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Vermicomposting: Reusing wastes to create beneficial organic fertilizer

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Abstract
The management of solid waste is one of the biggest problems we are now facing. Recycling garbage produces solely usable final goods, making it the greatest method for reducing waste. Nothing is lost in this situation; everything changes. The dramatic increase in garbage volume is a part of the environmental issue that has come with recent globalization. Composting, recycling, and creating biogas are a few methods for getting rid of solid waste. Nearly 700 million tonnes of organic garbage are thought to be burnt or dumped each year in India's cities and rural areas. Vermicomposting is the most appropriate, cost-effective, and ecologically friendly process for converting trash into nutrient-rich compost.

Keywords: Vermicomposting, sustainable agriculture, organic fertilizer, earthworms, compost

Introduction
Concern for soil preservation and environmental protection has traditionally prompted the adoption of sustainable agricultural techniques. Systemic fertilizers are preferred more in India, where farmers rely on them, causing the soil's fertility to decline and creating an unfavorable environment. As a result, compost is recognized as a key element in organic farming. According to the findings of multiple lengthy research, adding compost enhances the physical characteristics of soil by reducing bulk density and raising soil water holding capacity [3].

A significant source of organic manure is vermicompost. It is one of the effective composting procedures that uses earthworms to improve the compost's quality. Earthworms are invertebrate animals that arose around 600 million years ago and are members of the order Oligochaeta, class Chaetopod, and phylum Annelida [1]. Compost is made using many types of earthworms. Earthworms eliminate soil pathogens and transform organic waste into worm cast, which is a useful byproduct [5]. Worm cast includes a high proportion of humus and is rich in macro- and micronutrients. They contribute enzymes, growth hormones, and antibiotics to the breakdown process [5]. Vermicomposting is the word used to describe the biological process by which they consume cow dung and other organic waste and transform it into nutrient-rich compost. Farmers may easily implement this eco-friendly, environmentally healthy approach, which has a number of positive effects on plant development. However, instead of choosing sustainable farming, farmers often choose for intensive farming, which is bad for both the environment and human health.

There are many stages to the vermicomposting process [6]. The first stage is the first pre-composting phase, during which organic waste is pre-composted for close to 15 days before being fed to the earthworms. Volatile chemicals that are poisonous to earthworms are removed. The second phase is known as the mesophilic phase, during which organic matter breaks down and combines with soil particles to promote microbial activity and produce organic manure. The final stage is maturity and stability. The main factor in soil's improved chemical, physical, and biological properties is earthworms. They are referred to as soil conditioners since they are markers of soil health because they have the ability to modify microbial activity and directly impact microbial processes [2]. The importance of earthworms in the soil has accelerated the growth of vermitechnology. The population of earthworms is influenced by a number of variables, including food, temperature, moisture, light, and pH [4].

1. Food: This is one of the major factors that affect the population and community of earthworms. Due to the C:N ratio of the food material, the growth of earthworms is

constrained [4].

2. Temperature: Temperature affects the growth, metabolism, respiration, and reproduction of earthworms. Lower body temperature is sustained by their metabolic adjustments [4].
3. Moisture: They prefer to remain in moist soil as compared to dry soil. optimum moisture range between 50% and 80% has been considered for efficient vermicomposting [4]
4. Light: They are very sensitive to light [4].
5. pH: difference in physicochemical characteristics of waste mainly alters the pH of vermicomposting process [4].

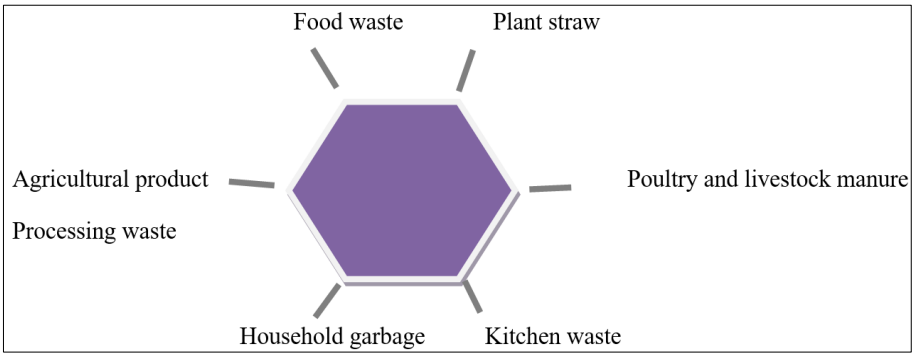


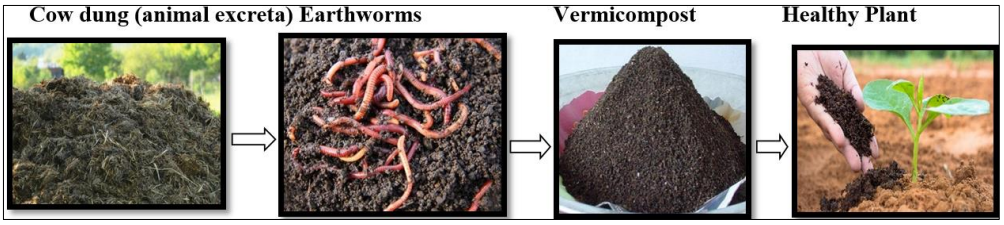
Fig 1: Recycling Wastes into Valuable Organic Fertilizer [10]

The term "organic wastes," sometimes known as "green wastes," describes waste products made from living things and human activity, primarily include crop straw, organic home waste, human and animal manure, etc. [10]. It is economically significant to recycle organic wastes to maintain soil quality and increase crop output.

Vermicompost increasing effect on agricultural crops

Numerous studies have demonstrated that the vermicompost increases agricultural output by allowing plants to absorb more nutrients. Additionally, it defends plants from a variety of pests and diseases by discouraging them, repelling them, or endowing plants with biological resistance [6]. Numerous field crops, vegetables, flower and fruit crops, as well as field crops, all benefit greatly from the growth and production enhancement effects of vermicompost.

Minimize the amount of water used for irrigation, reduce insect and termite infestations, and control weed growth. Improve seed germination and seedling growth and development. The beneficial impacts of the vermicompost that are used in agricultural production include big numbers of fruits per plant (in vegetable crops) and huge numbers of seeds per year (in cereal crops). Without using agrochemicals, earthworms and vermicompost can increase horticulture productivity [6].



Reduction in soil C:N ratio

Vermicomposting transforms household trash into compost in less than 30 days, has a lower C:N ratio, and retains more nitrogen than conventional composting techniques [8]. The quality of the organic waste utilized as a source material affects the C/N ratio.

Impact of vermicompost on soil fertility

Vermicompost's primary function is to alter the physical, chemical, and biological characteristics of soil through earthworm activity; therefore, they are known as soil managers [12]. It significantly enhances soil aeration, texture, and structure, and it also reduces soil erosion [12]. It improves the air-water interface in the soil by increasing the macropore space, which ranges from 50 to 500 µm, adversely benefiting plant growth, additionally, it has a positive impact on the soil's pH, microbial population, and enzyme activity [8, 12]. Earthworm digestive canal mucus contains certain antibiotics and hormone-like biochemicals that promote plant development and stimulate the breakdown of organic materials in soil [12].

Case study 1: nutrients composition between garden compost and vermicompost [9]

In this study, [8] did comparison between garden compost and vermicompost. Compared to garden compost, worm castings have a higher concentration of both macro and micronutrients (Table 1). It is clear from prior studies that vermicompost increases nutrient uptake by plants and supplies all nutrients in easily accessible form.

Earthworms devour a variety of organic wastes, resulting in a 40–60% volume reduction [9]. Each earthworm weighs between 0.5 and 0.6 g, consumes waste equal to its body weight, and excretes cast that is roughly equal to 50% of the waste it ingests each day [9]. Chemical and biological characteristics have been examined for these worm cast [9]. Casting moisture content varies from 32 to 66%, and their pH is in the range of 7.0 to 7.2.

Table 1: Nutrient composition of vermicompost and garden compost

Nutrient element	Vermicompost (%)	Garden compost (%)
Organic carbon	9.8-13.4	12.2
Nitrogen	0.15-1.61	0.8
Phosphorus	0.19-1.02	0.35
Potassium	0.15-0.73	0.48
Calcium	1.18-7.61	2.27
Magnesium	0.093-0.568	0.57
Sodium	0.058-0.158	<0.01
Zinc	0.0042-0.110	0.0012
copper	0.0026-0.0048	0.0017
Iron	0.2050-1.3313	1.1690
Manganese	0.0105-0.2038	0.0414

Case study: 2

Studies by Agarwal [11] found that the NPK value of vermicompost processed by earthworms significantly increases 3 to 4 times.

Table 2: The NPK value of vermicompost processed by earthworms significantly increases 3 to 4 times

S No.	Nutrient	Castle dung compost	Vermicompost
1	N	0.4-1.0%	2.5-3.0%
2	P	0.4-0.8%	1.8-2.9%
3	K	0.8-1.2%	1.4-2.0%

Source: Agarwal (1999) [11]; Ph.D. Thesis, University of Rajasthan, India

Result and Discussion

Organic waste can be effectively managed through vermicomposting. It is helpful in dealing the issue of waste disposal. Vermicompost use has numerous advantages for farmers, businesses, the environment, and the entire economy of the country. Vermiculture provides excellent nutrient-enriched vermicompost in addition to manage the solid waste. It is advantageous for sustaining a healthy ecology and sustainable organic agriculture. Cattle dung has low levels of organic carbons while plant debris and paper waste have high pH and organic carbon values. Other nutrients including total nitrogen, phosphorus, and potassium were only detected in very small levels in the three materials, but the carbon to nitrogen nutrient ratio performed quite well. The physical and chemical characteristics of plant debris, cow dung, and paper waste material were dramatically altered by the vermicomposting activity, which can be a useful tool for organic compost farming. According to the findings of the casting study, organic waste such as plant fragments, animal dung, and paper waste may be transformed into useable form and release nutrients with good efficiency. Even though there may not be much of an increase in nutrients, the plant is able to absorb them because of the slight change in nutritional value and the decreased C:N ratio. The microorganism-rich castings improve the plant growth hormones. The outcome revealed an increase in three different Earthworm species on three different substrates, including plant detritus, animal manure, and paper waste. Vermicomposting is an economical and environmentally favourable approach. It is the best approach for managing and developing solid waste. Using trash as a raw material and increasing soil fertility and soil health for sustainable agricultural practices, hold promise to play a vital role in environmental protection.

Conclusion

The vermicomposting process improves soil aeration, which in turn promotes the survival and spread of the beneficial bacteria inside such systems, which is progressively becoming more and more visible with each passing day. Vermicompost may be produced from biodegradable market waste, kitchen waste, agricultural waste, and city rubbish. Earthworms are best used to manage organic waste and improve easily available plant nutrients. Vermicompost merits praise for preserving and improving soil health. Together, earthworms and microbes work to control the bio-oxidation and buildup of organic waste during vermicomposting.

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