

Sustainable Transformation of Biowaste into Organic Manure Using *Eudrilus Eugeniae* to Enhance Soil Productivity

¹Feba. R. Philip and ²Dr Reji P.G

¹Department of Civil Engineering, UKF College of Engineering and Technology, Paripally, Kollam, Kerala, India

²Associate Professor, UKF College of Engineering and Technology, Paripally, Kollam, Kerala, India

Abstract - The unrivalled increase in the human population has resulted in the large-scale generation of biowaste, which serves as a rich source of plant nutrients. This study aims to determine the optimal composting duration, the appropriate quantity of *Eudrilus eugeniae* for efficient vermicomposting, and the best distribution of biowaste during the composting process. The composting was carried out for a period of two weeks, with sampling performed at the end of the second week. The macronutrient contents—organic carbon (C), nitrogen (N), and potassium (K)—were analysed to assess nutrient enrichment. Organic carbon was determined using a carbon analyser, total nitrogen through the Kjeldahl method, and total potassium using an Atomic Absorption Spectrophotometer (AAS). The pH of the compost was found to be 7.5, indicating a slightly alkaline nature. The organic carbon content was 3.11% in compost and 3.8% in vermiwash. Nitrogen was recorded as 1.98% in compost and 2.1% in vermiwash, while potassium was 1.98% in compost and 1.95% in vermiwash. These results indicate that vermiwash contains relatively higher NPK values compared to compost manure, making it a superior biofertilizer.

Keywords - *Eudrilus Eugeniae*, Vermicompost, Enzymatic Degradation, Nutrient Extraction, Biofertilizer.

I. INTRODUCTION

Ineffective waste management systems present substantial threats to ecological integrity and communal health. Demographic expansion serves as a catalyst for increased waste generation. This trend is exacerbated by industrial intensification, which has fundamentally altered consumption patterns, resulting in a proliferation of waste that is increasingly complex in volume, variety, and chemical composition detailed in [1-6]. Waste matter is typically categorized by its physical state (solid or aqueous) and its chemical properties; Inorganic Waste Synthetically derived matter characterized by the absence of carbon-based molecular structures and Organic Waste which is Biodegradable matter composed of organic compounds, which is susceptible to biological decomposition facilitated by microbial activity. Composting as a Sustainable Mitigation Strategy

Addressing the challenges of modern waste production requires the implementation of innovative, economically viable, and scalable methodologies. The transformation of organic refuse into compost represents a high-utility solution for waste treatment. As an organic soil amendment, compost provides critical ecosystem services, particularly within the agricultural sector. Its primary benefits include the enhancement of soil structure and the optimization of the soil's hydraulic conductivity and water-retention capacity.

Among the possible ways to manage these agricultural wastes, is a simple, cost effective and an eco-friendly method known as vermicomposting that helps re-cycle these wastes into useful substances. Vermicompost uses an aerobic and non-thermophilic process. Vermicompost is an environmentally friendly composting method which involves worms and microorganisms to convert organic matter into compost which is rich in

nutrients, enzymes, and vitamins. It is the biological degradation and stabilization of organic waste by earthworms and microorganisms to form vermicompost. Vermicompost is organic manure (bio-fertilizer) produced as the Vermicast by earth worm. Vermicast and Vermiwash (liquid vermicompost) enriches soil quality by improving its physicochemical and biological properties. It is eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product. Organic farming with the use of vermiproducts improves the texture, structure, water holding capacity of the soil and to some extent reclaims the problematic soil compared to organic fertilizers. It also improves quality of the produce was detailed in [7-10].

Vermicomposting is an affordable technological method utilized to convert organic waste into organic fertilizer through the collaborative actions of earthworms and microorganisms during the decomposition of organic materials.

II. MATERIALS AND METHODOLOGY

Eudrilus eugeniae; also called the "African nightcrawler", is an earthworm species native to tropical west Africa and now widespread in warm regions under vermicompost; it is an excellent source of protein and has great pharmaceutical potential. Fecundity, growth, maturation and biomass production were all significantly greater at 25 °C than 15°, 20° or 30°. (25 °C = 77 °F). The growth of individual earthworms increases as the population density lowers, but the greatest overall earthworm biomass production occurs at the highest population density. The greatest number of cocoons per week and the number of hatchlings per cocoon are obtained at 25 °C. Cocoons of *E. eugeniae* hatched in only 12 days at 25 °C, and the worms reach sexual maturity in as little as 35 days after hatching. The African nightcrawler grows well at a temperature of 24–30 °C (75–86 °F). Maximum weight of around 2.5 grams occurs within 8–10 weeks.



Fig 2.1 *Eudrilus eugeniae*

Reactor Bins: Plastic bins are great for entry level Vermi composters because they are readily available in many stores and they are quite easy to execution and installation.

Vegetable Waste: The Vegetable waste was reduced to a smaller size approximately 3-5cm. Vegetable waste taken such as waste cabbage, banana peel, and all other vegetables taken for food preparation. Oily and Greasy (Fatty) products, spicy foods, citrus skin and prepackaged should avoid. We can add up to 500-800gm per day of food scraps. After once understand the process and see your worm population multiplying day by day, so we can gradually start adding waste.

Blanket: To maintain humidity, water is sprayed in this blanket

Outlet Tap: Tap that is used to collect Vermi wash or liquid vermicompost

Gardening tools: Prong Hand Cultivator, Gloves

Cocopeat: Cocopeat is a byproduct of coconut husks that is used as a growing medium or soil conditioner. It is a light weight, spongy, corky material that is organic and biodegradable. This will help in moisture retention and buffering capacity.

Methodology

This study uses plastic containers that are arranged into three container traps that are placed outside the room. Make air holes and drainage holes with a diameter of 1.25 - 2.5 cm on the sides and bottom of the container. The reactor tank in the first trap or the top trap contains vegetable waste, fruit skins, soil and earthworm. While the second trap contains soil and worms. Bedding materials (shredded paper and soil) were then introduced into each plastic container. For the third trap or the lowest trap, it contains liquid compost so that a faucet is given to make it easier to take vermicompost liquid. The vegetable waste was reduced to a smaller size (approximately 3-5 cm).

Eudrilus Eugeniae need to be placed in a reactor that has been given soil beforehand so they can adapt to the environment. Mixing is intended while composting. The non-chlorine water was then sprinkled over each bedding material to regulate the moisture content and to maintain humidity. Composting kitchen waste is an easy way to cut down the amount of garbage that our home produces, and is one efficient way to start living more sustainably. we need to wait roughly 10-15 days before it will have good, usable compost and the best part end up with a fantastic soil amendment which provides everything your plants need to grow happy and healthy.

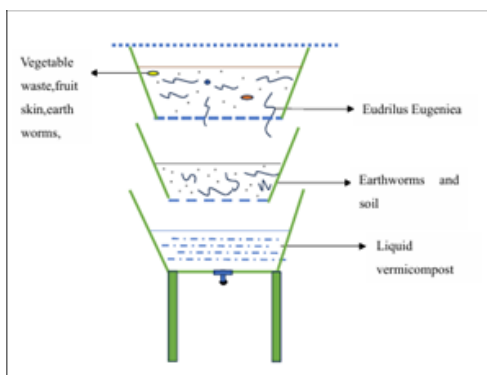


Fig 2.8 Schematic sketch of vermicompost

Setting up a worm farm is easy and it will hardly take 15-20 minutes to install. Two composting trays with several holes at the bottom, 4 legs, Top lid, 1 vermivash collecting tray, 1 cocopeat brick for bedding, 1 worm blanket, 1 worm tea cup, 1 pair of

hand gloves, 1 cultivator, 1 tap and mainly Earthworms (*Eudrila Eugeneia*). Assemble legs to water collecting tray and fit a tap to this tray. Worms need bedding that holds moisture well, so to prepare bedding of cocopeat brick, soak cocopeat in 7-8 litres of water and after 5-8 minutes, cocopeat will expand and then shredded newspaper and hardboard pieces is added to the bedding enough to fill the bin about 3- 5 inches height. after expanding of cocopeat add soil mixture is above it. Bedding made up of cardboard, newspaper strips or leaves, will hold moisture and contain air spaces essential to worms. Add some water to maintain 50-60% moisture, if too wet add shredded paper or shredded dry leaves. Add Earthworms that are given with organic manure and leave it for 2 days for the worms to settle in. It takes up to 2-3 days for the worms to get settled in their new home. Cover the setup with worm blanket close it with the top lid. This will provide shade and optimum conditions for the worms to thrive. Keep the unit in shade.

After three days cut kitchen waste into small pieces to help waste turn into compost quickly as possible. Approximately 3-5 cm in size. The best food scraps to use are peels, rinds, cores, leaves, and seeds from fruits and vegetables. Crushed eggshells, teabags, and coffee grounds also works well. it is especially important to avoid adding meat or bones and any types of dairy products and also avoid bread excessive amounts of citrus. And avoid large quantities of onion and citrus peels. if they are added in small quantity, sprinkle conditioner to maintain acidic level of your worm farm. Now we can start slow adding up to 250 grams per day to understand the process better. Later we can add up to 500-800 grams per day of food scraps. After once understand the process and analyse the worm population multiplied by day by day, we can gradually start adding waste.

Bury the food scraps inside the worm bedding. Using cultivator, it works the scraps more efficiently, spread the food scraps all across the bedding. Worms process anywhere between 25%-100% of their body weight of organic material per day. As per general thumb rule, if you are keeping a good worm bin environment, they should process an average of

50% of their body weight. i.e. 1kg worms=500 g of organic waste. Cover it with worm blanket and pour some water on it, it will help in maintaining your worm bin's moisture, traps any type of odour formed and doesn't attract any type of outside pest. After ten days, when tray is full, it can replace it with another tray to put new scraps and bedding. Worms will travel to new tray through drainage holes in search of food. After 8-9 days itself compost is ready and at this phase we can add more food scraps into the tray. The wonderful things about the worms are that whatever comes out the back, is more nutrient rich than what goes in their front. This ends up with nutrient rich worm castings and Vermiwash.

The vermiwash can be collected from the unit in this period. The water gradually percolates to the bottom through the compost carrying with its nutrients through the unit. These systems are completely odourless and the process can do all year round even in the winter season. At 13th day white Fungus is formed in the compost which resembles Actinomycetes that eats decaying organic matter and help to break down the food that is placed in the composting bin with worms, it turns becoming worm food themselves.

The worms reproduce in the worm bin and in no time they will multiply. however, the rate of reproduction is inconsistent and you can't count the worms very easily. At time progresses, we can notice the decreasing level of food scraps and increasing level of compost in bin. We can use vermiwash as a liquid fertilizer in 1:5 ratio i.e for 200 ml of vermiwash and 1 litre water and use for gardening. The vermiwash contains necessary plant nutrients, plant growth promoting hormones (auxin and gibberellins), enzymes (cocktail of protease, amylase urease and phosphates that acts as antimicrobial), symbiotic microbes, nitrogen fixing bacteria such as Azotobacter sp. and Rhizobium and some phosphate solubilising Bacteria) in addition to the macronutrients and micronutrients.



Fig 2.9 Ploughing Compost (partially digested)



Fig 2.10 (a) Completely digested Compost and (b)collection of vermiwash

If all the food items are converted then it's the harvest time. Vermicompost is the best fertilizer for plants, as it can easily be absorbed. All the organic material has undergone the breakdown process typically done by the worms. Drain water collection tray atleast once in 8-10 days. Before harvesting the compost bin keep under direct sunlight for 5-10 minutes. due to this, worms will migrate towards the bottom of the compost. Slowly scoop out the upper 3-5inch layer of the compost, keep the bottom layer in the tray as it will contain earthworms. We can use the compost as manure now itself, or it can store and use it later. After every 15-18 days we can easily collect 5-6 litres of vermiwash, vermiwash can be diluted to 10 to 25% and can be treated as a pesticide or fertilizer on the crops or on the soil. Finally, the result of project, is the vermiwash and

vermicompost, an organic manure which is formed organically from the kitchen waste.



Fig 2.11 Finally Produced Manures (compost and vermiwash)

Results and Discussion

Chemical analysis

Chemical analysis of vermicompost for organic Carbon was determined by using carbonaceous analyser, Total Potassium was determined by using atomic absorption spectrophotometer (AAS), and for total N (Nitrogen) was determined by Kjeldahl method. The Kjeldahl method is a simple method for the determination of total nitrogen in amino acids, proteins and nitrogen-containing compounds. Determination of nitrogen content in liquid fertilizer using the Kjeldahl method through three main processes, namely the destruction process, the distillation process, and the titration process.

Results

Nutrient Profile of Compost and Vermiwash

Si.No	Parameters	Compost	Vermiwash
1	pH	7.5	7.5
2	Organic carbon	3.11%	3.8%
3	Nitrogen	1.98%	2.1%
4	Pottasium	1.80%	1.95%

Table 4.1 Nutrient Profile of Compost and Vermiwash

As composting proceeds, the organic acids become neutralized, and mature compost give 6-8 pH Level, here obtained value is 7.5 which is Alkalic in nature. Organic carbon gives 3.11% in compost and 3.8% in Vermiwash, organic carbon can help improve soil stability and plant growth. Organic carbon act as a nutrient reservoir, improving nutrient availability for plants. It can lead to healthier plant growth and higher crop yield. Nitrogen is essential for plant growth and reproduction, it's a key component of many plant's structures and processes, here nitrogen is 1.98% in compost soil and 2.1% in Vermiwash. Pottasium is a vital nutrient for plant growth and development here potassium content is 1.98% and Vermiwash contains 1.95% respectively. Here we can inference the Vermiwash contains more N P K contents than manure.

III. CONCLUSION

The study focused on the conversion of agricultural wastes into bio-fertilizer using vermicomposting method. It can be concluded that agricultural waste materials can be converted into bio-fertilizer with earthworm playing a vital role for this conversion and producing a material that is eco-friendly, non-toxic, and consumes low energy input. There was reduction in weight of all the samples during the vermicomposting process. The N-P-K concentration (in ratio) for the bio-fertilizer is higher than that of the chemical fertilizer. Agricultural waste disposal using earthworms (vermicomposting) looks very promising as it can help to not only be used as a form of waste treatment but also to produce nutrient rich biofertilizer.

The macronutrient contents organic carbon (C), nitrogen (N), and potassium (K) were analysed to assess nutrient enrichment. Organic carbon was determined using a carbon analyser, total nitrogen through the Kjeldahl method, and total potassium using an Atomic Absorption Spectrophotometer (AAS). The pH of the compost was found to be 7.5, indicating a slightly alkaline nature. The organic carbon content was 3.11% in compost and 3.8% in

Vermiwash. Nitrogen was recorded as 1.98% in compost and 2.1% in Vermiwash, while potassium was 1.98% in compost and 1.95% in Vermiwash. These results indicate that Vermiwash contains relatively higher NPK values compared to compost manure, making it a superior biofertilizer.

The creation of bio-based fertilizer using cutting-edge technology, microbes, and optimization for a circular economy can revolutionize agriculture and meet the agricultural sector's need for effective and secure fertilizers that can help lessen soil contamination and damage brought on by the excessive use of synthetic fertilizers. Vermicompost organic fertilizer production has now become a major component of agribusiness models across the world with a very low initial investment. Vermicompost is the product or process of composting utilizing various species of worms to create a mixture of decomposing vegetable or food waste, bedding materials, and Vermicast.

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