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Effects of Physico Chemical Parameters on Biomass Produced by Using Earthworm Eudrilus Eugeniae

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ABSTRACT: Earthworms are a kind of segmented, nocturnal, terrestrial invertebrates that are widespread around the globe. They belong to the subphylum Oligochaeta of the Phylum Annelida. Earthworms are important to the breakdown of different types of wastes and the improvement of the soil's nutrient content. Earthworms are raised on artificial vermicomposting beds using a green method called vermiculture, also known as vermitechnology. Vermicomposting is a technique for creating nutrient-rich compost made by earthworms and microorganism activity. It is one of the simplest ways to recycle household wastes, garden wastes, animal wastes, agricultural wastes, and more to create high-quality, enriched compost. In this paper, extensive research is conducted on the various influencing factors for a vermicomposting unit, followed by the design of a vermicomposting pit and the number of earthworms required for the amount of waste obtained. This is followed by the selection of an optimal range for parameters such as temperature, potential hydrogen, moisture content, and natural enemies. The research was limited to growing the epigamic earthworm *Eudrilus eugeniae* with cow dung, curd, and country sugar. Crop production and plant growth are aided by vermicompost.

KEYWORDS: Bio-mass, Cow Dung, Earthworms, Eudrilus eugeniae, Plant Growth and Crop Production, Rearing, Soil Quality

INTRODUCTION

Earthworms are hermaphrodite, nocturnal, segmented invertebrate animals that are fairly universally distributed and distinguished by the presence of body setae. They are also cylindrical, coelomate, and hermaphrodite. Earthworms are well suited for their terrestrial and burrowing lifestyle. They like moist soil that is rich in dead organic matter to live in, and they are more prevalent in irrigated farmlands that are close to ponds, pools, rivers, and gardens. In 67 genera and 10 families on the Indian subcontinent, there are 509 species of earthworms (Julka, 1993). Earthworms come in more than 4400 different species, all of which may be distinguished from one another by their special physical and behavioural traits. Bouche has categorised earthworms into three classes based on their physical makeup and ecological tactics (1997).

They are epigeic, endogeic and anecic species characterized by the region of the natural soil environment in which they are found and, to some extent, by the needs and behaviors of the environment. Geobionts, which are also known as farmer's friends because they improve soil quality, water holding capacity, moisture content, and nutrient content by burrowing into the ground, are organisms that depend entirely on soil for all of their activities. Most animals prefer to reside in burrows and emerge at night in order to protect themselves from predators and desiccation.

Earthworms directly breathe oxygen via their skin and they live in damp, dark, and muddy environments. With their diet, the soil particles are ingested, aiding in the mechanical digestion process. It functions as a breathing organ and has a wet surface through which gas exchanges occur. They typically reside in the top few centimeters of the soil, in lawns and gardens, and in vertical burrows that are constructed with the aid of skin gland secretions up to a depth of 45 cm. They emerge at night from their burrows, which are primarily constructed for protection from predators and unfavorable weather conditions. They avoid poor soils like those that are highly clayey, sandy, dry, and acidic soils with a lack of organic material.

The potential of earthworms in soil processing has been realised due to their burrowing nature and composting of organic matter, and simple appropriate vermiculture biotechnology has been developed, which may solve waste processing and management problems to a large extent. Many countries' economies rely heavily on the paper mill and sugar cane industries, as well as animal and domestic waste. These industries produce a large amount of solid waste. Typically, these wastes are incinerated or disposed of in landfills. These disposal methods cause nutrient loss in the soil and environmental issues.

Vermicompost can be produced by using earthworms to break down a variety of organic residues, including sewage sludge, animal waste, crop residues, and industrial waste. This method has been advocated by Hartenstein and Bisesi (1988), Van Gestel et al. (1992), and Dominguez and Edwards (1997).

Several workers have emphasised the significance of earthworms in waste management, environmental preservation, organic farming, and sustainable agriculture (Senapati, 1992; Bhawalkar, 1993; Ghatnekar et al., 1998; Talashikar and Powar, 199).

They consume organic matter such as cell waste, dead leaf litter, and other. Despite not having any unique sensory organs, they are responsive to a variety of stimuli. They stay out of the sunlight and spend the summer months dwelling underground. Sometimes, if given the opportunity, they will encounter mechanical vibrations like throbbing, irritability, or pain brought on by their opponents, which will prompt them to immediately rise to the surface.

Numerous earthworms may be seen crawling on the ground while searching for food or oxygen during periods of heavy rain and while farmland is being tilled. The old belief that the worms had "rained down" was based on this; however, following a particularly heavy downpour, many earthworms come to the surface and perish. They are preyed upon by numerous bird species, frogs, badgers, shrews, and moles in particular. This is visible in the vermin beds, especially while vermicomposting.

Chemical fertilizers are used extensively in agriculture today to produce crops, which lowers the quality of the soil and has long-term effects on the food chain. Vermicompost use, as opposed to artificial fertilizers, has been found to improve soil productivity and quality by many researches. Vermicompost amendment has been proven to greatly increase crop productivity, according to many researches. According to Kashem et al. (2015), vermicompost has a greater impact on tomato yield than inorganic fertilizers' due to its higher tomato yield.

Crops grown on soils that have been treated with vermicompost are also found to have more nutrients than crops grown on unamended soils. Tomatoes grown under substrate treated with vermicompost, according to Gutiérrez et al. (2007), were better suited for juice. In order to manage organic solid waste, produce organic fertilizer, and reduce the use of chemical fertilizers, vermicomposting has become a viable technology. To preserve soil quality, it is occasionally combined with chemical fertilizers. The purpose of this study article is to address the production of vermicompost, as well as its effectiveness in promoting plant development and improving soil quality.

Earthworms consume decomposed biomass and excrete it as worm castings, which are digested remnants. Worm casts are often referred to as "Black gold." The castings are abundant in nutrients, chemicals that encourage plant growth, beneficial soil microflora and fauna, and they have the ability to hinder pathogenic bacteria. Vermicompost is a stable, fine-grained organic bio-manure that enhances the physicochemical and biological characteristics of the soil. It is very beneficial for growing crops and for nurturing seedlings. Growing in popularity as a key element of an organic farming system is vermicompost.

Vermicomposting can meet the criteria for items that were cultivated organically. The most popular and effective organic bio-fertilizer made by earthworms in nature is called vermicompost. In this work, we focused on *Eudrilus eugeniae* earthworm species and solely cultivated them in vermin beds. We carefully examined all the parameters and produced vermicompost.

MATERIALS AND METHODS

Collection of Raw Material for Vermicomposting

One and a half tones of fresh and 15-day-old cow dung were collected from a dairy farm in Tamil Nadu's Chengalpattu district. The moisture content of the medium was kept between 60% and 80%, and 3kg of curd and 3kg of country sugar were purchased from a store, as well as plantain leaves. The collected cow dung, agricultural waste, and kitchen waste were dried over on a polythene sheet for a few days before being used in the bed.

Collection of Earthworms

The epigeic earthworms (*Eudrilus eugeniae*) were obtained from the S.K vermicomposting farm located in Sriperumpathur village of Chengalpattu district, Tamil Nadu. Fully matured clitellate worms were taken from this stock culture for experimentation, and the different sizes of matured and immature worms were measured and weighed in the lab using a measuring scale and weighing machine before using for experimental studies.

Experimental Beds

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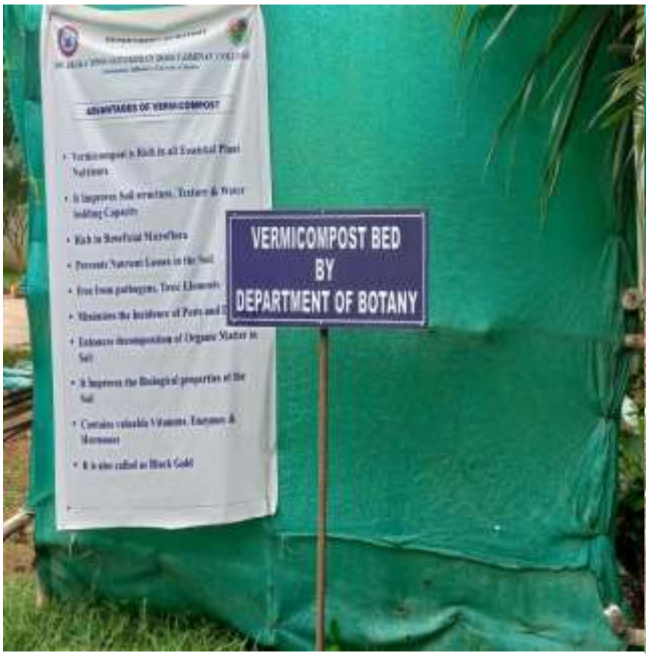
Three separate vermibeds measuring 3/½ Feet width x 7 Feet length was made in the Garden of Dwaraka Doss Vaishanv College in Arumbakkam, Chennai, Tamil Nadu. The Plantain leaves were evenly spread across the base of each of these beds. All the three beds was filled with layer of fifteen days old fresh cow dung, agro and kitchen wastes for mass culture of *Eudrilus eugeniae*. Throughout the study, the culture was constantly monitored, and the beds were watered twice a day. The pH, humidity, temperature and entry and exit of enemies were also checked on a regular basis. In the current study, experiments were carried out in continuously.

Bed-I was filled with a mixture of 500 kg of dried, fresh cow dung and one litre country sugar solution mixed one litre of curd was spread over the bed, and Bed-II was filled with a mixture of 250 kg of fresh and dried cow dung mixed with 250 kg of kitchen wastes and one litre of country sugar solution added with one litre of curd was spread over the bed and Bed-III was filled with a mixture of 250 kg of fresh and dried cow dung and 250 kg of agro waste and one litre of country sugar solution mixed with one litre of curd spread over the bed, and various sizes of clitellate worms were uniformly released on top of each beds, and it was daily sprinkled with water to decompose the wastes.

After twenty days, the waste was turned up and down to ensure proper aeration and decomposition, and curd and sugar solution were added to the bed to aid in their growth, development, reproduction, and decomposition. This experiment lasted 55 days for bed-I and 65 days for both beds-II and III.

The cemented vermibeds were covered with mesh garden hemp cloth because the hemp mesh cloth would be eaten by worms, and they were observed daily to check the various parameters required for earthworm survival and reproduction. This entire setup was kept running for 55 to 65 days until worms produced soft, finely granular vermicompost. To avoid direct sunlight, heavy rain, and predator danger, the experiments were conducted in the months of June, July, and August of 2021.



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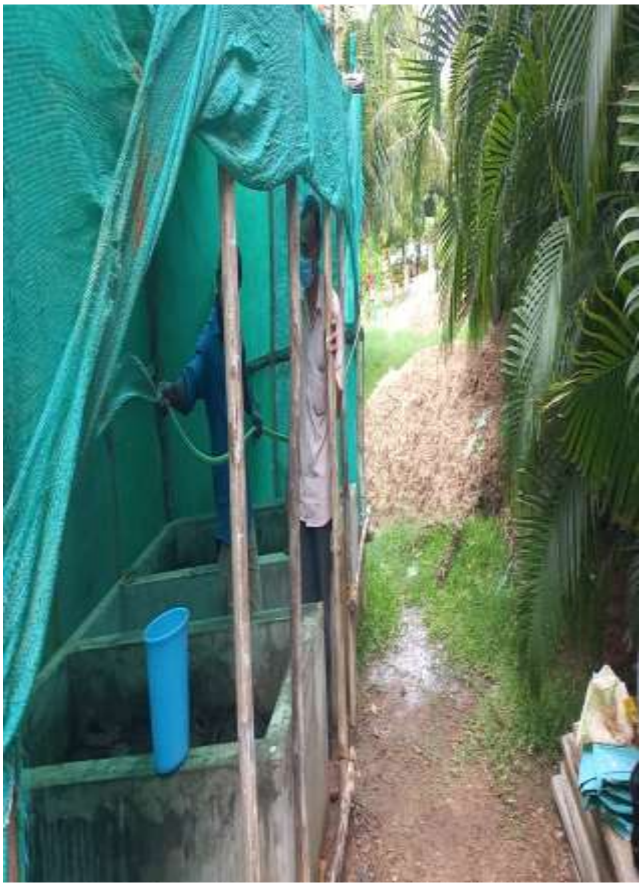

Sprinkling of curd with country sugar solution **watering the Vermicomposting Beds**

During the composting process, the compost materials were tested for physicochemical parameters such as pH, humidity, total Nitrogen, available Phosphorus, exchangeable potassium, heavy metals such as lead, cadmium, copper, and others (Piper, 1996; Jackson, 1973; Ishwaran and Marwaha, 1980), as well as earthworm number, cocoon production, and organic substrate weight loss (Tripathi, and Bharadwaj, 2004; Wantanabe and Tsukamato 1976).

During the course of investigation, the samples were examined at periodic intervals of 30, 45 and 60 days of vermicomposting.

Natural Enemies of Earthworms

Compost worms are not susceptible to microorganism-caused diseases, but they are preyed on by certain animals and insects. Some animals and insects have also been observed frequently visiting the vermin bed for prey during vermicomposting. During the observation, calotes were frequently seen visiting the composting bed, followed by frogs, centipedes, and mites.

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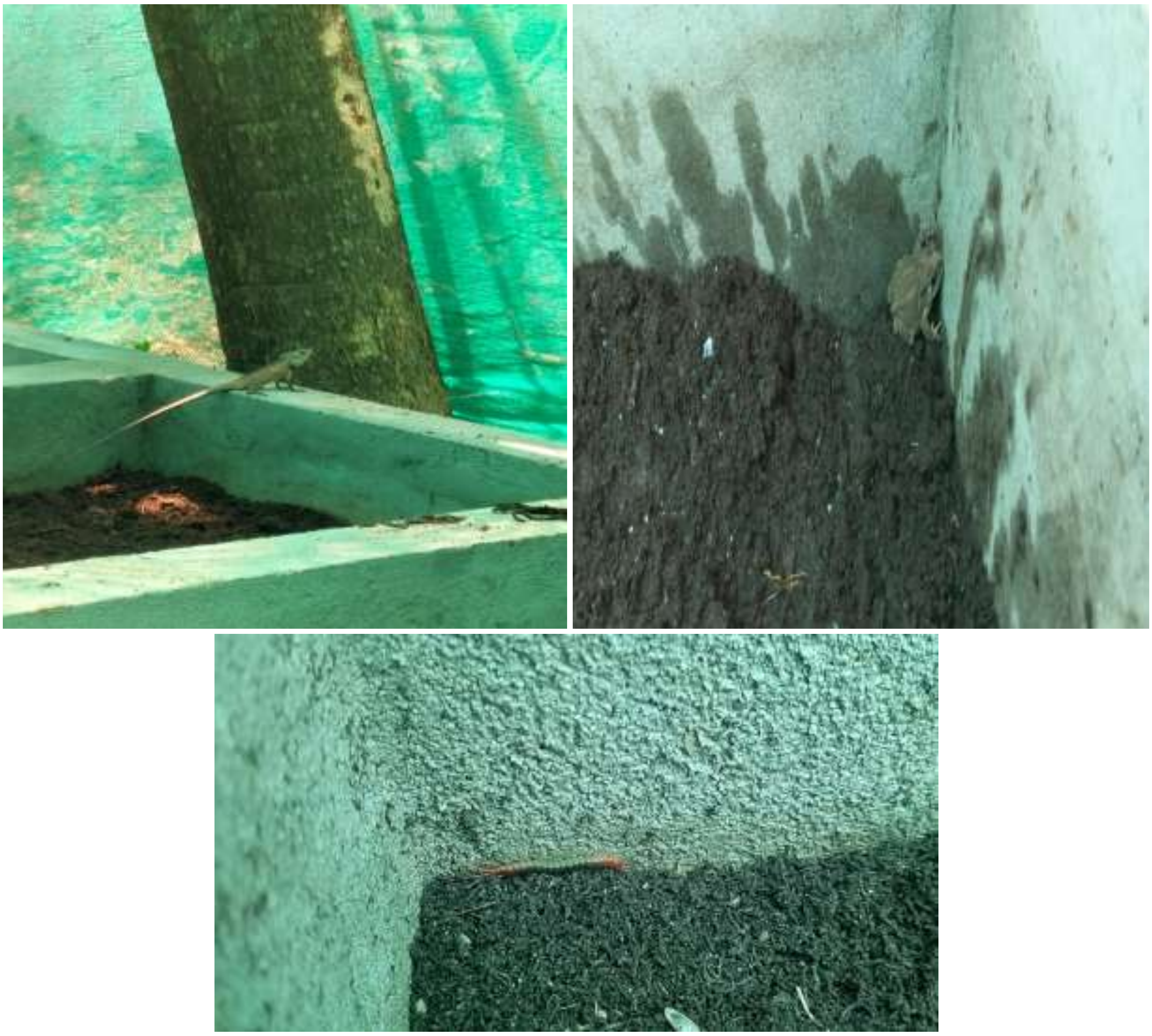

RESULTS AND DISCUSSION

Only cow dung waste has been used to fill Bed I, which has a high pH, organic carbon content, and other nutrients like total nitrogen (N) that is readily available. Phosphorus (N) and potassium (P) were also discovered in the cow dung. The physical, chemical, and biological characteristics of cow dung waste, which can be used as manure, were considerably changed during the vermicomposting process. The temperature and moisture content were kept at 20°C to 30°C and 70% to 85%, respectively.

Harvesting of compost

The fine and soft compost were harvested, weighed, and packed in a one kg polythene bag after 55 and 65 days of experimentation period respectively. During the composting process, 250 kg of compost were harvested from bed I and 200 kg from beds II and III respectively. The harvested compost was tested at Avison Enviro Systems LLP Lab for various physical and chemical analyses, and the results are shown in tables 1, 2, and 3.

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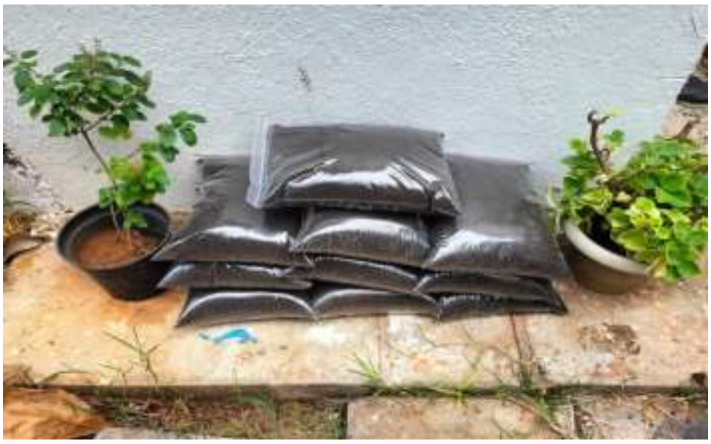
Drying and sieving of compost



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Heaping and Packing of vermicompost

Table.1 clearly shows that the pH decreases from 8.4 to 7.49 at 25°C on the 30th day of vermicomposting period (from 0 to 30 days). The pH of the vermicomposting was 7.49% after 55 days, with a C: N ratio of 11.7%, Nitrogen (N) was 0.63%, Phosphorus (P) 90mg/kg, Potassium (K) 308 mg/kg, and moisture was BDL (DL0.2%, Lead (L)-BDL (DL)-4.0mg/kg, and Cadmium (C) BDL (DL)-2.0mg/kg.

Table.2- (Bed-II) shows that as the vermicomposting period progresses, the pH decreases from 8.2 to 7.8 at 25oC (from 0 to 30 days). After 65 days, the pH of the vermicomposting was 7.36%, with a C:N ratio of 11.9%, Nitrogen(N) of 0.72%, Phosphorus (P) of 94mg/kg, Potassium (K) of 312 mg/kg, and moisture BDL (DL)-of 0.5%, Lead(L) of BDL(DL)-5.0mg/kg, and Cadmium(C) of BDL(DL)-3.

Table.3- (Bed-III) shows that as the vermicomposting period progresses, the pH decreases from 8.4 to 7.9 at 25oC. (From 0 to 30 days). After 65 days, the pH of the vermicomposting was 7.32%, with a C: N ratio of 12.3%, Nitrogen (N) of 0.82%, Phosphorus (P) of 96mg/kg, Potassium (K) of 318 mg/kg, and moisture BDL (DL)-of 0.3%, Lead (L) of BDL (DL)-4.0mg/kg, and Cadmium(C) of BDL (DL)-3.

These data are also supported by Elvira *et al*., (1998) who observed 20 to 42% loss of carbon as CO2 during vermicomposting of paper mill and dairy sludge. The increase in earthworm population might be related with the decrease in C: N ratio with the advancement of time (Ndegwa *et al.,* 2000). Cow dung, along with a country sugar solution mixed with curd, is easily digestible and decomposable, so the earthworms produced 250 kg of fine and soft compost from bed-I and form more cocoons in a short period of 55 days than the bed-II and bed-III, indicating that vermibiotechnology effectively reduces the amount of waste while also improving the nutrient content of the product (vermicompost) to be used as a biofertilizer in practices and weight loss in case of cow dung waste was found to be 50%.

Bed-II was filled with 250 kg of cow dung, 250 kg of agro waste, and 1 kg of country sugar solution mixed with 1 litre curd. Cow dung is easily digestible and decomposable, but kitchen waste contains a large amount of cellulose, so the earthworms took 65 days to produce 200 kg of fine and soft compost from bed-II and bed-III, and weight loss in the case of kitchen waste and agro waste was found to be 75%.

Earthworm biomass increased in all beds due to their hermaphrodite habit, and body weight and length increased in the same beds due to nutrient-rich raw materials in the vermi beds. Fifty earthworms were collected from each bed and their body weight and length were measured in the lab. Because bed-I and bed-II have been filled with cow dung and agro wastes, which are easily digestible and decomposable, the body weight of earthworms increases more in bed-I-22.926 gm than in bed-II-20.270gm and bed-III-10.916gm, and thus the compost induces the body weight shown in the table:5

Compost with worms

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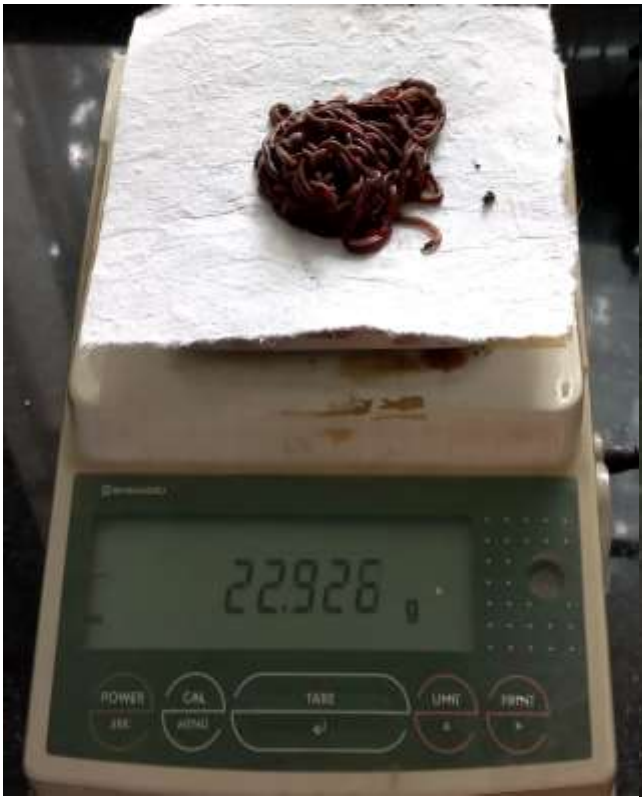
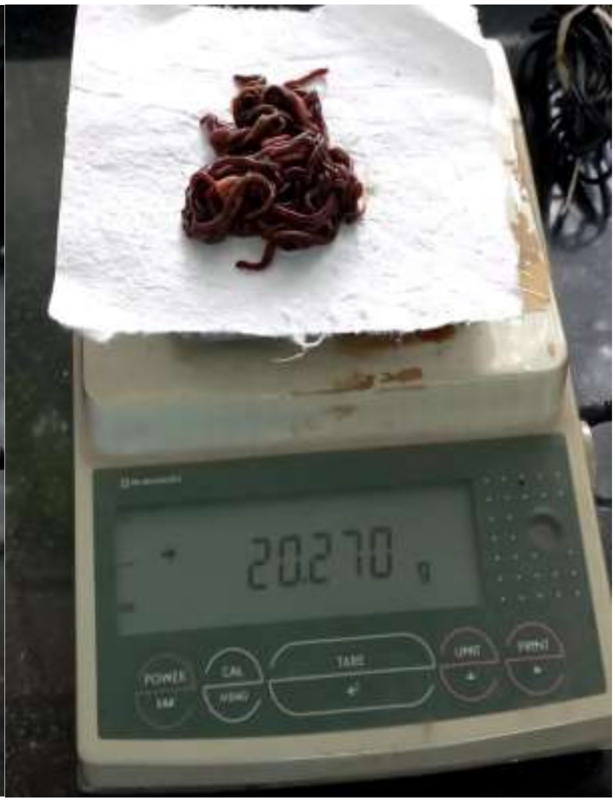
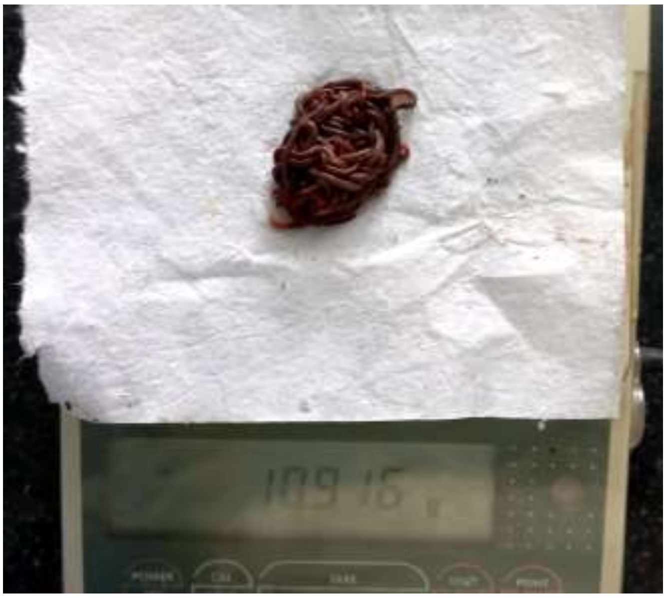
Weighing of Earthworms (50.Nos)



Bed-I



Bed-II



Bed-III

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Measuring

8.5cm **Earthworm with a Cocoon**

Table 1: Effect of Vermicompost on different Physico-Chemical Parameters of Cow dung waste in Bed-I After 55 days

S.No	Description	Method of Reference	Units	Results
1	pH@25 °C	IS:2720 (Part 26) 1987	_	7.49
2	Total Nitrogen as N	IS:14684 :1999	%	0.63
3	Phosphorous as P	IS:10158 :1982	mg/kg	90
4	Potassium as K	USEPA 7000 B-2007	mg/kg	308
5	Moisture	IS:2720 (Part 2): 1973	%	BDL (DL:0.2)
6	C:N Ratio	AES/EN/SLS/SOP/014	_	11.7
7	Lead as Pb	USEPA 7000B -2007	mg/kg	BDL (DL:4.0)
8	Cadmium as Cd	USEPA 7000B -2007	mg/kg	BDL (DL:2.0)

Table 2: Effect of Vermicompost on different Physico-Chemical Parameters of Kitchen waste after 65 days

S.No	Description	Method of Reference	Units	Results
1	pH@25 °C	IS:2720 (Part 26) 1987	_	7.36
2	Total Nitrogen as N	IS:14684 :1999	%	0.72
3	Phosphorous as P	IS:10158 :1982	mg/kg	94
4	Potassium as K	USEPA 7000 B-2007	mg/kg	312
5	Moisture	IS:2720 (Part 2): 1973	%	BDL (DL:0.5)
6	C:N Ratio	AES/EN/SLS/SOP/014	_	11.9
7	Lead as Pb	USEPA 7000B -2007	mg/kg	BDL (DL:5.0)
8	Cadmium as Cd	USEPA 7000B -2007	mg/kg	BDL (DL:3.0)

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Table 3: Effect of Vermicompost on different Physico-Chemical Parameters of Cow dung with agro Waste after 65 days

S.No	Description	Method of Reference	Units	Results
1	pH@25 °C	IS:2720 (Part 26) 1987	_	7.32
2	Total Nitrogen as N	IS:14684 :1999	%	0.82
3	Phosphorous as P	IS:10158 :1982	mg/kg	96
4	Potassium as K	USEPA 7000 B-2007	mg/kg	318
5	Moisture	IS:2720 (Part 2): 1973	%	BDL (DL:0.3)
6	C:N Ratio	AES/EN/SLS/SOP/014	_	12.7
7	Lead as Pb	USEPA 7000B -2007	mg/kg	BDL (DL:4.0)
8	Cadmium as Cd	USEPA 7000B -2007	mg/kg	BDL (DL:3.0)

Note: BDL – Below Detection Limit
DL – Detection Limit

Table 4 : Impact of vermicomposting on weight loss of organic substrate cow dung

S.No	Type of waste used	Weight of waste at initial stage(Cow dung)	Weight of waste at final stage (Cow dung)	Loss of weight during compost
1	Cow Dung	500kg	250 kg	50%
2	Cow dung with kitchen wastes	500 kg	300 kg	75%
3	Cow dung with agro wastes	500 kg	300 kg	75%

Table 5: Impact of composting on earthworm biomass after 55 and 65 days

BED-I Earthworm' body weight (gm)	BED-II Earthworm' body weight (gm)	BED-III Earthworm' body weight(gm)
20.270	9.788	10.976

The increase in earthworm population may be related to the decrease in C: N ratio as time passes (Ndegwa et al., 2000). It is clear that as the time period increases during vermicomposting, so do these parameters, with maximum values of total nitrogen (0.63%), available phosphorus (90mg/kg), and exchangeable potassium (308mg/kg) found after 65 days of vermicomposting. Gunadi and Edwards (2002) conducted a study that demonstrated that the nitrogen content in the end product was high after six months of vermicomposting. Vermibiotechnology clearly shows that it reduces waste while also improving the nutrient content of the product (vermicompost) to be used as a bio-fertilizer in agricultural practices.

The product vermicompost has a high maturity rate and high respiration index, which is a crucial factor in determining the manure's quality. The elimination of disease-causing pathogens in organic waste is an essential goal of vermicomposting. The organic waste is reportedly known to include 120 viruses and germs that are dangerous to humans. The germs that cause disease are reduced by 75% by the compost. Apart from increasing nutrients, compost improves the physical structure of the soil and its water retention capacity. Germination testing is a method of determining the rate of plant growth. Plant seed germination shows increased growth in vermicompost rather than commercial yielding. Furthermore, there is evidence that vermicomposting increases the rate of flowering, growth, and fruit yielding capability.

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CONCLUSION

Biomass and vermicompost are produced as a result of the biological process known as vermicomposting, which involves the interaction of earthworms and microorganisms. In this paper, a thorough investigation is made into all the parameters necessary for vermicomposting. The design consideration, which takes into account the surface area of the pit needed, the kind of earthworms needed, their selection criteria, and the quantity of worms needed are also covered in this paper. This paper provides the groundwork for further vermicomposting procedure.

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