Meena, A. L., Karwal, M., Dutta, D., & Mishra, R. P. (2021). Composting: phases and factors responsible for efficient and improved composting. Agriculture and Food: e-Newsletter, 1, 85-90.
[3]. Nithyananth, S., Samuel, L., Mathew, N., & Suraj, S. (2014). Design of waste shredder machine. Int. Journal of Engineering Research and Applications, 4(3), 487-491.
[4]. Wardhany, V. A., Hidayat, A., & Afandi, A. (2019, September). Smart chopper and monitoring system for composting garbage. In 2019 2nd International Conference of Computer and Informatics Engineering (IC2IE) (pp. 74-78). IEEE.
[5]. Elalami, M., Baskoun, Y., Beraich, F. Z., Arouch, M., Taouzari, M., & Qanadli, S. D. (2019, November). Design and test of the smart composter controlled by sensors. In 2019 7th International Renewable and Sustainable Energy Conference (IRSEC) (pp. 1-6). IEEE.
[6]. Katiyar, A., Gaur, A., Shrivastava, A., Khan, M. A., Singh, N. P., Saini, R., & Kaur, M. G. (2019). Design and construction of a shredding machine for recycling and management of organic waste.

International Journal of Trend in Scientific Research and Development, 3(4), 707-712.

[7]. Mustafa, M. Y., Calay, R. K., & Román, E. (2016). Biogas from organic waste-a case study. Procedia Engineering, 146, 310-317.

[8]. Kadir, A. A., Azhari, N. W., & Jamaludin, S. N. (2016). An overview of organic waste in composting. In MATEC Web of Conferences (Vol. 47, p. 05025). EDP Sciences.

[9]. Khalid, A., Arshad, M., Anjum, M., Mahmood, T., & Dawson, L. (2011). The anaerobic digestion of solid organic waste. Waste management, 31(8), 1737-1744.

[10]. Balaganesh, P., Vasudevan, M., Rameswari, R., & Natarajan, N. (2022). Recent Trends in IOT-Enabled Composter for Organic Wastes. In Sustainable Cities and Resilience: Select Proceedings of VCDRR 2021 (pp. 445-457). Springer Singapore.