Vermicomposting of green Eucalyptus leaf litter by *Eisenia foetida* and *Eudrilus eugenia*

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**Abstract**—Effective clearance of different types of waste has become significant to sustain healthy environment. Vermicomposting has become a suitable substitute for the safe, hygienic and cost effective disposal of organic solid wastes. Earthworms decompose organic waste leading to the production of compost which is high in nutrient content. The present work has been designed to reveal competitive and/or beneficial interactions by studying the inter-specific interactions in terms of growth, maturation, survival and vermicomposting efficiency of two earthworm species *Eisenia foetida* and *Eudrilus eugenia* exposed to green leaf litter of *Eucalyptus* and measured physical variables during entire process. The complete process was taken over a period of six weeks. Work was done in plastic beans in four sets. 100 % cattle dung was also taken as a control. During the process following parameters viz. pH, temperature, biomass reduction and moisture content were analysed. pH of vermicomposting substrate was recorded low initially acidic but at last stage set in alkaline range. In case of temperature, it was changed 16-18°C ± 1°C from initial value. This was higher than control cattle dung (13°C± 1°C). Organic biomass was also depleted during process which was about 70-71 % ± 1% from initial level as compared to cattle dung (46 %). Moisture content was lower initially then increased and set at high level.

**Keywords**—Vermicompost, earthworm, *Eucalyptus*, leaf litter, physical parameters.

**I. INTRODUCTION**

Generation of the substantial quantity of leaf litter produced by trees growing in the forests, sideways the roads, rail lines, in the garden as well as in farm has always been problem. Improper management of these leaf waste such as burning, dumping in public place etc. has deteriorate the health and environment. Sustainable remediation practices can only way to resolve this problem (Tilman et al., 2002).

Vermicomposting is an important practice of sustainable remediation, which has been used in many countries and product that obtained by this process called vermicompost. It is rich in plant nutrients. Vermicompost is a microbiologically active organic material formed from the interactions between earthworms and different type of microorganisms (Domínguez, 2004). Through the vermicomposting process, environmental risk of leaf waste material reduces by transforming into a safer and more stable product suitable for application to soil (Lazzcano et al., 2008), and also reduces the transportation costs because of the significant reduction in the water content of the raw organic matter. Composted materials are therefore gaining acceptance as organic fertilizers in sustainable agriculture, and there has been a considerable increase in research dedicated to the study of the effects of compost-like materials on soil properties and plant growth. Vermicompost production have been ever reported from leaf of different plant such as saw dust, paddy straw and wheat straw (Indrajeet and Singh 2010), Sugarcane leaf (Alagesan and Dheeba,2010), Ashoka tree leaf litter (*Polyalthialongifolia*), Teak tree leaves litter (*Tectonagrandis*) and Neem tree leaf litter (*Azadirachtaindica*) (Jayanthi et al., 2010), Tendu leaf litter (Mushan and Rao,2012), Mango and Guava leaf (Vasanthiet. et al., 2013), Rubber leaf litter (Nath and Chaudhuri,2014), Teak leaf litter (Nagalakshmi and Prakash 2016) etc.

We studied the vermicomposting of *Eucalyptus* leaf litter with two different species of earthworms i.e. *Eisenia foetida* and *Eudrilus eugenia*. *Eucalyptus globulus* was discovered on the island of Tasmania in 1792 by French explorers and was one of the first eucalypt species to be formally described. Eucalyptus belongs to the Myraccaceae family in the world, including more than 740 species. It is a long tree to a height of 35 to 40 meters, but it grows to a height from 80 to 100 meters in most of the country. Eucalyptus species is remarkable for their rapid growth. Nearly all Eucalyptus is evergreen but some tropical species lose their leaves at the end of the dry season (Kumar and Sahoo, 2011). Although leaf litters provided shelter and food to the terrestrial life and when it undergoes decomposition to produce nutrients that nourishes the soil. Eucalyptus litter has often been cited as of poor quality and slow breakdown rate (Boulton, 1991), characteristics which are linked to its high content of...
phenolic and tannins, and to its waxy cuticles (Bunn, 1988a; Campbell et al., 1992; Bärlocher et al., 1995). However, this genus has hundreds of different species growing in a wide variety of climatic and edaphic conditions, and showing broad differences in litter texture and composition (Mitchell, 1988). These disparities also show effects on composting of organic biomass (Graciano et al. 2005). The first of these studies suggested that breakdown of low quality leaves such as eucalyptus was mainly increased by concentrations of dissolved nitrogen and phosphorus (Pozo, 1993). Briones & Ineson (1996) also observed that the mass loss of Eucalyptus globulus increases when it mixed with Betula pendula.

In present investigation leaf litter of Eucalyptus sp. Mixed with cattle dung and allowed to vermicomposting. During the process physical parameters were also analysed.

II. MATERIAL AND METHODS

2.1 Collection of plant leaves and cattle dung: In present experiment cattle dung was collected from cattle houses in large-sized rectangular plastic pot containers and was brought to vermicomposting unit, Govt. Madhav Science College Ujjain. Eudrilus eugeniae and Eisenia foetida equally used in this study were obtained from vermiculture centre of Govt. Madhav Science College, Ujjain (M.P.) (Shouche et al. 2011). The leaf litter of Eucalyptus (Eucalyptus globulus) was used as a substrate was collected at random from the College campus of Govt. Madhav Science P.G. College, Ujjain (M.P).

2.2 Preparation for vermicomposting: Collected leaf wastes were chopped into small pieces. The chopped waste was mixed with cattle dung in 50:50 ratios. Control of both cattle dung (100 %) and leaf litter (100 %) was also taken for study.

2.3 Process of vermicomposting: Vermicomposting process was done in plastic container. Mixture was prepared and kept in bins (plastic container) and were kept in vermicomposting room. The windrow compost method was used which composting materials was not covered and ventilation was not provided with pipes. Waste materials were agitated or turned on a regular basis for enhances passive aeration (NRAES, 1992). Bins were sprinkled with distilled water after turning it upside down to maintain high moisture content. The waste was pre-decomposed for fifteen days prior adding of earthworms. Twenty earthworms (E. eugeniae and E. foetida) were added in each composting bins (Singh et al. 2004). As the surface appear black granular indicated vermicomposting process almost completed. At this stage Watering was stopped before seven days of harvest. Prepared vermicompost was stacked so that the earthworms settle at bottom and the vermicompost was collected from the top without disturbing the bottom layers. The harvested vermicompost was filtered through fine sieve in order to get fine uniform vermicompost.

2.4 Measurement of physical parameters: During vermicomposting of green Eucalyptus leaf litters some physical variables viz. pH, temperature, biomass reduction and moisture changes were measured. Determination of pH was done by a digital pH meter, electrical conductivity by a conductivity meter using 1:10 (w/v) vermicompost-water (double distilled) suspension. (Alidadi et al., 2005; Munnoli and Bhosle, 2009). Temperature was taken with the help of Mercury thermometer at the depth of 10 cm from two different sites and their mean value was taken in centigrade (Shouche et al. 2011). Biomass reduction was measured with the help of scale in centimetre. For moisture measurement, 5 gm. sample was taken, and then kept it in incubator for 24 hrs. at 105°C. After drying, dry weight was taken and on that basis percentage of moisture was determined (Fairey, 2002)
III. RESULT AND DISCUSSION

Most of the organic wastes when subjected to the feeding by earthworm also involve microorganisms then it converted into blackish powdery form called vermicompost. In present investigation leaf litter of Eucalyptus was used as organic substrate separately or with cattle dung in 50:50 ratios. During vermicomposting physical variables were also measured.
Table 1: Variation in pH, temperature, biomass reduction and moisture percentage during vermicomposting of green Eucalyptus leaf litter.

| No. of Weeks | pH          | Temperature in °C | Biomass depletion in Centimetre | Moisture percentage |
|--------------|-------------|-------------------|---------------------------------|---------------------|
|              | 100 % EL   | 50 % EL+ 50 % CD | 100 % EL | 50 % EL+ 50 % CD | 100 % EL | 50 % EL+ 50 % CD | 100 % EL | 50 % EL+ 50 % CD | 100 % CD |
| 1            | 5.5         | 5.6              | 33.7 | 36.3 | 38.5 | 28.9 | 26.42 | 14.84 | 67.62 | 64.33 | 60.35 |
| 2            | 6.2         | 5.4              | 32.6 | 34.4 | 35.4 | 25.39 | 23.45 | 12.78 | 69.36 | 64.45 | 61.37 |
| 3            | 6.5         | 5.7              | 30.6 | 32.5 | 33.8 | 23.86 | 21.23 | 11.11 | 70.28 | 65.45 | 62.95 |
| 4            | 6.7         | 5.9              | 28.7 | 29.8 | 32.5 | 20.42 | 19.84 | 10.68 | 72.53 | 66.69 | 63.83 |
| 5            | 6.9         | 7.2              | 27.5 | 28.8 | 29.9 | 18.77 | 17.38 | 10.34 | 74.29 | 67.79 | 64.69 |
| 6            | 7.2         | 7.3              | 26.7 | 26.9 | 27.5 | 16.57 | 15.83 | 9.72  | 75.58 | 68.83 | 64.89 |
| 7            | 7.3         | 7.4              | 24.9 | 25.7 | 25.5 | 14.42 | 14.89 | 8.74  | 75.43 | 70.52 | 65.65 |
| 8            | 7.5         | 7.5              | 21.9 | 24.5 | 24.7 | 13.83 | 13.95 | 7.95  | 77.75 | 71.19 | 66.28 |
| 9            | 7.6         | 7.7              | 21.6 | 22.9 | ----| 11.59 | 12.25 | ----  | 78.92 | 72.78 | ---- |
| 10           | 7.7         | 7.8              | 20.8 | 21.7 | ----| 10.9  | 10.52 | ----  | 79.35 | 73.32 | ---- |
| 11           | 7.8         | 7.9              | 20.3 | 21.6 | ----| 9.37  | 9.58  | ----  | 80.65 | 74.35 | ---- |
| 12           | 7.9         | 8.0              | 19.6 | 20.6 | ----| 9.22  | 9.12  | ----  | 80.89 | 75.49 | ---- |
| 13           | 8           | 8.1              | 18.8 | 19.7 | ----| 8.65  | 8.1   | ----  | 81.35 | 75.39 | ---- |

Note: EL=Eucalyptus leaf, CD = cattle dung.

During measurement of pH it was found that initially pH in both 100% and 50 % leaf waste was in acidic (5.5 ±0.2) as compared to alkaline in 100 % cattle dung (8.5±0.2). As process increased the pH was turn into alkaline and at the end of process set at alkaline range (8.0±0.2) while in control (100 % cattle dung) it was decreased and set around 8.0±0.2. The observed differences between the pH at the start and end of vermicomposting were +2.5, +2.5 and -0.5 in 100% leaf, 50 % leaf and 100 % cattle dung respectively. Our result concordance with Venkatesh and Eevera (2008) who have studied reduction and recovery of nutrients though vermicomposting by using Eudrilus eugeniae for a period of 60 days and stated that the final pH content of the vermicompost was towards the alkaline side. The initially lower pH was recorded due to production of organic acid.
and CO₂ by microorganisms due to presence of carbohydrate abundantly (Elvira et.al. 1998; Haimi and Huhta 1986). As carbohydrate source depleted, microbial metabolism shift into nitrogenous organic compound which leads to generate ammonia as a result pH turn increase (Ndewga et.al. 2000).

During vermicomposting, temperature was also measured throughout the process which showing in graph no. 4. It was observed that at beginning stage temperature was high that gradually decreased and at the end of vermicomposting set at constant level. Initial temperature of 50 % leaf waste was higher (36.3°C) than 100 % leaf waste (33.7°C) as compared to control that was 100 % cattle dung (38.5°C). After completion it was decreased up to around 19°C±1°C. The similar result also found with study of other researchers. Atchley and Clark (1979) carried out composting of different organic substances viz. card board, news paper, paper towel etc. and found that temperature was risen up to 60°C±2°C and fall down with in 24h. According to Mckinley and Vestal (1985), during composting of municipal sewage waste, temperature was raised in between 55-60°C initially then it was down gradually. Allan, (1979) concluded that the temperature of the composting pile was raised due to the biological oxidation of carbon.

The higher temperature in 50 % leaf was due to presence of more microbial community than 100 % leaf waste because the cattle dung serves the purpose of providing inoculum of microbes which carry out degradation of organic waste. During the process of composting, mesophilic flora predominates with their metabolic activity resulting in the increase in temperature of the organic waste. They are replaced by thermophilic organisms which survive at temperatures greater than 45°C to facilitate composting. When the temperature gets fall, mesophilic microorganism are become again active (Ansari, 2011).
The result of biomass reduction is shown in table no.1 and graph no.5 revealed that height of biomass showed decrease than initial contents in both 100 % leaf litter and 50 % leaf litter with 50 % cattle dung after decomposing wastes through earthworms. Initially height of biomass were 28.9 cm. (100 % leaf litter), 26.42 cm. (50 % leaf litter) as compared to cattle dung (14.84 cm) which depleted and set at 8.65 cm., 8.1 cm. and 7.95 cm. respectively. The maximum depletion was 71 % in 100 % leaf litter (70 % in 50 % leaf litter) as compared to 46 % in control (100 % cattle dung). The loss of carbon as CO₂ due to microbial respiration and assimilation of simple carbohydrates leads to biomass reductions from waste mixtures. Moreover, carbohydrates and other polysaccharides which are considered major source of carbon are digested rapidly by earthworms and some fraction of digested substances is then assimilated into worm biomass. The greater biomass reduction may be due to microbial richness of substrate materials. In such beddings the microbial respiration may lead to rapid C loss through CO₂ production. Also, earthworm fragments the waste feedstock into fine fractions which results in increased sites for microbial hydrolytic enzyme actions. The biological mutuality between earthworms and associated microbes is primarily responsible for C loss from the organic wastes. Kaviraj and Sharma (2003) reported 20–45% reduction in organic carbon contents of vermicomposted municipal solid waste mixed with CD. Similar observations have been reported by Prakash and Karmegam (2010) during vermicomposting of press-mud from sugar industry.
As shown in table 1 and figure 4, the level of moisture content in leaf litter was found to be maximum on 14th week of vermicomposting. Moisture is critical to the survival of earthworm species because it is the moisture within worm’s body that gives it shape, enables it to move and aids in the worm’s ability to absorb oxygen and it is also helpful for higher microbial activity due to which food matter is easy to feed upon. Moisture level was maintained at around 70% by addition of water every after 5th day. It was notice that initially moisture level was lower and then increased day by day. During vermicomposting process due to microbial decomposition of organic matter, heat is generating that turn water into vapour and moisture content decrease initially. As organic matter consumed, no further heat generate and in that condition moisture level remain high.

IV. CONCLUSION
In the present investigation, Eucalyptus green leaf litter waste was decomposition by E. foetida and E. eugenieae and produced vermicompost that had an increased level of moisture level, pH and decreased level of biomass and temperature. This process was also taken one hundred days (14 weeks) for turn leaf into vermicompost. The present study clearly suggests that either leaf or cattle dung vermicomposted separately with earthworm but if leaf litter mixed with cattle dung then degradation rate of leaf litter increase comparatively. The study recommends that Eucalyptus leaf wastes is suitable mix for making vermicompost rich in nutrients and microorganisms which can be used as suitable organic soil amendment.

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