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Composting of sugarcane waste by microorganism and subsequent vermicomposting: A practical implementation study

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ABSTRACT

The sugarcane waste can be processed in usable composed fertilizer towards a good source of additional income for farmers as sugarcane trash is produced in large quantities because of the cash-crop nature of sugarcane. The microbial processing can produce good quality organic fertilizer from sugar cane trash. The large amount of raw trash material remains more on the farm, so it can be used to prepare fertilizer naturally. The compost conversion will reduce the air pollution caused by burning of sugarcane trash at the farm, and also, the trash burning destroys soil organisms. Herein, a practical implementation of vermicomposting has been studied to generate the compost fertilizer from sugarcane trash. A prototype composting tray, measuring 30 cm by 80 cm, was developed for the experiment. The bottom layer of the tray is filled with cow dung and sugarcane trash, occupying 80% of the tray. It was sprinkled with water to moisten the contents. Two kilograms of Eisenia foetida worms were introduced for vermiculture. The vermicompost obtained was further applied for growing the crops.

Keywords: Eisenia fetida, Earthworms, Organic fertilizer, Sugarcane trash, Vermicomposting.

INTRODUCTION

Earthworms are soil-dwelling animals. It eats the organic matter of the soil and after eating leaves only the part required by its body and excretes the rest as feces.[1] It is also called vermicompost. There are 3,000 species of earthworms in the world, while 300 species of earthworms are found in India.[2] The length of the earthworm ranges from a minimum of 3 cm to a maximum of 4 meters. Earthworms of different lengths and thicknesses are found in different layers of soil. The smaller species of earthworms are usually found in the 10 to 20-cm soil layer. Larger types of earthworms go underground up to 3 meters deep and use the soil as food. The foreign species Eisenia Foetida is the best in the world for producing vermicompost.[3] A local species of earthworm, Perionyx excavatus, has also been shown to be good in vermicomposting. At present, this variety is widely used for the production of vermicompost,[4] so information about the identification and production of vermicompost has been given. Earthworms are not new animals to farmers. This animal can be found everywhere in compost pits or fields. But recently its existence has been destroyed by the farm. Its main reasons are the use of innumerable chemical fertilizers, large-scale use of pesticides, and less use of organic fertilizers. The color of earthworms is brown and reddish. The worm is round and characteristic at both ends tapering towards the anterior end. The body is segmented and has 100 to 120 segments. The 14th, 15th, and 16th segments are surrounded by glandular tissue. If it is, it should be considered that the worm has matured. Earthworms don't have eyes, just like they don't have bones. But there are light-sensing organs. Earthworms breathe through the skin, so the skin needs to be moist. There are three stages in the life of an earthworm namely egg, larval stage, and adult stage. All these stages require

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moist soil. The earthworm lays eggs every six to seven days. This egg contains 2 to 20 embryos. The egg stage lasts from 7 to 20 days depending on climatic conditions. The full stage of earthworms is 2 to 3 months. Then when it comes to its full state, a ½ cm size area at a distance of 2 to 3 cm from the mouth becomes hard. This is a sign of aging worms. In general the survival of an earthworm is 2 to 3 years. Chicks and adult earthworms fit 2000 in one kg. 100 kg of earthworms produce 1 tons of vermicompost per month. Food for earthworms should be at least partially rotted. Vermicomposting can be done using a both mixture of cow dung and organic manure. Vermi fertilizers can include wet field mulch, vegetable residues, partially decomposed crop residues, and Press Mud from sugar mills. But while using this feed for earthworms it is necessary to mix some amount of dung. Always grind the worm feed. Slurry from biogas plants can also be used as worm feed. While separating vermicompost and earthworms, heaps of vermicompost should be laid on tarpaulin or burlap in the sun so that the earthworms will sink to the bottom of the earth due to the sun and the earthworms and vermicompost can be separated. As far as possible, do not use durable, weedy weeds when separating manure. That means the earthworms will not be harmed. Vermicompost has a slightly higher nutrient content than cow dung.[5] At the same time, there is a large amount of useful microorganisms, hormones, etc. Vermicomposting averages Nitrogen 1 to 1. 5%, Phosphorus 0 to 9% and Potassium 0.4%. It is reused to prepare excellent manure, like mulching, creating electricity, and combining raw materials to make bricks. Additionally, harvesting fruits and vegetables and, most important plays a process called vermicomposting to turn organic waste products into compost that may be used as a growing medium for plants.[6] Cattle manure is the ideal original material for the creation of vermicompost. In recent decades, vermicompost is preferred by all the scientist throughout the globe. Planning for solid waste is necessary for a sustainable society.

BACKGROUND

For the disposal of solid waste, vermicomposting should be employed rather than landfilling. Organic waste can be managed using the low-tech, ecologically friendly process of vermicomposting. Vermicomposting necessitates organic waste, allowing for a quicker and more cost-effective conversion of farm solid waste into high-quality, organic manure. These fertilizers include degraded organic materials and earthworm droppings. It helps with orchards and vigorous crop cultivation. Vermicomposting aids in keeping a sustainable agricultural environment in balance. Recently, letting them decompose can turn them into organic manure. Field solid waste can be combined with processed compost, which has a lower C / N ratio.[5] Therefore, compared to other composting techniques, vermicomposting is a good approach to composting organic waste in a shorter amount of time.[7] The following observations were made in papers 2 and 3. Earthworms are employed in the vermicomposting process to break down organic waste into vermicompost, a humus-like substance. Vermicompost has a higher nutritional profile than conventional compost.[8] The permeability properties of the soil utilized with vermicompost are good. Vermicompost contains considerable amounts of soluble salts.[9] Earthworms and microorganisms are used in the vermicomposting process. The finished product has outstanding permeability characteristics and a decent texture. It has superior porosity, superior air circulation, and good water drainage capabilities.[10] It also has improved water retention capabilities, soil microbial activity, and better nutrient conditions. It promotes plant growth and soil fertility. Agricultural inputs that are biological rather than heavily relying on chemical fertilizers and pesticides. The ecology and the soil are not harmed by organic farming. Vermicompost and Vermicast have both been demonstrated to aid in the growth, promotion, and protection of crop plants.[4] Fruit trees and other crops receive crucial nutrients from organic debris that is present in the field.[11] Additionally, it blends with the soil and enhances the texture. Boosts the soil's fertility. Earthworms break down organic materials, which enhances the soil's carbon-to-nitrogen ratio. Crop yields grow as the soil cavity widens. The soil becomes more nutrient-dense. The soil's ability to store water is improved when organic matter is used in the field. Vermicompost is a biological fertilizer that is highly nutritious and less expensive. The obtained vermicompost had great nutritional value.[2] Vermicomposting, the process of using worms to decompose organic waste, offers numerous benefits for both the environment and agriculture. It enhances soil fertility by producing nutrient-rich compost, which improves soil structure, water retention, and microbial activity. This natural fertilizer boosts plant growth and yields without the need for chemical inputs.[12] Vermicomposting also helps in waste management by reducing the volume of organic waste that ends up in landfills, thus lowering greenhouse gas emissions. It promotes sustainable farming practices, minimizes soil erosion, and contributes to healthier ecosystems. Overall, vermicomposting is an eco-friendly and cost-effective way to recycle organic matter and improve soil health.[12,13]

METHOD

Embarking on the journey of vermicompost production, the prototype model development begins with the meticulous layering of a tray measuring 30*80 cm (Figure 1). This base layer comprises a synergistic blend of sugarcane waste and cow dung, reaching an 80% fill, with water gently sprinkled over to foster optimal conditions for decomposition. The subsequent addition of trash, depicted in Figures 2, showcases the progressive growth of the composting material. Figure 3 delve into the specifications of the tray, elucidating its dimensions (length, width, and height), and providing a holistic view of the composting setup. Figure 4 shows the prototype model filled with all required material. Figure 5 shows inserting 2 kg of species into prototype model.

Scalable unit is produced in my own farm. Figure 6 shows full strength of species used. Figure 7 shows purchase of 10 kg Eisenia Fetida to my own farm. Upon reaching the final stage of the composting unit's assembly (Figure 6), the seamless integration of layers indicates readiness for the vermicomposting process. Eisenia foetida, introduced in Figure 7, plays a pivotal role in enhancing composting efficiency, with approximately 2 kg strategically added to the mixture. Figure 7 shows the open plot beds. Figure 8 shows the closed bed structure used. Some beds are open and some beds are closed in plastic structure. Advantages of closed bed is that we can collect worm wash which used as spraying.[14] Figure 10 shows the Vermiwash collection. Figure 11 shows 2 tons of final output available at the end of process which is too much healthy for crop. Figure 11 shows died structure of Eisenia Fetida.

The life cycle of Eisenia foetida unfolds, depicting their growth and incorporation into the Golden Cilantro plot. The narrative culminates in Figure 12, revealing the flourishing results of this sustainable practice - a thriving organic plot of Golden Cilantro, underscoring the positive impact of vermicompost on agricultural yield.

Figure 1. Base Layer.

Figure 2. Trash adding.

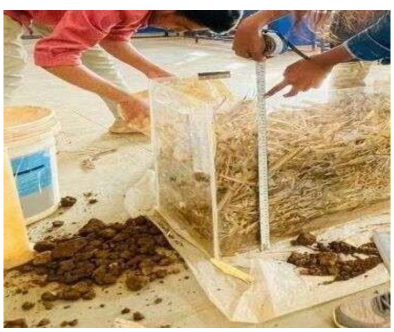

Figure 3. Height of Tray indicating 50 cm.

Figure 4. The Total tray is filled with input material.

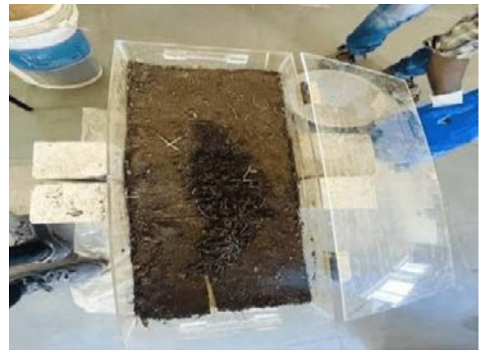

Figure 5. Tray filled with Vermin.

Figure 6. Group of Eisenia fetida.

Figure 7. Packing of Eisenia fetida with moisture soil.

Figure 8. Harvesting of the final product from the open bed.

Figure 9. Closed bed of sugarcane waste & cow dung.

Figure 10. Vermiwash from closed bed.

Figure 11. Final manure from vermicomposting and Died Eisenia fetida

Figure 12. Organic Golden Cilantro Plot.

RESULTS AND DISCUSSION

The concentration of nutrients such as manganese and iron in sugarcane trash increases during summer rains due to oxidation and reduction processes. As a result, symptoms of manganese deficiency are reduced. The nutrient content of sugarcane trash is typically examined from June to October, a period of rapid sugarcane growth in India, coinciding with the return monsoon. During this time, the moisture content in the soil increases, contributing to higher concentrations of manganese and iron. These soil moisture levels vary both seasonally and within the same year.

Nutrient sampling, aside from manganese and iron, is less affected during the summer and spring months. Therefore, June and July are the ideal months for collecting sugarcane trash, as access to the fields becomes more difficult in August and later due to the growing crop. This paper highlights a comparative study of trash samples collected during the summer and later months. The growth of worms and nutrient levels increases by 30%, making the compost suitable for plant growth.

Table 1 provides a technical analysis of the final compost produced, showing that sugarcane waste from vermicomposting contains nearly all essential nutrients required for soil fertility.

Table 1. Nutrient growth.

Sr. No.	Param eters	Initial nutrient status (0 Day)	Control compost without Eisenia Foetida (15 Days)	Test (vermicompost with Eisenia Foetida (30 Days)
1	pH value	6.49±0.36	6.70±0.38	6.15±0.49
2	EC (ds/m)	0.99±0.39	0.93±0.19	0.78±0.23
3	C (%)	43.9±0.47	36.2±0.41	19.4±0.43
4	N (%)	1.4±0.51	1.6±0.29	2.5±0.57
5	P (%)	2.47±0.59	2.38±0.53	2.67±0.44
6	K (%)	1.41±0.42	1.55±0.23	1.57±0.39
7	Ca (%)	1.57±0.36	2.21±0.55	2.39±0.44
8	Mg (%)	1.49±0.52	1.67±0.57	2.02±0.39

The following are the advantages of vermicompost:

1. Improves soil texture.
2. A suitable change is made in the composition of the soil particles.
3. Soil erosion is reduced.
4. The evaporation rate decreases.
5. Waste disposal reduces health-related issues.
6. The proper level of the soil surface is maintained.
7. Earthworms bring up the subsoil and make it of better quality
8. Beneficial bacteria in the soil increase exponentially.
9. The duration of watering the soil is reduced.
10. Air, water, and land become pollution-free.
11. Soil erosion and salinity are reduced.
12. Cultivation is done without damaging the roots of the plants due to earthworms.

Since there is a lot of humus in vermicompost, Nitrogen, phosphorus, Potassium, and other micronutrients are readily available to the plants.

The following best practices should be followed to promote vermicomposting in agriculture:

1. Awareness Programs and Training: Various government organizations conduct awareness programs and training sessions on the ammoniation of sugarcane trash using urea for livestock feed. These programs also educate farmers about the negative impact of burning sugarcane trash on climate change. As a result, more farmers are choosing to produce vermicompost from sugarcane waste instead of burning it in the fields.

2. Farmer Groups and Support: With the assistance of the Agriculture Technology Management Agency (ATMA), farmers are organized into groups for discussions and lectures on urea enrichment techniques. This study also provides insights into the nutritional composition of sugarcane trash during the summer months.

3. Urea Ammoniation Benefits: The urea ammoniation method has been found to be more beneficial for farmers than traditional urea treatment, as it improves the palatability and fiber digestibility of the fodder. It also supplies nitrogen as a protein source more effectively than other methods.

4. Technical Support and Resources: Government technical staff regularly provide guidance on livestock feeding and the utilization of dry fodder. They also offer continuous support to help farmers correctly apply the urea enrichment method, ensuring there is no confusion. Additionally, the government provides all necessary materials for the urea enrichment process to interested farmers.

By following these practices, farmers can enhance the use of sugarcane trash for vermicomposting and improve its value for both agriculture and livestock.

Conclusion

The disposal of sugarcane industrial byproducts, such as bagasse, presents a significant environmental challenge. However, sugarcane press waste can alternatively be treated to generate vermicompost. Due to the significantly lower C:N ratios, the final vermicompost is more stable. This research lays the groundwork for using press mud in vermicomposting by mixing it with cow dung in appropriate proportions. Our findings indicate that press mud can be successfully converted into high-quality vermicompost by combining it with up to 50% cow dung and vermicomposting it using Eisenia foetida.

According to the study, if sugar mills adopt vermicomposting technology, they can achieve two key benefits: converting waste into a valuable product and reducing the amount of industrial waste disposed of in landfills and open dumps. Eisenia foetida is used to break down the sugarcane bagasse and leaves during the vermicomposting process. As the nutrient source diminishes, the population of surviving worms gradually declines. While a 1:1 ratio of waste to soil showed the fastest degradation, the most economically viable ratio for large-scale operations is 70% waste to 30% soil. This approach is recommended for commercial waste management.

The potential of vermicomposting sugarcane bagasse and leaves is so promising that further studies should be pursued to refine the process. The experimental setup, involving the use of Eisenia foetida to compost sugarcane trash and cow dung, was highly successful. It produced a dark-colored, soil-like vermicompost with a pleasant, earthy odor. The resulting compost is rich in eco-friendly micro- and macronutrients, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), copper (Cu), zinc (Zn), and iron (Fe).

Future studies could explore the potential of using other organic waste from the agricultural sector for vermicomposting. Otherwise, sugarcane trash remains a hazard to human health, the ecosystem, and the atmosphere when burned, releasing air pollutants. This makes it difficult for farmers to manage. The final yield of vermicompost enhances agricultural productivity and reduces reliance on chemical pesticides. For industries, it offers a cost-effective solution for pollution control. Additionally, this practice supports the national economy by reducing costs for purchased inputs, minimizing the formation of wasteland, and boosting the rural economy.

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CONFLICT OF INTEREST

The authors decleares that they do not have any conflict of interest regarding this research.

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