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Vegetable Wastes Based Vermicomposting by *Lumbricus rubellus*

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Abstract: We have vast cultivable land and enough water in this planet, still we are unable to fulfill the basic needs of the people. It is roughly estimated that about 24,000 people die every day from hunger or hunger-related causes. In the present study in the 20th day of the experiment, 50% of vegetable wastes were decomposed and in the same time, number of *Lumbricus rubellus* (red earthworms) in the vermin-bed has been gradually increased and in 40th day of the experiment, 90% of decomposition has been observed and simultaneously the number of red earthworms in the vermin-bed has also been gradually increased. Finally, the dark layered vermicompost has been sieved and stored. At the end of 40th day, the vermibed substrates were removed, vermicompost's was sieved and stored. By improving such type of vegetable waste-based vermicomposting, we can reduce the usage of chemical fertilizer in the gardens and in the agricultural land. Vermicompost increases the soil fertility and that is the best way to form the healthy environment in the world.

Keywords: Vermicompost, Soil fertility, *Lumbricus rubellus*, Vegetable wastes

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Introduction

In order to increase the crop production for fulfilling the nutritional requirements of the day-by-day increasing population, the system relies exclusively on the use of chemical fertilizers. Therefore, increase in population, environmental pollution, contamination in water and soil are the major concerns in today's world and there is a reason to search for alternative methods of increasing plant production in an eco-friendly manner, adequate management of natural, renewable resources and the reduction of chemical inputs.

Vermicompost is the excreta of earthworm and is a very good soil conditioner, which is rich in humus. Earthworm's excretory system consists of nephridia as excretory organ i.e., Septal Nephridia/ Typical Nephridia, Integumentary Nephridia and Pharyngeal Nephridia. The worms for vermin-composting are redworms (*Lumbricus rubellus*) and red wigglers (*Eisenia fetida*). Earthworm feeds on vegetable waste, compost, and organic bedding produces a "cast". Soil bacteria such as *Bacillus, Pseudomonas*, *Streptomyces* and its secondary metabolites act against various co-existing phytopathogenic fungi and human pathogenic bacteria.

The digestive system of earthworm is a straight tube starting from mouth, muscular pharynx, oesophagus, thin-walled crop, muscular gizzard, foregut, midgut, hindgut, digestive glands, and anus. The digestive system consists of mucus containing protein and polysaccharides, organic and mineral matter, amino acids and microorganism's such as bacteria, protozoa and micro fungi. The increased total organic carbon, organic carbon, and nitrogen and moisture content in the earthworm gut provide suitable environment for the activation of microbes and endospores germination. Based on the above studies, insufficient information for the production of vermicompost by using vegetable wastes from houses has been observed. This has prompted us to undertake this present study.

Organic matter degraded by the earthworm is called as vermicompost. It can be used as top soil or as organic manure in fields to prevent shortage of minerals and soil erosion. The worm cast is a better source of organic manure than other anaerobically degraded composts because of the following facts: the worm cast consists of loosely packed granular aggregate of semi-digested matter that provides energy for establishment of various microorganisms; some of the microbes which are found in association with the cast are responsible for deodorizing excrements derived from organic wastes with intolerable odour (Watanabe *et al.,* 1982).

Atlavinyte *et al.* (1971) and Atlavinyte and Vanaagas (1982) reported that the worm activated soil and worm cast provide essential nutrients in available form to plants. Moreover, the bio-chemical activities of established microbes and worm exudates have a stimulatory effect on plant growth. Biomass production of worms on the one hand helps to enhance the process of waste degradation and, on the other; residue free worms can be used as an alternate source of protein for poultry birds and fish (Kale, 1993).

Kale *et al.* (1982) reported in their study that the dung materials used in the culture media strongly influenced the biology of *Perionyx excavatus.* Worm growth, maturation, cocoon production and cocoon viability were affected by the food supplied. Albanel *et al.* (1988) analyzed the casting of *Eisenia fetida* fed on sheep manure alone or mixed with cotton wastes every two weeks for three months and compared it with the same manures in the absence of earthworms.

The results of a study of vermicomposting of pre-treated pig manure in Hong Kong, using the earthworm *Eisenia fetida,* was reported by Griffiths (1988). Pig manure was first composted and then supplemented with 4 per cent calcium sulphite before feeding to the worms. The earthworm *Pheretima asiatica* was found to stabilize most of the solids arising from the treatment of pig-waste, including raw pig manure (Wong and Griffiths, 1991). Jambhekar (1994) suggested that sieving and shredding of organic waste should be carried out when town waste or city waste is used. Kavian *et al.* (1996) made an attempt to convert paper mill biodegradable solid effluents into biofertilizers, using vermiculture biotechnology. Even 75 per cent concentration level was found suitable for biodegradation. Mba (1996) carried out vermicomposting and field investigation trials to assess the impact of organic wastes, poultry dropping (Capo), Cow dung (Caco), guava (*Psidium guajava*) leaves, and cassava peel (Cas) using *Eudrilus eugeniae.* Bioconversion of solid paper-pulp mill sludges and primary sewage sludge for 40 days at a ratio of 3:1 (dw:dw) was studied by Elvira *et al.* (1996) in containers with and without earthworms (*Eisenia andrei*). This mixture was found to be a suitable medium for optimum growth and reproduction of the earthworms. Regardless of the presence of earthworms, degradation occurred during the bioconversion period, but the presence oforganic matter, favored the breakdown of structural polysaccharides and increased the humification rate. The ability of the earthworm *Eisenia fetida* to transform coffee pulp into valuable compost was evaluated by Orozco *et al.* (1996). The potential of the earthworm *Octochaetona serrata,* to decompose kitchen vegetable refuse, cow dung, leaf litter, cloth, paper and grasses was assessed by Gupta (1997) by litter bag exclusion method. The action of the worm accelerated the decomposition of the wastes by 19-60 per cent. Parthasarathi and Ranganathan (1998) reared the composting earthworms *Lampito mauritii* and *Eudrilus eugeniae* in four substrates-soil (S), sawdust (SD), press mud (PM) and press mud-sawdust mixture (PM:SD 1:1). Elvira *et al.* (1998) studied vermicomposting with earthworms accelerated the mineralization of *Eisenia andrei* of sludge from a paper mill mixed with cattle manure in a six-month pilot-scale experiment. Total Kjeldhal Nitrogen (TKN) and total phosphorus (TP) increased significantly ($p<0.05$) by the end of the vermicomposting period, probably because of mineralization of the organic matter. These increases were more appreciable for Fe, Zn and Ni in the control treatment (M).

The aim of this investigation was to produce vermicompost by using vegetable wastes and other wastes and to study the increase of red earthworms' population in the experimental design.

Materials and Methods

Vegetable Wastes Based Vermicomposting:

The waste parts of vegetables like onion, tomato, potato, capsicum, leaves, some waste papers and coconut husks were collected and all these things were taken for making vermicompost. These things were chopped and turned over manually for 15 days in order to pre- compost it so it becomes palatable to earthworms. The soil was taken from the garden and some quantity of the soil was spread over inside the mud pots. Then some amount of above said coconut husk, vegetables wastes and some waste papers were spread one by one in between each layer of soil. Again, the second layer of soil was applied and followed by the same procedure. This was repeated for 4 to 5 times. Then, 7 number of red earthworms *Lumbricus rubellus* (Fig. 1) were introduced into the experimental design. Small amount of water was sprinkled over the soil. Every day, the entire set up was observed and the results were recorded.

Fig. 1: *Lumbricus rubellus.*

Results and Discussion

Table 1: Number of red earthworms *Lumbricus rubellus* formed during the developmental period

S. No.	Days	Number of Red Earthworms (*Lumbricus rubellus*)
1	4th	8
2	8th	10
3	12th	13
4	16th	15
5	20th	16
6	24th	18
7	28th	21
8	32nd	25
9	36th	28
10	40th	35

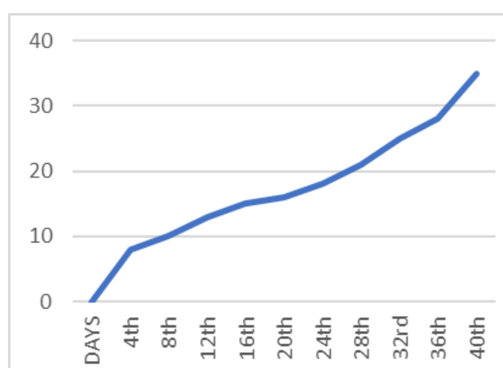

Fig. 2: Number of red earthworms *Lumbricus rubellus* formed during the experimental period.

Fig. 3: Decomposing of wastes taken for the experiment.

Fig. 4: Decomposing after 20th day of the experiment.

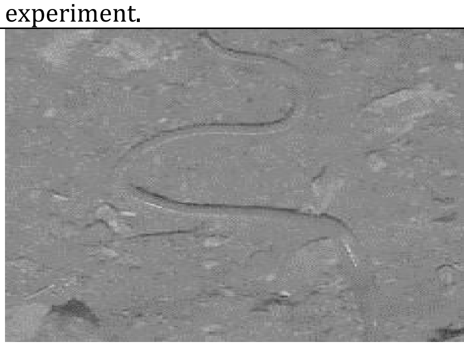

Fig. 5: Decomposing after 40th day of the experiment.

Fig. 6: Control soil.

Fig. 7: Experimental soil after 10th day.

Fig. 8: Experimental soil after 20th day.

Fig. 9: Experimental soil after 40th day.

After 4th and 8th day, 8 to 10 earthworms were formed. After 12th and 16th day 13 to 15 earthworms were formed. Then, at the end of 20th, 24th, 28th, 32rd, 36th and 40th day 16 to 35 number of red earthworms *Lumbricus rubellus* has been observed in the experimental design, respectively (Table 1; Fig. 2). At the end of 40th day, the vermibed substrates were removed, vermicompost's was sieved and stored. The vermicompost was slightly dark in color when compared to the control soil taken for the process. After 10th to 20th day of the experiment, 50% of vegetable wastes were decomposed and in the same time number of red earthworm in the vermin-bed has been gradually increased (Fig. 4).

In 40th day of the experiment 90% of decomposition has been observed and simultaneously the number of *Lumbricus rubellus* in the vermin-bed has also been gradually increased (Fig. 5). Finally, the dark layered vermicompost has been sieved and stored (Fig. 6, 7, 8, 9). Several earthworm species have been identified as detritus feeders that can be reared in a wide variety of organic waste material (Matthew and Mariana, 2023; Siddiqui and Singh, 2023; Singh and Singh, 2023). Some of these epigeic species have been shown to be suitable candidates for vermiculture,

e. g., *E. fetida, E. eugeniae* and *P. excavatus* (Harteinstein *et al*., 1979; Haimi and Huhata, 1986; Kale *et al*., 1982; Reinecke and Venter, 1987; Daniel and Karmegam, 1999; Ramalingam and Thilagar, 2000; Karmegam and Daniel, 2000 a, b; Yvonne *et al*., 2019). Earthworms play a key role in the degradation of soil organic materials and recycling of nutrients in the soil ecosystem. The vermicomposting studies carried out with various organic materials using *E. eugeniae* and *E. fetida* also gave similar results (Daniel and Karmegam 1999; Karmegam and Daniel, 2000a, b). The current study revealed that in the 20th day of the experimental period, 50% of vegetable wastes were decomposed and in the same time number of red earthworms in the vermibed has been gradually increased. Then finally in the 40th day of the experiment, 90% of decomposition has been observed and simultaneously the number of red earthworms in the vermin-bed has also been gradually increased. As a result, the (black) dark colored vermicompost has been formed.

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