EPH - International Journal of Agriculture and Environmental Research
ISSN (Online): 2208-2158
Volume 10 Issue 01 February 2024

DOI: https://doi.org/10.53555/eijbps.v10i1.50

VERMICASTING: THE PROCESSING OF ORGANIC WASTES THROUGH EARTHWORMS.

Jagannath Naik[1], Tanmayee Mahanaik[1], Mahima Pradhan[1], Akash Kumar Das[1], Khushi Symon[1], Meniswini Rout[1], Somali Das[2*]

[1]Students of Biotechnology in NIIS Institute of Information Science & Management
[2]Faculty in Biotechnology, NIIS Institute of Information Science &Management*

Corresponding Author: somali536@gmail.com

Abstract

Vermicomposting is a sustainable waste management technique that utilizes earthworms to convert organic waste into nutrient-rich vermicompost. This process yields a high-quality biofertilizer with diverse microbial communities, enhancing soil health and crop productivity. Through the interaction of earthworms and microorganisms, organic matter is broken down into a finely degraded substance resembling peat. Vermicompost is enriched with essential plant nutrients like nitrogen, phosphorus, and potassium, making it an eco-friendly alternative to chemical fertilizers. Research has shown that vermicomposting improves soil structure, moisture retention, and nutrient availability, leading to better crop yields and overall soil health. Additionally, vermicomposting reduces environmental pollution and promotes sustainable agriculture by minimizing reliance on chemical in puts. It offers numerous benefits, including social, economic, and environmental advantages, making it a valuable practice for waste management and agricultural sustainability.

Keywords-*Vermicompost, Earthworm, Soil, Waste, Management, Biofertilizer*

INTRODUCTION

Vermicompost proves to be a highly nutritional organic fertilizers and powerful growth promoter over the standard composts and a protective farm input. It increases the physical, chemical and biological properties of soil by restoring and improving its natural fertility against the destructive chemical fertilizer which has destroyed the soil properties and decreased its natural fertility over the years. The vermicompost are enriched in NPK where the content of nitrogen – 23%, potassium – 1.85 to 2.25% and phosphorus 1.55 to 2.25%. It also consists of micronutrients which is beneficial to soil microbes and also contain plant growth hormones and enzymes (Sinha et al.,2009). The sustainable way of agriculture learning is new and innovative methods developed by both farmers and the farm scientists which is also similar to learning from the traditional knowledge, practices of the farmers and implementing what were good in them and also relevant in present times. Vermiculture was practiced by traditional and ancient farmers with enormous benefits accruing for them and their farmlands. Therefore, there is a need to revive this traditional concept through Moden scientific knowledge. A Vermiculture Revolution Sir Charles Darwin called the earthworms as farmers friends (Gupta et al.,2014). The earthworm population is about 8-10 times higher in uncultivated areas. This clearly indicates that earthworm population decrease with the soil degradation and thus can be used as a sensitive indicator of soil degradation (KP et al.,2004)

Vermicompost is the procedure of decomposition of organic waste with the help of earthworms for yielding a better end product called vermicast (Thakur et al.,2021). There are various of ways for vermicomposting method. This vermicomposting procedure is done by mesophilic process by using microorganisms and earthworms that are active at 10-32°C temperature which is produced within the pile of moist organic material (Tamanreet Kaur.,2020). Vermicomposting is a cheap and effective technology for processing or treatment of organic wastes in many countries. Many investigations have established the viability of using earthworms in treatment of agricultural wastes such as cattle dung, pig manure, crop residues (Hong-Dung Tran.,2016). There is different type of vermicomposting that depend upon the amount of production and composting layout. The small-scale vermicomposting is done for the personal necessity and the farmer can harvest 5-10 tonne annually, while large scale vermicomposting is done at commercial scale by recycling large quantity of organic waste with production of more than 50-100 tonne annually. Vermicomposting is done by several methods but methods are described under two types of system: -

- Types

1.Batch system: It simply involves the mixing of bedding and vegetable wastes together and also adding the worms, once all these mixing are done and then letting everything to sit without adding anymore material expect from water.

I.Static pile windrows: The piles of mixed bedding and feed which are layered on the top of the bedding, these are then diffuse with worms and, allowed to stand until the processing is completed. They are generally elongated in widower style but can also be square, rectangle or any other shapes depending upon person to person.

2.Continous flow system: The compost worms are provided with the organic material from the top and worm casting are harvested at bottom or it is removed from bottom tray and also the worm working in the top layer remain undisturbed

i.Top fed widower: They set up a continuous flow operation but they are not mixed, this means the bedding is placed first then diffused with worms and covered repeatedly with thin layer of food. The worms consume the food bedding and drop their casting near the bottom of the widower.

ii.Wedges: It is the modification of top fed widower where the initial stock ofworms in bedding is placed inside the coral type structure of not more than feet or 1m in height.

iii.Top fed bed: It work like top fed widower but its main difference is the beds, these beds are built with insulated sides or bales of straw can be used to insulate at winter.

3. Widower vermicomposting: These are the long rows of cow manure, it is typically stack with the manure in rows which measure up to 3ft high and 3ft wide, with a row which sometimes stretch up to more than 100ft long, in this the farmer seed the widowers with the worms and making certain to keep the rows moist. At the end fresh manure is add to the existing rows which draws the worms forward to keep the process moving.

4.Beds or Bins vermicomposting: Its one of the simplest forms in which it involves bin made up of plastic and non-aromatic woods, these bins are filled with paper, compost manure of animal and dead and decaying leaves which is then mix with soil to provide worm with material through which to burrow. This bedding also require water to stay moist through which the worm can breathe.

5.Stacked Bins: This addresses the issue of space by adding the vertical dimension to vermicomposting. the bin must be small enough to be lifted either by hand or with a forklift, when they are full of wet material. They are fed continuously, but involves handling them on regular basis.

6.Pit or trench: Pit and trench composting are similar process but the difference is the shape of the holes. In pits we can make any kind of holes and throw the waste inside it whereas in trench it is generally more organized and uses long and narrow ditches. The farmers generally go for pits by digging large holes to bury the worms and organic waste materials before adding the bedding and worms. They must line the pit to prevent worms from escaping into surrounding soil (Pilli et al.,2019)

S.NO	Nutrient	Content
1	Organic carbon	9.15 to 17.98%
2	Total nitrogen(N)	1.5 to 2.10%
3	Total phosphorus(P)	1.5 to 1.50%
4	Total potassium(K)	0.60%
5	Calcium (Ca)and Magnesium (Mg)	22.00 to 70.00 me / 100g
6	Available Sulphur(S)	128 to 548 ppm
7	Copper (Cu)	100 ppm
8	Iron (Fe)	1800 ppm
9	Zinc (Zn)	50 ppm

(Krishnamayee Sethi,2018)

- Earthworm selection

Earthworm population is about 8-10 times higher in inactivated area. This clearly indicates that earthworm population decrease with soil degradation and thus can be used as a sensitive indicator of soil degradation of soil degradation. Earthworm ingests organic wastes which include scrap papers, farm yard manure, crop residues, residues of food and leftovers. It was reported that earthworms act as mechanical blenders. Earthworm casting products (worm manure) are rich in plant growth regulator, microbial activity and secured with pest repellence attributes as well. The earthworms are vertebrates that belong to phylum Annelida and class oligochaete earthworms create tunnel in the soil by burrowing which aerate the soil to allow air, water and nutrient to reach deep with the soil (Thakur et al.,2021). They can eat the soil which was organic matter (decaying vegetation or leaves) as they cannot use organic matter directly after the organic matter is earthworm release waste from their bodies called casting. This casting contains all nutrient that the plant can use, there are almost 4,400 species of earthworms that have been recognize but only a few are used for vermicomposting (Thakur et al.,2021).

The interaction between earthworms and microorganisms takes place in three stages micro stage, meso stage, and macro stage. The macro stage interaction is not widely known due to which the importance was given to micro and meso stages of interactions. In micro stage the interaction food requirements for the earthworm are seen. In meso stage the interaction is done in such a way that the soil characteristics are guided by activity of earthworm (Sarat Ganti.,2018).

Vermicomposting has increased its popularity in both industrial and domestic settings as compared with conventional composting because it provides a way to treat organic wastes more quickly. In manure composting, it can generate products which have lower salinity levels. The earthworm species or composting worms most often used are red wigglers Eisenia fetida or Eisenia Andrei, though European nightcrawlers Eisenia hortensis, as well as Dendrobaena veneta and red earthworm Lumbricus rubellus could also be used. Red wigglers are recommended by most vermicomposting asthey have some of the best cravings and breed very rapidly (Sathiyavathi et al.,2023). Waste management is considered as an essential part of a sustainable society, thus the demandingdiversion of biodegradable sections of the societal waste from landfill into substitute management processes such as vermicomposting.Both vermicompost & its body liquid (vermicast) are proven as both growth promoters & protectors for crop plants. (Adhikary,2012)

Environmental degradation caused by human caused activities, such as overutilization of natural resources and pollution, is a major global issue. The continuous growth of the human population has led to an increase in waste generation, which significantly contributes in the environmental deprivation. In developing countries, the most common practice of waste processing and management includes: land-filling, incineration, unscientific dumping, vermicomposting. The vermicomposting aims to provide a wide-ranging reasonable valuation to different waste management strategies, including eco-friendly vermic-transformation technology, and critically appraise their effectiveness in achieving environmental sustainability (Hajam et al.,2023).

5.Stacked Bins: This addresses the issue of space by adding the vertical dimension to vermicomposting. the bin must be small enough to be lifted either by hand or with a forklift, when they are full of wet material. They are fed continuously, but involves handling them on regular basis.

6.Pit or trench: Pit and trench composting are similar process but the difference is the shape of the holes. In pits we can make any kind of holes and throw the waste inside it whereas in trench it is generally more organized and uses long and narrow ditches. The farmers generally go for pits by digging large holes to bury the worms and organic waste materials before adding the bedding and worms. They must line the pit to prevent worms from escaping into surrounding soil (Pilli et al.,2019)

S.NO	Nutrient	Content
1	Organic carbon	9.15 to 17.98%
2	Total nitrogen(N)	1.5 to 2.10%
3	Total phosphorus(P)	1.5 to 1.50%
4	Total potassium(K)	0.60%
5	Calcium (Ca)and Magnesium (Mg)	22.00 to 70.00 me / 100g
6	Available Sulphur(S)	128 to 548 ppm
7	Copper (Cu)	100 ppm

8	Iron (Fe)	1800 ppm
9	Zinc (Zn)	50 ppm

(Krishnamayee Sethi,2018)

- Earthworm selection

Earthworm population is about 8-10 times higher in inactivated area. This clearly indicates that earthworm population decrease with soil degradation and thus can be used as a sensitive indicator of soil degradation of soil degradation. Earthworm ingests organic wastes which include scrap papers, farm yard manure, crop residues, residues of food and leftovers. It was reported that earthworms act as mechanical blenders. Earthworm casting products (worm manure) are rich in plant growth regulator, microbial activity and secured with pest repellence attributes as well. The earthworms are vertebrates that belong to phylum Annelida and class oligochaete earthworms create tunnel in the soil by burrowing which aerate the soil to allow air, water and nutrient to reach deep with the soil (Thakur et al.,2021). They can eat the soil which was organic matter (decaying vegetation or leaves) as they cannot use organic matter directly after the organic matter is earthworm release waste from their bodies called casting. This casting contains all nutrient that the plant can use, there are almost 4,400 species of earthworms that have been recognize but only a few are used for vermicomposting (Thakur et al.,2021).

The interaction between earthworms and microorganisms takes place in three stages micro stage, meso stage, and macro stage. The macro stage interaction is not widely known due to which the importance was given to micro and mesostages of interactions. In micro stage the interaction food requirements for the earthworm are seen. In meso stage the interaction is done in such a way that the soil characteristics are guided by activity of earthworm (Sarat Ganti.,2018).

Vermicomposting has increased its popularity in both industrial and domestic settings as compared with conventional composting because it provides a way to treat organic wastes more quickly. In manure composting, it can generate products which have lower salinity levels. The earthworm species or composting worms most often used are red wigglers Eisenia fetida or Eisenia Andrei, though European nightcrawlers Eisenia hortensis, as well as Dendrobaena veneta and red earthworm Lumbricus rubellus could also be used. Red wigglers are recommended by most vermicomposting asthey have some of the best cravings and breed very rapidly (Sathiyavathi et al.,2023). Waste management is considered as an essential part of a sustainable society, thus the demandingdiversion of biodegradable sections of the societal waste from landfill into substitute management processes such as vermicomposting.Both vermicompost & its body liquid (vermicast) are proven as both growth promoters & protectors for crop plants. (Adhikary,2012)

Environmental degradation caused by human caused activities, such as overutilization of natural resources and pollution, is a major global issue. The continuous growth of the human population has led to an increase in waste generation, which significantly contributes in the environmental deprivation. In developing countries, the most common practice of waste processing and management includes: land-filling, incineration, unscientific dumping, vermicomposting. The vermicomposting aims to provide a wide-ranging reasonable valuation to different waste management strategies, including eco-friendly vermic-transformation technology, and critically appraise their effectiveness in achieving environmental sustainability (Hajam et al.,2023).

EARTHWORM

According to taxonomy, earthworms belong to the phylum annelida. They are long, slender,cylindrical, and Segmented and bilaterally symmetric soil-dwelling invertebrates with a smooth cuticular coating covering their sparkling, brownish bodies. After a month and a half, earthworms can weigh between 1400 and 1500 mg and are hermaphrodites in terms of reproduction.The composition of an earthworm's body is as follows: 65% protein, 14%fat, carbs, and 3% ash [Ahmad et al.,2021].Earthworm life cycle Varies in 3–7 years, depending on the environmental circumstances.

The earthworm's digestive system is a linear tube that begins in the mouth, travels through the pharynx, esophagus, thin-walled colon, gizzard, and digestive glands before ending in the anal cavity. Earthworm mucus contains symbiotic microbes, such as bacteria, protozoa, and microfungi, as well as amino acids, minerals, organic materials, polysaccharides, and proteins. An increase in the earthworm gut's moisture content and overall organic C:N ratio creates ideal conditions for bacterial germination. Endospore and waking up dormant microbes. Digestive enzymes such as amylase, protease, cellolase, chitinase, lipase, and urease have been identified from earthworm food canals [Ahmad et al ,2021].

Mannose and cellulose were discovered to be transported through bacteria' guts.Earthworms initiate the active vermicomposting stage by breaking down the raw material and increasing the surface area of microbial degradation substrates. When organic matter passes through the intestine, it mixes with digestive enzymes and bacteria connected to the intestine before being partially broken down and removed from the intestine as "casts." At that point, microbes begin to break the material down, contributing to the maturation stage [Ahmad et al.,2021].

Earthworms are classified as vertebrates in the class Oligochaeta and phylum Annelida. Earthworms get their name from the fact that they are nearly always terrestrial, burrow into rich, moist soil, and emerge at dusk to feed.Earthworms are soft-bodied, elongated, cylindrical, and thread-like creatures with homogeneous ring-like structures running the length of their bodies. Annuli, which are circular grooves that accentuate the outside of these bodies, are segments that are arranged in a linear series [Thakur et al.,2021].There are around 4,400 known species of earthworms worldwide. Nevertheless, very few of these earthworms are utilized for vermicomposting. Vermicomposting is a quicker method of composting than traditional methods [Thakur et al.,2021].

DIFFERENCE OF EARTHWORM TYPES

Mainly earth worms are two types:

(I)Borrowing

The burrowing type of earthworms are Pertima elongate and Pertima asiatica. The nonburrowing type of earthworms are Eisenia feitda and Eudriluseugenae. They live deep in the soil. They live in the upper layer of soil surface. There life span is for 15 years. There life span is for 28 months. They are pale in colour. The colour of these earthworms is red or purple. They are 20 to 30 cm long. They are 10 to 15 cm long. They convert organic waste into vermicompost slower than the non- burrowing earthworm.

(II)Non-Borrowing

The non- burrowing type of earthworms are Eisenia feitda and Eudriluseugenae. They live deep in the soil. They live in the upper layer of soil surface. There life span is for 15 years. There life span is for 28 months. They are pale in colour. The colour of these earthworms is red or purple. They are 20 to 30 cm long. They are 10 to 15 cm long. They convert organic waste into vermicompost slower than the non- burrowing earthworms. They convert organic waste into vermicompost faster than the Burrowing earthworms.

TYPES OF EARTHWORM

Earthworms can be classified into three groups according to the area of the environment that they primarily live in. Earthworms can be classified into three primary types: endogeic worms, which live below ground, anecic worms, who live below ground but explore above and below soil level to search food sources, and epigeic worms, commonly known as surface dwellers since they live above soil level.

In order to identify the many roles that these kinds of worms play in our environment, it's critical to recognize and comprehend the differences between them. For instance, an epigeic worm is probably a suitable choice for composting because it feeds extensively and excretes nutrients quickly, which aids in the compost's breakdown. Although a wellmeaning gardener may add compost-based worms to their garden soil in an attempt to improve the quality of the soil, these worms will be ineffective if added because they do not burrow and will not happily reside below soil level.

1. Epigeic earthworm

The word "epigenic" means "on the earth" in Greek because these worms live on the soil's surface among decomposing organic materials rather than digging tunnels. Theseearthworms are also known as compost earthworms or surface-dwelling earthworms sincethey reside on the soil's surface, amidst compost heaps and leaf piles. They consumedung, leaf litter, and decomposing plant materials as food. Since they are poor burrowers,they would rather reside in dirt and loose organic debris.

Because of their dark pigmentation, they may dwell above ground more safely by hiding among leaf heaps and topsoil. They are also somewhat shielded from UV radiation by their dark coloration. Since they live above ground and are therefore more vulnerable topredators, their ability to move more quickly than other worm species—thanks to theirpowerful muscles relative to their size—is crucial. These worms are crucial to thecomposting process because they swiftly eat and expel the debris, hastening its breakdown. Additionally, they may procreate quickly, which increases the worm populationin the compost. Their length typically ranges from less than an inch to seven inches,making them rather little.

2.Endogeic earthworm

Usually measuring between one and twelve inches, these worms are somewhat small. With weaker muscles than epigeic worms, they move more slowly and have a tendency to be exceedingly pale or translucent and colorless. As they consume the soil, they contribute to the aeration of the soil by blending minerals and oxygen.

3.Anecic earthworm

The word "anecic" means "out of the earth" because, despite their underground habitat, these worms emerge to the surface of the soil to feed. These worms dig permanent burrows down to a depth of six feet by tunneling vertically through the mineral layers of soil. They have extensive burrow systems that can reach a diameter of up to one inch. These worms gather organic debris, such as fallen leaves, from above ground and carry it back underground to their burrows. They've also been observed to consume some litter and dirt.These worms include nightcrawlers, fishing bait worms, and some of the most popular varieties of earthworms. They don't need to move swiftly, hence they have the weakest muscles and move the slowest of all the worm species. Though they are mostly found underground, local worms in particular frequently have a milky appearance and some coloring. They vary greatly in size, from one inch to an enormous sixty inches (University of Alberta).

EARTHWORM SPECIES

In North America, there are 182 species of earthworms recognized, while there are 27 species in the United Kingdom. More than thirty percent of the earthworms found in North America are introduced. This indicates that they are non-native species that have entered the continent, mainly through the sale of worms used as fishing bait or the import and export of plants. Since non-native worms can grow invasive and jeopardize the equilibrium of natural ecosystems, their

introduction is truly a major problem. On the other hand, native worms are highly beneficial to our environment and have many advantages for our plants and soil.

1.Readhead earthworm
Scientific name : Lumbricusrubellus
Family : Lumbricidae
Although it originated in Western Europe, this worm has spread throughout North and South America, where it is now considered an invasive species. Ecosystems are suffering greatly as a result of its ravenous eating habits, particularly in regions where native earthworms are absent. The existence of these worms has a domino effect that puts some plant species and microbial ecosystems in danger. In certain regions of Europe, where it first appeared, it is also starting to cause issues. It is most prevalent in coniferous forests and is known to reside in the top soil layers or among heaps of decomposing leaves.

2.Common earthworm
Scientific name : Lumbricusterresrtris
Family : Lumbricidae
This species of earthworm, also called the "lob worm" or "dew worm," is endemic to Western Europe, but it has spread throughout North and South America, Asia, Africa, and Oceania due to the transportation of plants and worms for fish bait. It is an invasive species that consumes the top layers of soil as well as leaf piles that are present on the soil's surface. Their powerful muscles allow them to move fast in the face of foxes, shrews, and birds, among other known predators. They have a reddish-brown color and are darker at one end. They are most frequently observed in wet weather, and in dry seasons, they may burrow in the top soil layers to escape the heat and the elements.

3.Green worm
Scientific name : Allolobophorachlorotica
Family : Lumbricidae
Making up 34% of all identified earthworms, this endogeic worm is the most prevalent kind discovered in the United Kingdom. Some of these worms have bilin pigment, which gives them their green hue, hence the common term "green worm." It is more likely that you will come across a green worm that is actually pink, though, as the majority of these worm mspecies are pink variants. Grasslands are more likely to have the genuinely green varieties, though experts are not sure why this difference occurs. In addition to having a slightly yellow-colored ring around the top end, the pink morphs may have three suckers-like discs visible if you examine the underside of the saddle attentively.

4.European Nightcrawler
Scientific Name: Eisenia hortensis
Family: Lumbricidae
Although it is most usually employed as a worm for fishing bait, this worm is also known as the "Greenhouse worm" or the "Compost worm" because of its growing popularity as a tool in the composting industry. The worm becomes more blue-gray in color when it has fed, but it becomes pinkish when it hasn't. Their tails are paler than the rest of them, and they feature numerous stripes and heavy banding. Compost, manure, bark, decomposing leaf or other organic garden matter piles, and other moist or damp places are frequent habitats for these worms.

5.Brandling worm
Scientific name : Eisenia fetida
Family : Lumbricidae
Seldom can one find these surface-dwelling epigean worms in soil strata. They eat and live on compost, manure, and decomposing plants. The brandling worm's ability to move swiftly, like other epigean worms, helps protect it from predators. Each segment features bristle-like structures that resemble hairs that can stick to surfaces to assist move the worm forward or backward and increase its mobility.The foul-smelling fluids that the worm releases when it is handled are referred to as "fetida". The translation literally means "foul-smelling." Predators are thought to be deterred by doing this.This worm is also often known as the "Tiger worm" or the "Trout worm." It is native to Europe, although it has been brought to every continent except Antarctica.

6.Giant Gippsland Earthworm
Scientific Name: Megascolides australis
Family: Megascolecidae
With an average length of thirty to forty inches, this worm, which is endemic to Australia, is one of the largest in the world. The worm's hue is pink-gray on the back half, and dark purple on the front, including the head. It is usually found in moist deep soils, including those beside streams and riverbanks. They can burrow down to a depth of five feet in the soil, but they often dig intricate tunnels two feet or less.
They consume organic stuff found in the soil, such as roots, but they will occasionally poke their heads above the surface in quest of additional food. It is well recognized that the population of this worm is in decline, and that soil cultivation and contemporary farming methods are to blame. The worm's slow growth and poor reproduction rate make it even more difficult for it to reproduce and increase in population.

7.Kentucky Earthworm
Scientific Name: Komarekionaeatoni
Family: Komarekionidae
There are no other worm species in the Komarekionidae family except this one. It is found in Pennsylvania, North Carolina, Tennessee, Indiana, and Illinois. It is indigenous to the United States. Because of its widely scattered range and the deteriorating state of its natural habitat, it is regarded as a vulnerable species. Both soil disturbance and the introduction of other exotic worms pose a threat to it.

8.Oregon Giant Earthworm
Scientific Name: Driloleirusmacelfreshi
Family: Megascolecidae
This rare species of worm is one of the largest in North America, growing to an average length of almost three feet. Since it was first discovered in 1903 near Salem, only fifteen locations in Oregon have reported seeing this worm. The most recent recorded observation of this worm occurred in 2008. The term "lily-like worm" used to describe members of the genus Driloleirus relates to the perfume that the worm is meant to emit when it is handled and is fragrant like flowers.
It has been noted that they can dig down to a depth of fifteen feet. Although they love moist, organic soil and spend most of their time below, they will occasionally emerge during periods of intense rain. These worms live mostly in the soil under forests, and it's thought that the acidic soil that fir trees need to flourish is suitable for them to live in.

9.Louisiana Mud Worm
Scientific Name: Lutodrilusmultivesiculatus Family: Lutodrilidae
Within the family Lutodrilidae, there is only one species of worm. Living in mudflats and swamps in its native Louisiana, it is semiaquatic. This worm is only found in its native state and its range is quite restricted. It is regarded as an uncommon species.

10. Washington Giant Earthworm
Scientific Name: Driloleirus americanus
Family: Megascolecidae
This unusual worm was initially seen in the vicinity of Washington in 1897, but by the 1980s,
no sightings of the species had been reported, leading to the belief that it had gone extinct. Though environmental organizations have petitioned for the worm to be recognized as an endangered species, two specimens were found in 2010, and as a result, the worm is currently regarded as having vulnerable conservation status.
In order to avoid drought, the worm is reported to dig down to a depth of about fifteen feet, reaching its lowest point in the summer. Although it is believed that this worm can reach a length of more than three feet, recent discoveries of the worm have revealed that they are only around half of this predicted length. It can seem translucent, pale pink, or white because it lacks pigmentation.

11. Gray Worm
Scientific Name: Aporrectodeacalignosa
Family: Lumbricidae
This worm is frequently seen in the UK, where it digs non-permanent tunnels in the upper soil layers. Its characteristic hue helps to identify it; it is usually two to three inches long. The worm has three bands at the front that are colored brown, gray, and pink.

12. African Nightcrawler
Scientific Name: Eudriluseugeniae
Family: Eudrilidae
This worm, which is native to West Africa, has spread to tropical and warm regions with constant temperatures ranging from 75 to 85 °F. This worm's shiny sheen and overall dark purple color make it easy to identify. It tapers to a very small tip at the back. This specific worm is highly recognized for its remarkable ability to accelerate the deterioration of organic materials.

13. Composting Worm
Scientific Name: Perionyx excavatus
Family: Megascolecidae
It is believed that the Himalayan highlands are the birthplace of this tropical worm. These days, this worm is mass-produced commercially for composting purposes. It has acquired appeal in the North American market recently as home composting has grown more and more popular. It is well recognized for its capacity to quickly create worm castings, which are helpful in the speedy decomposition of compost. It grows best in damp environments.

Material and methodology

Collection of material

The partially decomposed material was mixed with cow dungin three different ratios. The experiment was conducted inthe bed of size (length 6, width 2 and height 2) ft. The bedwas filled with Banana plant stem, cow dung, and vegetablewaste according to the different treatments. Healthy, juvenileearthworms of Eisenia Fetida were released in the bed at therate 40.

Earthworms

Many varieties of earthworms are utilized in carbon-basedcomposting; however, Eisenia fetida worms are the mostcommonly used worms for vermicomposting because to theirhigh conversion rate, which occurs in approximately 55–60days. Effective epigamic species, like E. fetida, were tested fortheir composting efficiency with native earthworm species,including Perionyx sansibaricus, Pontoscolexcorethrurus, andMegascolexchinensis. The efficiency was evaluated in relationto the vermicomposting time, compost quality, and earthwormbiomass potential at compost maturity. Eisenia Fetida is used inthis research, and it has a high conversion rate.

Cow Dung

Many animal and mildew species can find food in cow dung,which they pause and recycle into the soil and the nutrition chain. Pests like flies and scrounging worms can infiltrateplaces where cows—or other animals with parallel faces—arenot local since their excrement is often not broken down by native organisms. In Australia, foreign slurry beetles havebeen introduced to aid in the soil's reprocessing of cattlemanure. In general, cattle don't like to eat near theirexcrement. This may lead to the creation of larger uncovered areas of highly fertilized soil. These environmental updates, known as "islets", can be helpful for many parkland arthropods, counting spiders (Araneae) and microbes (Hemiptera). They have a significant function in continuing biodiversity in heavily utilized grasslands. Banana Plant Waste. A valuable crop for food production, bananas are widely grown in humid countries and are considered one of the most important fruit crops in the world. Because it recycles agricultural waste, its massive by-products provide an excellentbasis of highly valuable raw materials for other businesses. By doing this, a significant amount of untapped biomass and environmental issues are prevented from being lost. This analysis covers the use of banana by-products, including peels, leaves, pseudo stems, stalks, and inflorescence, in a wide range of food and non-food applications. These include serving as coagulating agents, skin colour and Flavors enhancers, additional sources of function and micronutrients, nutraceuticals, cattle feed, sources of normal fibres, and recognized sources of bioactive compounds and biofertilizers. The important primary elements discussed in reference to the future prospects and testing are the important components thatwere discussed in relation to the sustainability and potential use of these byproducts. In order to sustain this renewable resource and give small-scale agricultural companies another source of income without compromising its quality or care in the face of competition from other commercial crops, it is crucial that all accessible by-products be transformed into extremely profitable outputs. In the early days of human farming, one of the first crops grown was the banana. In addition to being employed in many ceremonial contexts, banana byproducts have continued to be used to wrap meals, clothing, and other items, thereby extending cultural diversity.

Bananas are typically produced alongside a number of other crops, including rice, sugarcane, pineapple, mangoes, oil palm, and bananas, as part of modern agriculture's fruit crop or cash crop production

Vegetable Waste

Waste from the vegetable supply chain varies significantly depending on how it is processed. Worldwide, more than 30% of the waste comes from the retail and consumer level, of which the wastages at the processing and post-harvest levels account for the majority. The waste generated poses a threat to the environment and calls for a pollution free model. Research on the characterization of unused, rotten and discarded fractions indicates their potential for reuse.

Generating renewable energy by bioconverting potato wastes is of paramount importance as it has been proven to be a viable method for the application of fresh vegetable residues. Scientists and industry are now fully involved in a number of projects, including the technology.

CONCLUSION

- Comparing vermicomposting to composting, there is a benefit. Usually, this is because the ‘humus’ component of vermicompost is expelled by earthworms, and in a traditional composting system, the gradual decaying of organic matter takes a very long time to generate humus. In my view, vermicomposting organic waste will be a great help in addressing the issue of trash disposal. The method of recycling plant nutrients lowers the amount of inorganic fertilizers used. African earthworm species are superior to Indian earthworm species in this regard. Vermicomposting is a practical, efficient, eco-friendly, and fruitful method. The grape marc can be readily expanded to generate a wide range of beneficial compounds for industrial uses. It’s critical to coordinate this manufacturing with appropriate use and industrial application.

- Due to its origin, affordability, ease of use, consistency, dependability, repeatability, and environmental friendliness, vermiwash has found potential uses in the stainable development of agricultural biotechnology. Application of vermicompost in the field improves soil quality by boosting microbial biomass and activity, which are essential for nutrient cycling, the synthesis of plant growth regulators, and defense against insect-pest and soil-borne illnesses. For

farmers, the government runs a program called the “Cent Vermicompost Scheme.” The plan aims to assist farmers with the establishment and operation of their vermicompost operations as well as with their working capital and investment needs [Thakur et al.,2021].

- This study describes vermicomposting as the process of turning garbage into black gold, which contains enzymes including urease, cellulase, protease, Macro and micronutrients such nitrogen (N), phosphorus (P), potassium (K), iron (Fe), zinc (Zn), sulfur (S), growth regulators and promoters, chitinase, lipase, and amylase [Ahmad et al.,2022].

- Vermicompost usually has a greater overall nutritional profile than regular compost. The use of vermicompost in soil enhances a number of factors, including microbial activity, carbon microbial biomass, nutritional status, potential for cationexchange,structure, and aggregation. Thus supporting soil health and encouraging plant growth. This input has therefore been shown to benefit farmers. When you sow vermicompost, make sure you deeply till the soil to fully benefit from it. The price of the expensive chemical fertilizer .It is possible to minimize input by using vermicompost in crops [Ali Ahmed et al.,2021].

- Earthworm biomass and vermicompost are produced by the biological process of vermi composting, which is the interaction of earthworms with microorganisms. In this work the paper includes a detailed investigation into all the requirements needed for vermicomposting, including the type of earthworms needed, their selection criteria, and the necessary number of worms, as well as design considerations involving the necessary pit surface area. The foundation for the vermicomposting process is presented in this study. [Ganti S et al.,2018].

- Vermicomposting is an alternate waste management technique that yields vermicompost with a higher nutrient content than manures and compost. Thus, it can be used to replace chemical fertilizers in order to lessen the harmful effects of chemicals on crops and people.

It is possible to increase crop output by using vermicompost alone or in conjunction with fertilizers. It is the best way to address the current issue of decreasing soil fertility and for food production. It is also the most effective way to prevent pollution, soil degradation, and the inappropriate use of chemical fertilizers. Natural fertilizers are what nature intended they should be. It enhances the physical properties of the soil, meaning that plant roots receive better aeration, water drainage, cation exchange facilitation, and sustained nutrient availability, all of which lead to improved plant absorption and growth.

- When compared to inorganic fertilizers, the use of vermicompost provides significant advantages for the environment, productivity, and crop quality. Farmers must be made aware of the benefits of vermicomposting and its use, as it may be a better option [Pilli et al.,2019].

- Based on the current review, it can be stated that earthworms and microorganisms efficiently recycle organic waste, which is important for agricultural crop development and productivity. Compost material has a high nutritional value, and the process of composting efficiently turns waste products into beneficial byproducts [P Saranraj et al.,2012].

- High respiration index and maturity rate are important indicators of the quality of the manure, and they are both present in the product that is generated. An important goal of vermicomposting is the removal of microorganisms that cause disease from organic waste. There are 120 identified dangerous germs and viruses in organic waste, according to research. By 75%, the disease-causing organisms are reduced by the compost. Plant growth exhibits a corresponding improvement in soil productivity that results from the application of VC. The study also suggests utilizing VC at an optimal rate to maximize cost efficiency based on the type of crops planted and their nutritional requirements. In general, VC supports organic farming [Yadav et al.,2023].

DISCUSSION

Vermicomposting is a biological process which involves the interaction between earthworms and microorganisms leading to the formation of earthworm biomass and compost. The important goal of vermicompost is the reduction disease causing pathogen in the organic waste [Ganti S et al.,2018]. Vermicomposting is rich in macronutrients and micronutrients, vitamins, growth, hormones, enzymes such as amylase, lipases, cellulose and immobilize microflora. It can increase the production of crops and prevent them from harmful pests without polluting the environment [Margit Olle et al.,2019]. Vermicompost is produce with high nutrient content than compost and manures. So, it can be used to shift from chemical fertilizers to reduce hazardous effect of chemicals to both crop and human being. The use of vermicomposting constitutes an important alternative source of fertilizer that has environmental benefits [Pilli et al.,2019]. Vermicompost is an eco-friendly and sustainable method for waste management that involves the conversion of organic waste into vermicompost. Compared to traditional composting and manure production, vermicomposting yields. It has relatively high nutrient content.Numerous organic material have been evaluated for growth and reproduction of earthworms as these materials directly affect the efficiency of vermicompost.Vermicomposting is a productive, easy, environmental-friendly and viable method. It can be easily expand a variety of useful products. It is important to parallel to suitable this production with suitable utilization and industrialization application. In sustainable

development in agriculture biotechnology, the quality of soil enhances with the application of vermicomposting the field by increasing microbial activity and microbial mass that are key components in nutrient cyclins, production of plant growth regulators, and protecting plants from soil-borne diseases and insect-pest attacks [Thakur et al.,2021]. Vermicompost is consider as promising alternative to harmful chemical fertilizers and pesticide in crop production. It is popular as a major component of organic agriculture to produce healthier foods and better option for management of organic solid wastes. The earthworm microbe interactions provide bright future of vermicompost use in organic farming systems [Dhruva P et al.,2017]. Vermicompost contents higher nutrients that feeding material to the earthworm. It is a natural source of organic fertilizer that contains huge numbers of various kind of plant beneficial microorganisms and enzymes other important biochemical substances[Varsha Kumari et al.,2020]. During vermicomposting, the interactions between earthworms and microorganisms modify the biochemical and physical properties of organic waste. Microorganisms and earthworms interact at various levels to digest the organic waste and convert it to useful manure [Vyas et al.,2022].

Acknowledgement – All the authors have contributed equally

REFERENCES

[1]. Vermicomposting of spent mushroom compost using perionyxexkavatus and artificial nutrient compound: International Journal of Environmental & Agriculture Research (IJOEAR) : Free download, borrow, and streaming : Internet Archive. (2016b, June 30). Internet Archive. https://archive.org/details/ IJOEARJUN201610.
[2]. Kaur, T. (2020). Vermicomposting: An Effective Option for Recycling Organic Wastes. IntechOpen. doi: 10.5772/intechopen.91892 .
[3]. Anjana Thakur, Adesh Kumar, Chava Vinay Kumar, Basava Shiva Kiran, Sushant Kumar, Varun (2021). A review on vermicomposting: By-products and its importance.Plant. Cell Biotechnol,Mol. Biol 22, 156-164.
[4]. Nagavallemma KP, Wani SP, Stephane Lacroix, Padmaja VV, Vineela C, Babu Rao M and
[5]. Sahrawat KL. 2004. Vermicomposting: Recycling wastes into valuable organic fertilizer. Global Theme on Agrecosystems Report no. 8. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. Shruti Gupta, Tanuja Kushwah and Shweta Yadav.(2014).Role of Earthworms in promoting Sustainable Agriculture in India,Int.J.Curr.Microbiol.App.Sci 3(7) .449-46.
[6]. Krishna Sethi,(2018, October 5). [Slide show]. SlideShare. https://www.slideshare.net/krishnaSethi1/ vermicomposting-118274903 .
[7]. Hajam, Y. A., Kumar, R., & Kumar, A. (2023). Environmental waste management strategies and vermi transformation for sustainable development. Environmental Challenges, 13, 100747, https://doi.org/10.1016/j.envc.2023.100747.
[8]. Adhikary, S. (2012). Vermicompost, the story of organic gold: A review. Agricultural Sciences, 03(07), 905–917. https://doi.org/10.4236/as.2012.37110.
[9]. S.Sathiyavathi1, S.Thamarai Selvi S ,Study of Vermicomposting with Coirpith, Eggshell,Vegetable Waste and Onion Peel,International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160.
[10]. Kiran pilli,Durgam Sridhar .2019 ,Vermicomposting and its uses in Sustainable Agriculture,Research Trends in Agriculture Sciences (pp.73-88)
[11]. Gajalakshmi, S., Ramasamy, E., & Abbasi, S. (2002).Vermicomposting of paper waste with the anecic earthworm Lampitomauritii Kinberg, Indian Journal of Chemical Technology, 9, 306-311.
[12]. Khan, M. A., & Tripathi, K. N. (2020). Vermicomposting with cow dung, banana plant, and vegetable waste. International Research Journal of Engineering and Technology (IRJET), 7(6).
[13]. Ahmad, A. H., Aslam, Z., Bellitürk, K., Iqbal, N., Idrees, M., Nawaz, M., Nawaz, M., Munir, M., Kamal, A., Ullah, E., Jamil, M. A., Akram, Y., Abbas, T., & Aziz, M. M. (2021). Earth Worms and Vermicomposting: A review on the story of Black Gold. Journal of Innovative Sciences, 7(1). https://doi.org/10.17582/journal.jis/2021/7.1.167.173.
[14]. Ahmad, A., Aslam, Z., Bellitürk, K., Ullah, E., Raza, A., & Asif, M. (2022). Vermicomposting by biorecycling of animal and plant waste: A review on the miracle of nature. Journal of Innovative Science. Retrieved from https://www.researchgate.net/publication/364351027/Vermicomposting.
[15]. Ahmad, A., Aslam, Z., Bellitürk, K., Iqbal, N., Naeem, S., Idrees, M., Kaleem, Z.,Nawaz, M. Y.,Nawaz, M., Sajjad, M., Rehman, W. U., Ramzan, H. N., Waqas, M.,Akram, Y., Jamal, M. A., Ibrahim, M. U., Baig, H. A. T., & Kamal, A. (2021).Vermicomposting Methods from Different Wastes: An Environment Friendly,Economically Viable and Socially Acceptable Approach for Crop Nutrition: AReview. International Journal of Food Science and Agriculture, 5(1), 58-68. Retrieved from http://www.hillpublisher.com/journals/jsfa.
[16]. Ganti, S. (2018). Vermicomposting. University of Petroleum and Energy Studies,Andhra Pradesh, India. International Journal of Waste Resources, 8(2). DOI:10.4172/2252-5211.1000342.
[17]. Pilli, K., & Sridhar, D. (n.d.). Vermicomposting and its uses in sustainable agriculture.Retrieved from https://www.researchgate.net/publication/335378138.
[18]. Saranraj, P., & Stella, D. (2012). Vermicomposting and its importance in improvement of soil nutrients and agricultural crop. Novus Natural Science Research, 1(1).
[19]. Yadava, V., Rajput, A., & Mishra, B. K. (2023). Review of Recent Developments in Vermicomposting for Agriculture and Environment Applications. DizhenDizhi Journal, 15(3), 214.

[20]. Olle, M. (2019). Review: Vermicompost, its importance and benefit in agriculture. Agraarteadus Journal of Agricultural Science, 2(X), 93-98.
[21]. Vyas, P., Sharma, S., & Gupta, J. (2022). Vermicomposting with microbial amendment:
[22]. implications for bioremediation of industrial and agricultural waste. BioTechnologia, 103(2), 203-215. https://doi.org/10.5114/bta.2022.116213.
[23]. Chaulagain, A., Dhurva, P., &Gauchan, J. L. (2017, July). Vermicompost and its role in plant growth promotion. International Journal of Research, 4(8). Retrieved from https:// edupediapublications.org/journals.