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 fourteen 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 compaired 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 detoriate 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 (Lazcano *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 (Vasanthi*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 Myraceae 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.

Before chopping

After chopping

Fig.1: Green Eucalyptus leaf used in experiment.

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)

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Fig.2: Different stages of vermicomposting of green Eucalyptus leaf.

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.

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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 % CD	100 % EL	50 % EL+ 50 % CD	100 % CD	100 % EL	50 % EL+ 50 % CD	100 % CD	100 % EL	50 % EL+ 50 % CD	100 % CD
1	5.5	5.6	8.5	33.7	36.3	38.5	28.9	26.42	14.84	67.62	64.33	60.35
2	6.2	6.4	8.4	32.6	34.4	35.4	25.39	23.45	12.78	69.36	64.45	61.37
3	6.5	6.7	8.3	30.6	32.5	33.8	23.86	21.23	11.11	70.28	65.45	62.95
4	6.7	6.9	8.2	28.7	29.8	32.5	20.42	19.84	10.68	72.53	66.69	63.83
5	6.9	7.2	8.2	27.5	28.8	29.9	18.77	17.38	10.34	74.29	67.79	64.69
6	7.2	7.3	8.1	26.7	26.9	27.5	16.57	15.83	9.72	75.58	68.83	64.89
7	7.3	7.4	8.1	24.9	25.7	25.5	14.42	14.89	8.74	75.43	70.52	65.65
8	7.5	7.5	8.0	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.

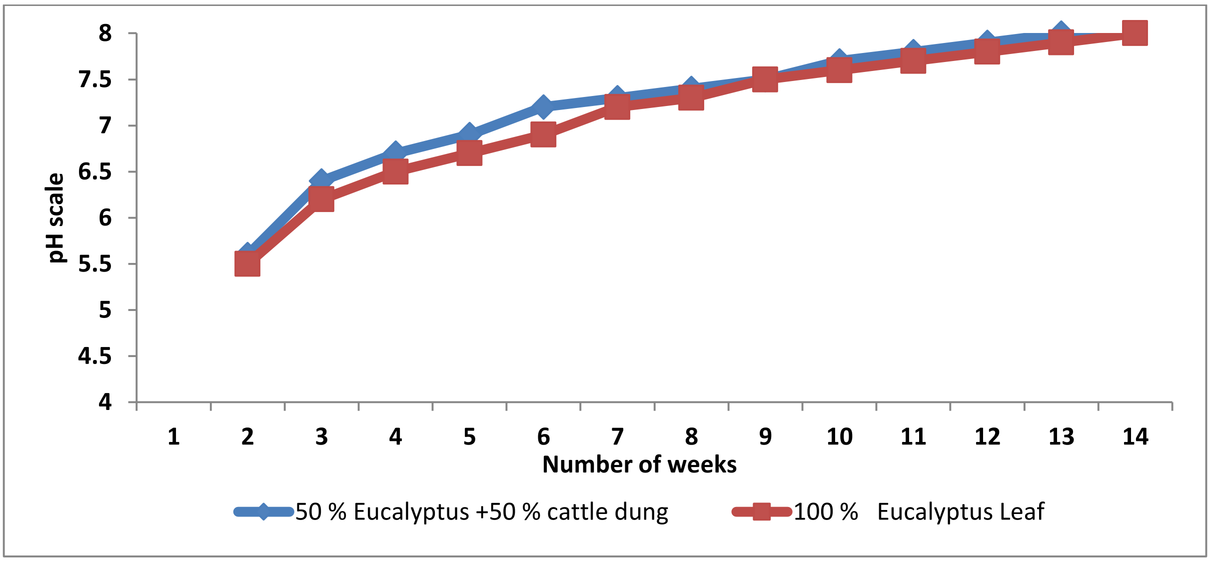

Fig. 3: Graph showing drift of pH during vermicomposting of green Eucalyptus leaf litter.

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 compaired 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

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and CO_2 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 (Ndegwa *et.al*. 2000).

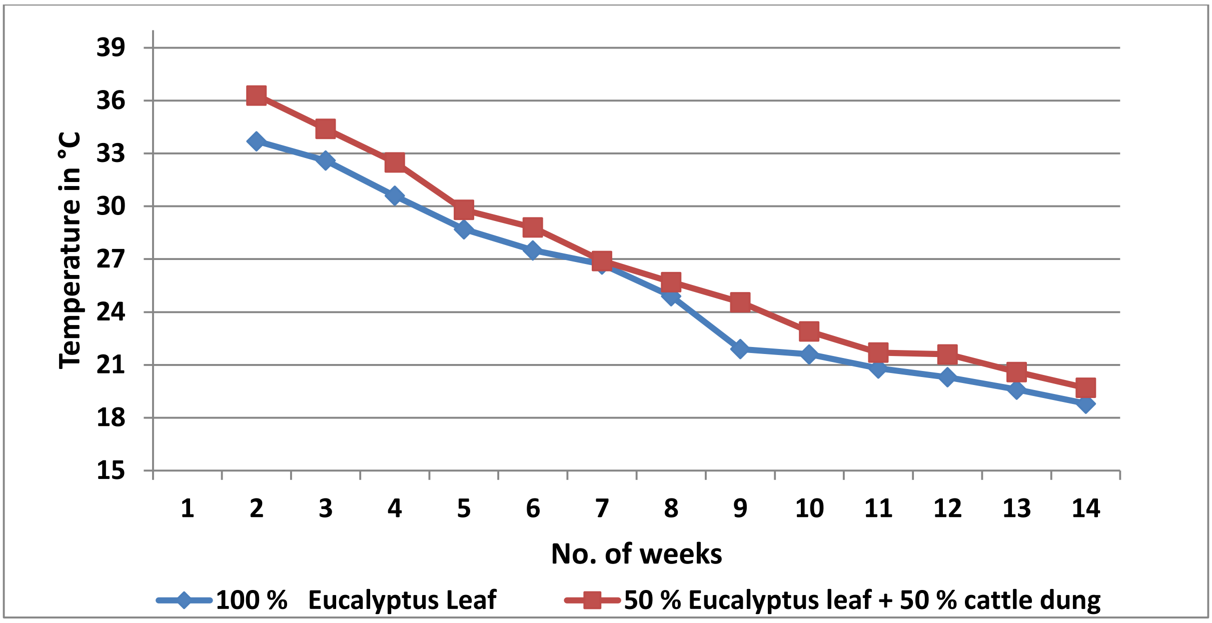

Fig. 4: Graph showing changes in temperature during vermicomposting of green Eucalyptus leaf litter.

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 compaired 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).

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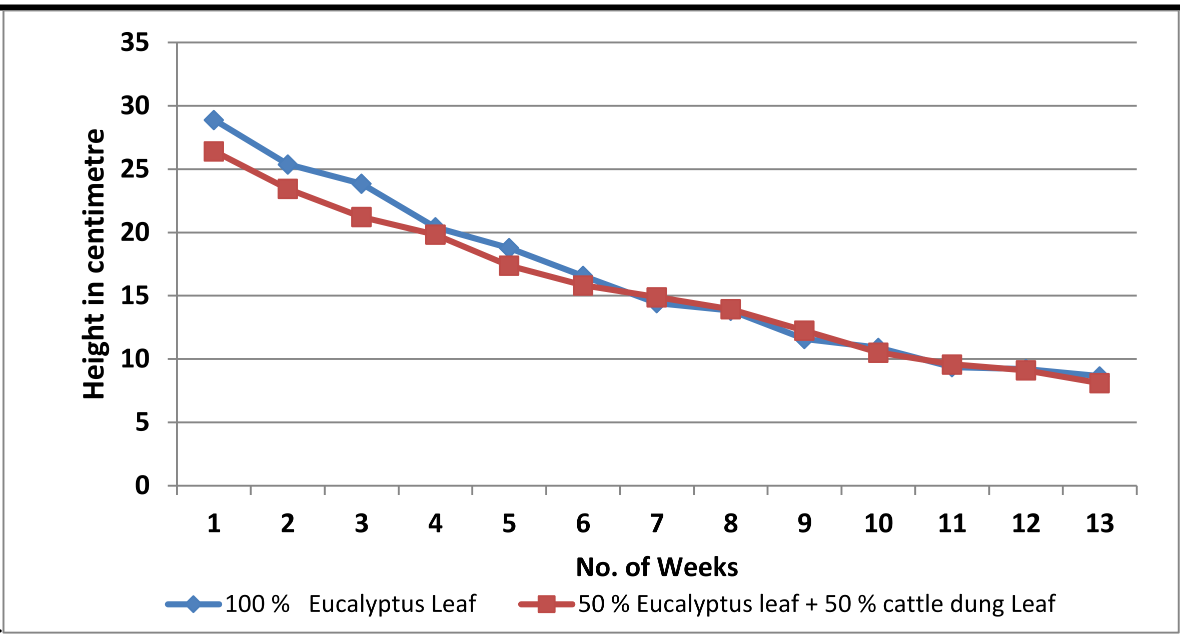

Fig. 5: Graph showing reduction in biomass during vermicomposting of green Eucalyptus leaf litter.

The result of biomass reduction is shown in table no.1 and graph no.5 revelled 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 compaired 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 compaired to 46 % in control (100 % cattle dung) .The loss of carbon as CO_2 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 leads to rapid C loss through CO_2 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.

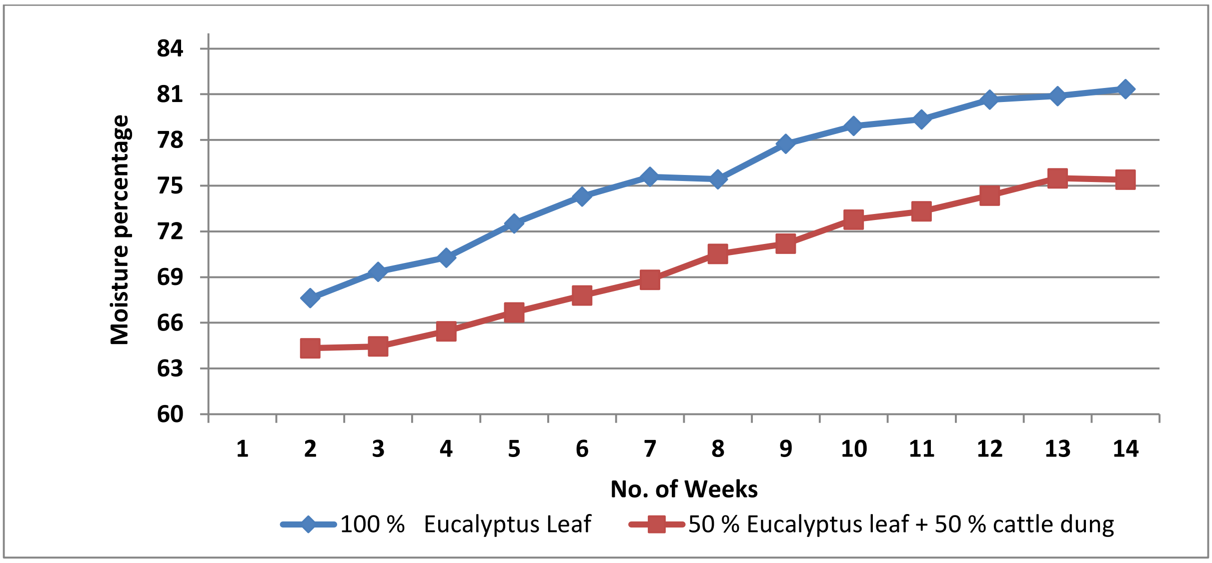

Fig. 6: Graph showing changes in moisture percentage during vermicomposting of green Eucalyptus leaf litter.

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 5^{th} 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. eugeniae 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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REFERENCES

[1] P. Alagesan, and R. Dheeba (2010).Utilization of earthworms in organic waste management. *Proceedings of the 15th International Forestry and Environment Symposium*.26-27

[2] Alidadi H., Paravaresh A. R., Shahmansouri M. R. and Pourmoghadas P. (2005) Combined compost and vermicomposting process in the treatment and bioconversion of sludge. *IranJ. Environ. Health. Sci. Eng.* 2(4),251-254.

[3] Allan F.M.B.(1979).Resource recovery and recycling.John Wiley &Sons.USA.

[4] Ansari A. A.(2011.).Vermitech: an innovation in organic solid waste management.*Journal of Sustainable Development and Environmental Protection*.1(1), 107–113,

[5] Atchley K and Clark J. B.(1979). Variability of temperature, pH, and moisture in an aerobic composting process. *Applied and Environmental Microbiology*. 38(6),1040-1044.

[6] Bärlocher F., C. Canhoto& M. A. S. Graça.(1995). Fungal colonization of alder and eucalypt leaves in two streams in central Portugal. *Arch. Hydrobiol*. 133, 457–470.

[7] Boulton A. J.(1991). Eucalypt leaf decomposition in an intermittent stream in south-eastern Australia. *Hydrobiologia*.211,123–136.

[8] Briones M.J.I, Ineson P. (1996). Decomposition of eucalyptus leaves in litter mixtures. *SoilBiol. Biochem.* 28,1381–88.

[9] Bunn S. E., (1988a). Processing of leaf litter in a northern jarrah forest stream, western Australia: I. Seasonal differences. *Hydrobiologia*. 162, 201–210.

[10] Campbell I. C., James K. R.,Hart B.T.&DevereauxA. (1992). Allochtonous coarse particulate organic material in forest and pasture reaches of two south-eastern Australian streams. II. Litter processing. *Freshwat. Biol*. 27, 353–365.

[11] Domínguez J. (2004). *State of the art and new perspectives on vermicomposting research*. In: C.A. Edwards (Ed.). Earthworm Ecology (2nd edition). CRC Press LLC. 401-424.

[12] Elvira C.,Sampedro L, Benitz E, Walter I, &Calbo R (1998).Vermicomposting of sludge from paper mill and dairy industries with Eisenia Andrei: A pilot scale study. Bioresource Technology.63:205-211.

[13] Fairey N.A.(2002). An evaluation of five methods for the determination of moisture in grass seeds, *Can. J. Plant Sc.*, 82(2), 401-405.

[14] FaireyN.A.(2001) An evaluation of five methods for the determination of moisture in grass seeds. *CanadianJournal of Plant Science*.401-405.

[15] Graciano C, Guiamet, JJGoya. JF(2005). Impact of nitrogen and phosphorus fertilization on drought responses in *Eucalyptusgrandis*seedlings. *For. Ecol. Manage*. 212, 40-49.

[16] Haimi J andHuhta V,(1986).Capacity f various organic residues to support adequate earthworm biomass for vermicomposting. *Biology and fertility of soils*.2,23-27.

[17] Indrajeet and Singh, J. (2010). Preparation of recipe for quality production of vermicompost. *Journal of recent advances in applied sciences* (JRAAS) 25,12-14.

[18] JayanthiB., Ambiga G. and Neelanarayanan P. (2010). Utilization of mixed leaves litter for converting into vermicompost by using an epigeic earthworm *Eudrilus eugeniae*.*Nature Environment and Pollution Technology*. 9(4),763-766.

[19] Kaviraj, Sharma, S.(2003)**.** Municipal solid waste management through vermicomposting employing exotic and local species of earthworms. *Bioresour. Technol*. 90 (2), 169–173.

[20] Kumar H.D. and Sahoo L. (2011).A review onPhytochemical and pharmacological of *Eucalyptus globulus*:A multipurpose tree.*International Journal of Research in Ayurveda & Pharmacy*.2 (5),1527-1530.

[21] Lazcano C., Gómez-Brandón, M. and Domínguez, J. (2008). Comparison of the effectiveness of composting and vermicomposting for the biological stabilization of cattle manure. *Chemosphere*, 72, 1013-1019.

[22] Mckinley, V. L. and Vestal, R.(1985) Physical and chemical correlates of microbial activity and biomass in composting municipal sewage sludge. *Applied and Environmental Microbiology*. 50(6), 1395-1403.

[23] Mitchell A.(1988). A field guide to the trees of Britain and Europe.2nd. ed., Collins & Sons Ltd.

[24] Munnoli P. M. and Bhosle S. (2009) Effect of soil and cow dung proportion on vermicomposting by deep burrower and surface feeder species, *J. Sc. Industr. Res.* 68(1), 57-60.

[25] Munnoli P.M. and BhosleS.(2009) Effect of soil and cow dung proportion on vermin-composting by deep burrower and surface feeder species. *Journal of Scientific and Industrial Research*.68,57-60.

[26] Mushan, L.C. and Rao, K. R.(2012). Physico-chemical analysis of tendu leaf litter vermicompost processed By E*udrilus eugeniae*. *DAV International Journal of Science* 1(2),100-102.

[27] Nagalakshmi P. K. and Prakash, M.(2016). A Microcosm Study of Cast and Gut of an epigeic earthworm *Perioynxceylanensis*reared on different substrates**.** *Int. J. Curr. Trend. Pharmacobiol. Med. Sci.*1(2),45-51.

[28] Nath, S. and Chaudhuri, P. S.(2014).Growth and reproduction of *Pontoscolexcorethrurus* (Muller) with different experimental diets. *Tropical Ecology* .55(3),305-312.

[29] Ndegwa PM,&Thompson SA, (2000). Effects of C-to-N ratio on vermicomposting in the treatment and bioconversion of biosolids. *Bioresource technology*.76,107-112.

[30] NRAES (1992). On-farm composting (Ed. Rynk, Robert). Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, Ithaka, New York.

[31] Pozo, J.(1993). Leaf litter processing of alder and eucalyptus in the Agüera stream system (North Spain). I. Chemical changes. *Arch. Hydrobiol*. 127, 299–317.

[32] Prakash, M. &Karmegam, N.(2010). Vermi stabilization of press mud using *Perionyxceylanensis* Mich. *Bioresource Technology*.10 , 8464–8468.

[33] Shouche, S. Bhati, P. and Pandey, P. (2011). Study about the changes in physical parameters during vermicomposting of floral wastes. *Journal of Environmental Research and Development.*6(1),63-68.

[34] Singh N.B., Khare A.K., BhargavaD. and Bhattacharya, S.(2004).Effect of substrate depth on vermicomposting. *Journal-EN*. 85,16-21.

[35] Tilman D., Cassman K.G., Matson P.A., Naylor R.and Polasky S. (2002). Agricultural sustainability and intensive production practices. *Nature*, 418, 671-677.

[36] Vasanthi K., Chairman K., and Ranjit Singh A.J.A.(2013).Vermicomposting of leaf litter ensuing from the trees of Mango *(Mangiferaindica)* and Guava *(Psidiumguujuvu)* leaves.*International Journal of Advanced Research*. 1(3),33-38.

[37] Venkatesh R.M. and Eevera T. (2000).Mass reduction and recovery of nutrients through vermicomposting of fly ash. *Applied Ecol. Environ. Res.* 6(1),77-84.