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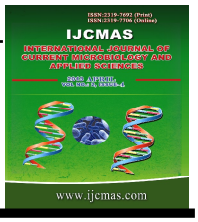

Original Research Article

Management of paper waste by vermicomposting using epigeic earthworm, *Eudrilus eugeniae* in Gwalior, India

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Keywords

Eudrilus eugeniae; vermin-composting; Waste paper; cowdung.

A B S T R A C T

The use of earthworms in the degradation of various types of wastes is continuing from the past so many years. These wastes include industrial, agricultural and domestic wastes etc. This study examines the potential of the African night crawler *Eudrilus eugeniae* in the vermicomposting of waste paper. As waste paper is rich in carbon while deficient in nitrogen cow dung was mixed with it to make it suitable for earthworms. A mixture of waste paper and cow dung in the ratio of 1:1 was found to be the best ratio than 2(paper waste):1(cow dung) and 3(paper waste):1(cow dung). In 65 days time good quality compost was prepared by earthworms. Physical and biochemical parameters were analyzed during this period of 65 days. Pre decomposition of 15 days and subsequent vermicomposting of 65 days indicates the role of this species in vermibiotechnology. Increase was found in all the parameters like, Total nitrogen (%), Available phosphorus (%) and Exchangeable potassium (%) while a decrease was found in pH and C:N ratio as the timing of vermicomposting increased from o days to 65 days.

Introduction

Earthworms are important Vermiresources having simple, cylindrical, Coelomate and segmented body characterized by presence of setae. Earthworms are terrestrial worms well adapted for burrowing life. They depend on soil for all of their activities hence they are called geobionts. In order to protect themselves from enemies and desiccation most of the species prefer to live in burrows and come out during night in search of food (night crawlers). Earthworms are also known as rain worms, as they are seen in large numbers during rains, manure worms, as some varieties flourish well in manures and compost heaps, angel worms as they suddenly appear like angels after some days of rains, or fish worms as they are largely used as fish bait and fish food.

Earthworms play a significant eco-functional role in soil ecosystem by affecting physical, chemical and biological properties of the soil. Earthworms have dynamic potentials and can do wonderful jobs for man and biosphere. The potentials of earthworms have been proved in decomposition of waste materials. Many organic by-products of agricultural production and processing industries are currently seen as .waste' and thus become potential environmental hazards. A portion of this waste is currently reused, recycled or reprocessed: however a majority of it is disposed off in Landfills (anaerobic composting), which is a matter of concern due to many factors including cost and environmental issue. Due to ill effects of modern technologies and un-sustainable developments, the importance of eco-friendly technologies is now stressed upon.

The potential of earthworms in soil processing due to their burrowing nature and composting of organic matter has been realized and simple appropriate vermiculture biotechnology has been developed which may solve the problems of waste processing and management to a large extent. The paper mill industries form an important part of the economy in many countries. These industries generate a large volume of solid wastes. Also educational institutions generate a bulk amount of waste paper. These wastes are usually incinerated or disposed in landfills. These methods of disposal leads to loss of nutrients in the soil and cause environmental problems.

Applied use of earthworms in the breakdown of a wide range of organic residues, including sewage sludge, animal wastes, crop residues, and industrial refuse to produce vermicompost, has been recommended Hartenstein and Bisesi, 1988; Van Gestel *et al*., 1992; Dominguez and Edwards, 1997. The importance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture has been highlighted by several workers (Senapati, 1992; Bhawalkar, 1993; Ghatnekar *et al.,* 1998; Talashikar and Powar, 199).

The worms actually enhance microbial activity and diversity (Fracchia *et al*., 2006; Lazcano *et al*., 2008) and lead to rapid degradation of waste and recovery of nutrients. World paper industry has been registering a growth rate of 2.8% per annum. More landfill space will be required for dumping the toxic organic sludge generated by this industry. It has been observed that although paper sludge is a good source of organic carbon, this sludge cannot be applied directly to fields as it is deficient in other nutrients (Kaur *et al*., 2010).

The microflora in the intestine of worms and gut enzymes, as well as microflora present in the waste, are involved in decomposition , Kavian and Ghatneker, 1991. Enhanced organic matter decomposition in the presence of earthworms has been reported, Suriyanayanam *et al*., (2010) carried out a study and reported that paper sludge can be used as a good bulking agent or good source of carbon in composting. Sludges from paper mill industries can not be used as a feeding material of epigeic earthworms (Butt, 1993; Elvira *et al* ., 1995; Gratelly *et al*., 1996). Therefore they need to be mixed with other nitrogen rich organic wastes to provide nutrients (Butt, 1993).

Materials and Methods

Collection of material

The cattle dung (10 days old) was procured from nearby dairy farm. The moisture content of the medium was maintained at about 60%.-70% and the paper waste was procured from the S.O.S in Zoology, Jiwaji University Gwalior. The paper waste was procured office and various research laboratories of the Department. The procured paper was shredded before using by means of a paper shredder.

Collection of animals

Earthworms (*Eudrilus eugeniae*) were procured from vermicomposting center, located in charak Udhyan of Jiwaji University, Gwalior. For the present study, separate vermi-bed was made using ten days (10 days) old cattle dung for mass culture of *Eudrilus eugeniae*. The culture was constantly monitored throughout the period of study with time by time spraying of water. Mature clitellate worms for experimental purpose were taken from this stock culture.

Experimental Setup

Two sets of experiments were conducted in the present study.

Pre-decomposition experiment

A ceramic tank of 45x30x15 cm measurement was filled with a mixture (3 kg) of dung and shredded paper, it was daily sprinkled with water so that it gets decomposed. Also this waste was turned up and down for proper aeration and decomposition.This experiment continued for 15 days.

Composting experiment

In this study plastic container was filled with the pre-decomposed mixture of cow dung and shredded paper. 25 adult, mature, clitellate worms were taken from the stock culture and were uniformly released on the top of the containers of all the three experimental containers. The experiments were conducted inside the vermicompost hut located in charak udhyan garden of Jiwaji university, Gwalior, in order to avoid the danger of predators and rain during the months of July and September.

The containers were covered by mesh garden cloth and were observed daily in order to check the various parameters necessary for the survival and reproduction of earthworms.This whole setup was maintained for 65 days till the finely granular vermicompost was prepared.

During the composting process the material was analysed for different physico-chemical attributes such as pH, total Nitrogen, available Phosphorus, exchangeable Potassium, as per the methods suggested by other workers (Piper, 1996; Jackson, 1973; Ishwaran and Marwaha, 1980) as well as for earthworm number, cocoon production and weight loss of organic substrate (Tripathi, and Bharadwaj,2004; Wantanabe and Tsukamato 1976). During the course of investigation, the samples were examined at periodic intervals after 30 and 65 days of vermicomposting.

Results and Discussion

Paper waste material is characterized with high values of pH, organic carbon. However, other nutrient such as total nitrogen available phosphorus and exchangeable potassium were found in very trace amounts. The process of vermicomposting activity significantly modified the physical and chemical properties of paper waste material that can be an important tool for organic farming. It is indicated in Table.1 that during vermicomposting the pH declines (from 8 to 7.3) with the advancement of vermicomposting period (from 0 to 65 days).

It might be on account of high mineralization of nitrogen and phosphorus into nitrates/nitrites and ortho-phosphate.

After 65 days of Vermicomposting there is about 8.75% decline found in pH, 82.23% in C:N ratio. 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).

Table .1 Effect of vermicompost on different physico-chemical parameters of paper waste

S. N0.	Parameters	Duration of Vermicomposting		
		0 day	30 day	65 day
1	pH	8	7.6	7.3
2	Total nitrogen (%)	0.15	0.23	0.36
3	Available phosphorus (%)	0.78	0.95	1.18
4	Exchangeable potassium (%)	0.090	0.132	0.36
5	C : N ratio	30.9	16.46	5.49

Table.2 Impact of composting period on earthworm number, biomass and cocoon production

Type of Waste	Earthworm Number			Body Weight (gm)			Cocoon Production		
	0 Days	30 Days	65 Days	0 Days	30 Days	65 Days	0 Days	30 Days	65Days
Paper waste	25	28	42	33.75	38.23	55.75	Nil	18	47

Table.3 Impact of vermicomposting on weight loss of organic substrate

Type of Waste	Initial weight of Substrate(gm)	Final weight of Vermicompost(gm)	Loss % during vermicompost
Paper waste	3000gm	1350gm	55

It is clearly evident from the result of Table 1 that the values of total nitrogen, available phosphorus and exchangeable potassium increased over 65 days of vermicomposting. Lowest values of total nitrogen (0.15%), available phosphorus (0.78%) and exchangeable potassium (0.090%) were found in control (0day). Moreover, as the time period increases during vermicomposting, these parameters also increases and their maximum values i.e. total nitrogen (0.36%), available phosphorus (1.18%) and exchangeable potassium (0.22%) were obtained after 65 days of vermicomposting. Gunadi and Edwards, (2002) also carried out a study and demonstrated that after six months of vermicomposting, the nitrogen content in the end product was high. The data shown in table 2 clearly indicates that there was no mortality of worms in the predecomposed paper waste. Garg *et al.*, (2006) while working growth and reproduction of *E. foetida* in animal wastes also opined that precomposting is very essential to avoid the mortality of worms. the changes in biomass and cocoon production were also noted by Suthar , 2007 and attributed the cause of difference in substrate composting quality.

Table.3 clearly indicates that vermibiotechnology reduces the amount of waste and also improes the nutrient content of the product (vermicompost) to be used as a biofertilizer in agricultural practices. Weight loss in case of paper waste was found to be 55%.

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