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Solid Waste Management And Vermicomposting: A Review

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Abstract
This review investigates composting, types of composting such as aerobic, anaerobic, and vermicomposting, and it also explores the benefits of composting in reducing pollution and global warming. It also discusses the important factors influencing composting, such as temperature, pH, moisture, etc. The study also examines future perspectives regarding composting. It majorly elaborates about organic composting, vermicomposting, and its applications. It also offers insights into optimizing the composting process for different types of organic wastes. It demonstrates composting and vermicomposting of solid organic waste, which is considered economically viable; thus, solid waste management techniques are also discussed in this review. It focuses on understanding the role of vermicomposting as a tool in reducing solid waste and promoting decluttering of the earth.
It is noteworthy to mention that various microorganisms such as bacteria and various enzymes produced during composting process play a crucial role in the degradation of the organic waste which is much needed for the preparation of the compost.
It also briefs about how composting can be done on a small scale in municipal or industrial setting. It also promotes about organic farming and its applications replacing the current usage of chemical fertilizers.

Keywords: *Composting, Vermicomposting, Organic composting, Types, Methods, Economic, Social and Environmental benefits.*

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I. Introduction

Figure 1 COMPOSTING PIT

Composting is a self-heating biological process [bioengineered,2022] in which breaking down of organic materials such as food scraps, yard waste and other biodegradable items into nutrient rich substance takes place to form a compost. This process occurs naturally through the action of microorganisms such as bacteria and fungi which decompose the organic matter over time. The product obtained through composting is used as soil fertilizer, apart from improving the soil quality it also helps in managing the waste produced through many activities, ultimately called as waste management. As, microbial action is very important in the whole composting process, according to various research conclusions there are certain conditions which Favour the growth of microbes, duration of composting process and quality of compost formed

1. Particle size
2. Oxygen content
3. Moisture content
4. Ph
5. Temperature.

As we are discussing about composting, we should not forget to mention about the pollution of the soil which is today's prevailing problem. Removing the land fill, soil washing, solvent extraction and incineration are some old physical and chemical techniques used for soil remediation [impact of composting strategies on soil treatment, 2001] but which are not that effective. Now, composting is the new solution to the soil pollution and a new way for organic farming. In this review we will also discuss about how composting is fruitful in treating the major soil contaminants such as pesticides

[2,4-dichlorophenoxyacetic acid] and polycyclic aromatic compounds as these take a long period of time to decompose in soil. We are also here discussing about the types of composting and their classification. Composting is divided into three types

✓ Aerobic composting
✓ Anaerobic composting
✓ Vermicomposting.

❖ AEROBIC COMPOSTING

(Ivana cosic,Kristijan,kolacko, MarijaVukovic,Nina kopicic Aerobic treatment)

Aerobic composting is an environmentally friendly method to recycle organic matter (sir Albert Howard the founder of composting)

Utilizing microorganisms that thrive in the presence of oxygen, we can transform kitchen scraps, yard trimmings, and other organic wastes into nutrient-rich compost.

This process not only reduces the burden on landfills by cutting down organic waste but also creates a natural fertilizer that improves soil health and supports overall plant growth.

Establishing an aerobic compost system involves thoughtful setup and maintenance. We begin by selecting a suitable location and structure, ensuring there's ample air flow to support the aerobic microorganisms. (D V Wadkar, P R modak, V S Chavan "Aerobic Composting of solid waste")

- Aerobic composting converts organic waste into valuable compost using oxygen-dependent microorganisms.
- A well-maintained balance of 'greens'(nitrogen rich materials) and 'browns' (carbon rich materials) is essential for providing the necessary nutrients for the microbes.
- Regular pile management, including turning and moisture control, is critical for successful aerobic composting.

- This type of composting is generally faster and produces a high-quality end product with less environmental impact due to the absence of methane, a potent greenhouse gas.

ADVANTAGES OF AEROBIC COMPOSTING:
1.This process reduces the burden on landfills by cutting down organic waste.
2. Creates a natural fertilizer that improves soil health and supports overall plant growth.
3.This type of composting is generally faster and produces a high-quality end product with less environmental impact due to the absence of methane, a potent greenhouse gas. (

❖ANAEROBIC COMPOSTING

Anaerobic composting occurs in the absence of oxygen. The anaerobic decomposition is typically slower and can produce a stronger odour due to the production of methane and other sulphurous gases. In this method, microorganisms that thrive in oxygen-free environments work to decompose materials such as kitchen scraps, plant residue, and animal manure.

(E.Gasparikova, S.Kapusta,I.Bodik "Anaerobic Treatment ")

Anaerobic composting occurs in a sealed environment where oxygen is limited or absent. This creates different by-products and has distinct implications for the compost produced.

Due to the absence of oxygen, this process moves at a slow pace. And as a result, it generates methane, a potent greenhouse gas, and a more pungent odour compared to aerobic methods.

The main trump card for applying this process is that it can be considered less labour-intensive than its aerobic counterpart as it does not require aeration or turning.

Understanding the balance of conditions necessary for successful anaerobic composting is crucial. Ensuring that the right mix of waste materials is used, that the system is properly sealed, and that any potential issues are promptly addressed can lead to effective compost production.

ADVANTAGES OF ANAEROBIC COMPOSTING:
1.The main trump card for applying this process is that it can be considered less labour-intensive than its aerobic counterpart as it does not require aeration or turning.
2.Anaerobic composting produces biogas, a renewable energy source that can reduce greenhouse gas emissions from fossil fuels.
3.Anaerobic composting has lower operating costs, making it commercially viable.
(Derco,K.Kratochvil "Anaerobic composting ")

❖VERMICOMPOSTING

Figure 2 COMPOST ALONG WITH EARTHWORMS

Vermicomposting is a reforming process by which organic waste is broken down through the synergistic actions of earthworms and microbial communities. Vermicomposting has been shown to credibly reduce organic biomass and generate high-quality fertilizer for plants. Vermicomposting is a nutrient-rich organic enhancement generated from organic waste through the combined action of earthworms and microorganisms. The contributions of earthworms towards vermicomposting can be grouped into two phases: (i) an active phase characterized by the ingestion and processing of the organic wastes by earthworms and, (ii) a maturation-like phase in which microbes degrade the earthworm-processed materials.

Vermicompost is characterized by high porosity, high water-holding capacity, and low C:N ratio. It stimulates growth, seed germination and development, flowering, and fruit production of a variety of plant species.

Compost is a natural fertilizer that allows an easy flow of water to the growing plants. The earthworms are mainly used in this process as they eat the organic matter and produce castings through their digestive systems. (Y.Yi-wei et al, "Vermicomposting potential ", A Yadav,R.Gupta,V.K.Garg)

Advantages Of Vermicomposting

The major benefits of vermicomposting are:

1. Develops roots of the plants.
2. Improves the physical structure of the soil.
3. Vermicomposting increases the fertility and water-resistance of the soil.
4. Helps in germination, plant growth, and crop yield.
5. Nurtures soil with plant growth hormones such as auxins, gibberellic acid, etc.

(D.Singh and S.Suthar " vermicomposting of herbal pharmaceutical industry waste")

Disadvantages of Vermicomposting

Following are the important disadvantages of vermicomposting:

1. It is a time-consuming process and takes as long as six months to convert the organic matter into usable forms.
2. It releases a very foul odour.
3. Vermicomposting is high maintenance. The feed has to be added periodically and care should be taken that the worms are not flooded with too much to eat.
4. The bin should not be too dry or too wet. The moisture levels need to be monitored periodically.
5. They nurture the growth of pests and pathogens such as fruit flies, centipede and flies.

(W.M.Nada**,**L. Van Rensburg and S.Claassens.)

METHODS OF VERMICOMPOSTING:

Vermicomposting is the process of using earthworms to convert organic waste into nutrient-rich compost. Here are the common methods of vermicomposting:

* PIT METHOD
* BIN METHOD
* HEAP METHOD

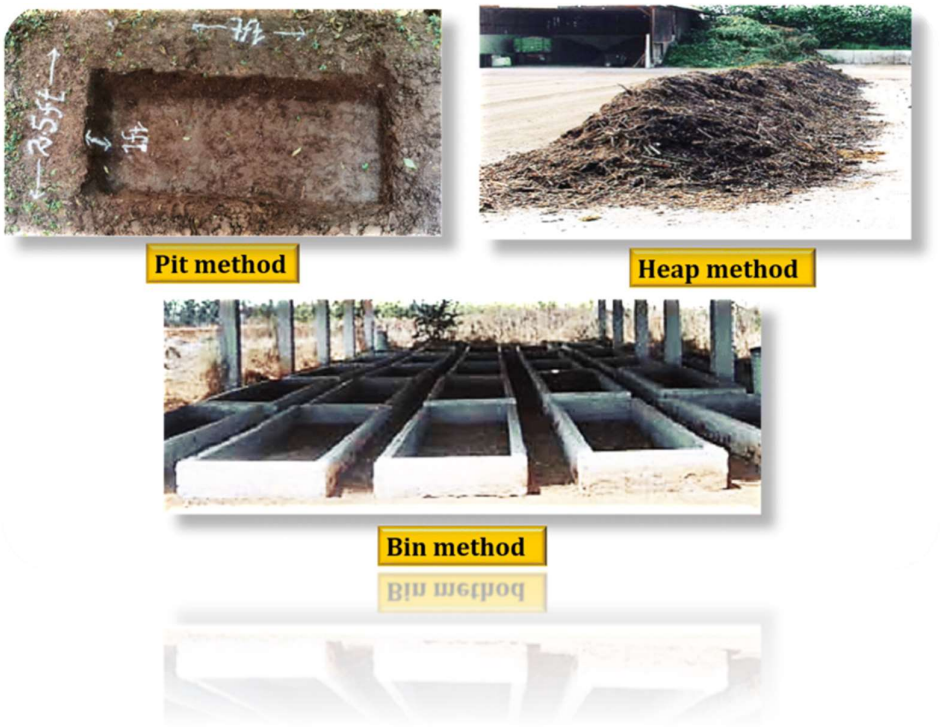

Figure 3 METHODS OF VERMIOMPOSTING

PIT METHOD:
Organic waste is placed in a pit dug into the ground, and worms are introduced into pit.
Process: The pit is lined with organic waste such as leaves, plant materials, and kitchen scraps. Earthworms are added, and over time they break down the waste into compost.(A.Abu, C.May ,N.Zalima and N. Abudallah)

Composting is done in pits that are 5x5x3 feet in size and made of cement. Thatch grass or any other locally accessible material is used to cover the structure. Due to inadequate aeration, water plugging at the bottom, and higher production costs, this approach is not chosen.
Advantages: Cost-effective and can handle larger volumes of waste.

BIN METHOD:

The bin method involves using container, such as wooden or plastic bin, to house the earthworms and organic waste.

Process: Organic matter (kitchen waste, garden waste) is added to the bin along with bedding material like shredded newspaper or cardboard. Red wiggler worms (Eisenia fetida) are commonly used for vermicomposting.(A.A Ansari and K.Sukhraj " Effect of Vermiwash and Vermicompost on Soil Parameters)
Advantages: Simple, low-maintenance, can be done indoors and outdoors.

HEAP METHOD:

Organic waste is placed in a heap, and worms are introduced to compost it.

Process: Similar to the pit method, but instead of placing the waste in a pit.it is piled up on the ground. Organic material is added in layers, and worms are introduced to work through the heap. The heap is maintained by adding moisture and covering it to retain warmth.

Advantages: Simple and cost-effective for moderate to large volumes of organic waste.

By choosing the right method based on the scale of operation and resource available.

(Edwards CA, Arcon NQ, Ismail SA)

CONDITIONS REQUIRED FOR VERMICOMPOSTING

1. SOIL PH:

The ph of the soil is very important to achieve the target goals of composting. This soil is prepared using organic waste, the bottom layer is filled with soil and brown organic waste [up to 10 to15cm] then next it is filled with alternating layers of organic waste and soil and third layer is the covering layer where a thin layer of soil is used to over the top layer. Through this process we can prepare the composting soil, now when we check the ph of this soil [mixture of the layers], we get a ph between 6-7, which describes the alkaline to neutral nature soil suitable for the growth of earthworms.

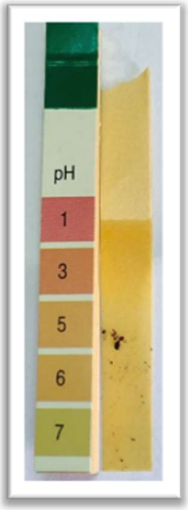

Figure 4 PH OF COMPOSTING SOIL

2. MOISTURE CONTENT:

The moisture content plays a very crucial role in growth of earth worms as mostly grown in damp and moist areas.

Always the moisture content should be maintained between 30-40% for the favourable growth of earth worms so that good quality vermicompost can be produced.

3. OXYGEN:

Ample amount of oxygen is required for rapid decomposition. With proper aeration, the composting can be completed in shorter time producing mature compost more quickly.

4. TEMPERATURE:

The temperature should be between 20-30*c as the growth or multiplication of worms will be more rapid under these conditions.

ECONOMIC IMPORTANCE OF VERMICOMPOSTING

Vermicompost has many economic benefits, including:

Organic fertilizer

Vermicompost is a valuable organic fertilizer that is rich in nutrients, such as nitrogen, phosphorus, and potassium. It can improve plant growth, increase crop yield, and enhance the quality and shelf life of produce.

Waste management

Vermicomposting is an environmentally friendly way to manage organic waste by turning it into nutrient-rich compost. This reduces the need for chemical fertilizers.

Self-employment

Vermicomposting can be a profitable business opportunity that can lead to self-employment.

Economic growth

Vermicomposting can contribute to economic growth by creating a market for high-quality vermicompost products.

Reduced pesticide use

Vermicompost can help reduce the use of chemical pesticides and the cost of food production. Studies show that vermicompost can help control disease by almost 75%.

Soil improvement

Vermicompost can improve soil structure, aeration, and water holding capacity. It can also prevent soil erosion (Chaoui H,Edward's CA, Brickner M)

VERMICOMPOSTING AS A CAREER

A career as a vermiculturist involves working with worms and organic waste materials to create vermicompost, an organic fertilizer that improves soil health and crop yields. Vermiculturists may work in a variety of roles, including:(Albanese E, Plaixats J, Cabrera, B.ravindaran)

Vermicomposting management

Overseeing the entire process of collecting, sorting, and converting organic waste into vermicompost

Worm culture management

Ensuring the health and growth of the worms by monitoring factors like temperature, moisture, and pH levels

Compost quality assurance

Testing and analyzing the quality of the vermicompost to determine its suitability for agricultural use

Research and development

Exploring and developing new techniques and technologies related to vermicomposting

Education and outreach

Teaching farmers, gardeners, and others about vermicomposting techniques and best practices vermicomposting can lead to significant benefits for individuals, communities, and the planet as a whole.

Figure 5 GRAPHICAL REPRESENTATION OF GLOBAL VERMICOMPOSTING

II. Conclusion

In conclusion, vermicomposting presents an effective and sustainable solution for waste management and soil enhancement. By utilizing earthworms to decompose organic matter, this method not only reduces landfill waste but also produces nutrient-rich compost that improves soil health and promotes plant growth. The process is eco-friendly, requires minimal resources, and can be implemented on both small and large scales. As awareness

of environmental issues grows, vermicomposting offers a practical approach to fostering a circular economy, enriching agricultural practices, and contributing to healthier ecosystems. Embracing.

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