NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 2, ISSUE 6, JUNE-2015

RECYCLING OF SOLID WASTES INTO ORGANIC FERTILIZERS USING LOW COST TREATMENT: VERMICOMPOSTING

P.B.Londhe,
M. Tech. Environmental Science And Technology,
Department Of Technology, Shivaji University, Kolhapur, India

S.M.Bhosale
(Assistant Professor Department Of Technology,
Shivaji University, Kolhapur, India)[2]

ABSTRACT

Increasing in the human population, urbanization and change in life style has increased the waste load and there by pollution loads on the urban environment to unmanageable and alarming proportions. The existing waste dumping sites are full beyond capacity and under unsanitary conditions leading to pollution of water sources and spreading communicable diseases, foul smell and odors, release of toxic metabolites, unaesthetic ambiance and eye sore etc. Vermcomposting is the better option to tackle with this problem. It is the process of conversion of organic wastes by earthworm to valuable humus like material which is used as a natural soil conditioner.Vermicompositing is environment friendly and cost effective technique for solid waste management. It serves two main purposes for the welfare of humans as it helps in the degradation of solid waste and the cast produced during this process is used as a natural fertilizer. This technique is much better than chemical fertilizer because it is not associated with any kind of risk. Earthworms are potentially important that are capable of transforming garbage into gold. Eisenia fetida is the most commonly used species of earthworms for vermicomposting.

The vermicomposting was done for 45 days in which E. fetida earthworm were used. There were four substrate prepared of different composition. The present study was carried out for recycling of different type of organic waste. Four different phases is to be preparing by using different type of partially decomposable organic waste. Eisenia fetida is introduced in each of these four partially decomposable phases. Moisture content in bed is maintained by spreading water over it and to cover with moist gunny bag. The temperature was monitored at every week. The parameter such as pH, electrical conductivity, C/N Ratio, N, P and K are measure during the specifics interval of time in which result show that the nutrient content at the end of 45 day is increases. Vermicompost is the process which will convert organic waste into valuable fertilizer.

KEYWORDS: Eisenia fetida, Earthworm, NPK, organic waste, Vermicomposting**.**

INTRODUCTION

Solid waste is defined as the organic and inorganic waste materials produced by different sources and have lost value in the eye of their owner. It has been estimated that India, as a whole, generates as much as 25 million tones of urban solid waste of diverse composition per year. But per capita waste production in India is minisculous compared to the per capita production of wastes in the industrialized countries. It is estimated that the per capita waste generated in India is about 0.4 kg/day with the compostable matter approximately 50-60%. Most common practices of waste processing are uncontrolled dumping which causes mainly water and soil pollution. Besides dumping or sanitary land filling, the final disposal of solid waste can be carried out by other methods like incineration and composting.

In order to meet the solid waste load, the solid waste from various sources is recycled reuse. One such onsite method of solid waste management is vermicomposting. Vermicomposting technology is globally becoming a popular solid waste management technique. Vermicomposting is the bioconversion of organic waste into a bio-fertilizer due to earthworms' activity. The earthworms feed on the organic waste and the earthworms' gut acts as a bioreactor whereby the vermicasts are produced. By the time the organic waste is excreted by the earthworms as vermicasts, it will be rich in nitrogen (N), phosphorous (P) and potassium (K) as well as trace elements depending on the feedstock type used. The vermicomposting process is a mesophillic process and operating conditions such as temperatures, pH, electrical conductivity and moisture content levels must be optimized. Normally, the vermicomposting process takes place in vermi-reactors which include plastic, earthed pots and wood worm bins.

There are an estimated 1800 species of earthworm worldwide. But the most commonly used is Eisenia fetida, commonly known as the "compost worm", manure worm, 'red worm', and red wiggler. Worms can digest several times than their own weight each day and large quantities of excreta are passed out through an average population of earthworm. Amount of substrate consumed depends upon substrate properties and environmental conditions.

MATERIAL AND METHOD

1. Pre-composting:

The shredded organic wastes are spared in layer and expose to sunlight for 5 to 10 days to remove pathogenic microorganisms and noxious gases. The pre composting process takes 5 to 10 days for their completion except cotton waste which require 20 to 25 days for their decomposition.

2. Collection of material:

The material required for vermicomposting such as vegetable waste, fruit waste are collected from house. Also paper wastes are collected from department of technology. While remaining material such as soil, cow dung, and coconut shell, agricultural wastes are collected from nearby farm house.

3. Collection of earthworm species:

Earthworms are collected from vermicomposting center, located in Zill Parishad Office, Kolhapur.

4. Substrates used for vermicomposting:

Followings are the substrates used for vermicomposting process:

T1	Soil + Cow dung (0.5-1)
T2	Soil + vegetable + fruit waste (1:1)
T3	Soil + agricultural waste + cow dung (1:1)
T4	Soil + paper waste +cow dung (1:1)

5. Experimental-design or Vermicomposting:

The Vermicomposting was done in Plastic Boxes (42 x 24 x 18 cm) under shed condition. In to 4 set of experiment were conducted for Vermicomposting. In each set of experiment four different type of waste is used. In this experiment, four pots T1 to T4 were arranged. The important parameter i.e. moisture and temperature were controlled by means of spraying water over the bed thereby, the temperature maintain not to exceeding 35°C by placing wet gunny bags over bed and moisture were maintained between 50-60% at least 20 adult Eisenia Fetida was introduced in each tray. And the pre compost was finally covered with mat to protect earthworm from bird. The appearance of black granular powder on top of vermin beds indicates harvest stage of compost. Watering was stopped for at least 5 days at this stage and vermicompost was collected from the top without disturbing the lower layer. Liner is provided at the bottom of the boxes and finally fills up the material in it.

6. Preparation of Boxes:

Vermicomposting can be made in concrete tanks, wooden boxes, and plastic boxes or in mud pots. Depending on the availability of the raw material and land it may vary. We are choosing the plastic boxes for our project work.

Table. No.1. Preparation of vermin bed

LAYER	INGERIDENTS
7 th Layer	Soil (2cm)
6 th Layer	Cow dung (2 cm)
5 th Layer	Earthworm species (1 cm)
4 th Layer	Vegetable waste, fruit waste, agricultural waste, paper waste, etc.(3 cm)
3 th Layer	Soil (3 cm)
2 th Layer	Coconut shell (3 cm)
1 th Layer	Liner (1 cm)

Fig. No.1. Preparation of vermin bed

CHEMICAL ANALYSIS:

In the continuous process operation study, the pit was filled up with different solid waste constituents with use of Eisenia Fetida are the common type of earthworm species. To maintain the moisture content in the pit, the water is sprinkle on the pit. The initial and periodically characteristics of the solid waste were analyzed during the period of two months. The parameter studied were pH, N, P, K, C/N Ratio, OC, EC, etc. The analysis was carried out in two sets 20 days and 45 days. The 20 days analysis was done during the month of April, 2015 and 45 days during at the end of the month of April, 2015. The results are shown in the table (with respective parameter) 2 and 3.

Table. No.2. 20 days analysis of vermicomposting sample

Sr. No	Parameter	Initial	B1	B2	B3	B4
1	pH	7.30	7.41	6.67	6.24	6.78
2	EC	3.75	3.64	3.12	3.49	3.62
3	OC	21.4	19.7	18.8	15.1	17.2
4	TN	0.91	0.98	1.02	1.03	0.95
5	TP	0.22	0.23	0.24	0.29	0.23
6	TK	0.18	0.24	0.34	0.29	0.30
7	C:N	23.51	20.10	18.43	14.66	18.10

Table. No.3. 45 days analysis of vermicomposting sample

Sr. No	Parameter	B1	B2	B3	B4
1	pH	6.97	6.89	6.51	6.60
2	EC	3.51	2.97	3.24	3.47
3	OC	18.2	16.6	10.4	16.3
4	TN	1.12	1.14	1.09	0.99
5	TP	0.25	0.26	0.33	0.24
6	TK	0.31	0.47	0.43	0.45
7	C:N	16.25	14.56	9.54	16.46

RESULT AND DISCUSSION

1. pH:

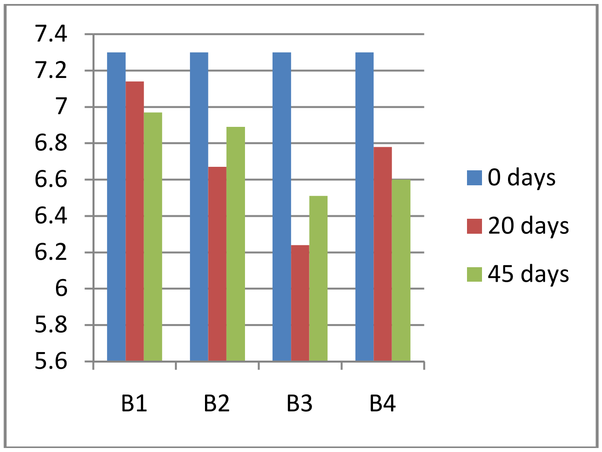
The pH of solid waste constitutions was checked after 20 days and 45 days. For, the initial 20 days the pH decreased. The lowering of pH due to productions CO_2 which was an acidic gas and when it came in contact with water it might had formed carbonic acid, due to which pH had decreased. But after some days the pH was B2 and B3 increased gradually during vermicomposting because the progressive utilization of organic acids and decomposition of organic waste. Near neutral pH of vermicompost may be attributed by the secretion of NH4+ ions that reduce the pool of H+ ions. Neutral pH helpful for effective decomposition and Due to mixing of inoculants increases their pH value.

The initial pH value of all pit is 7.30. While after 20 days, value of B1, B2, B3 and B4, is 7.14, 6.67, 6.24, and 6.78 respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 6.97, 6.89, 6.51, and 6.60. The variation of pH is as shown below in table No.10. The variation in pH with respect time days is as shown in graph No.1.

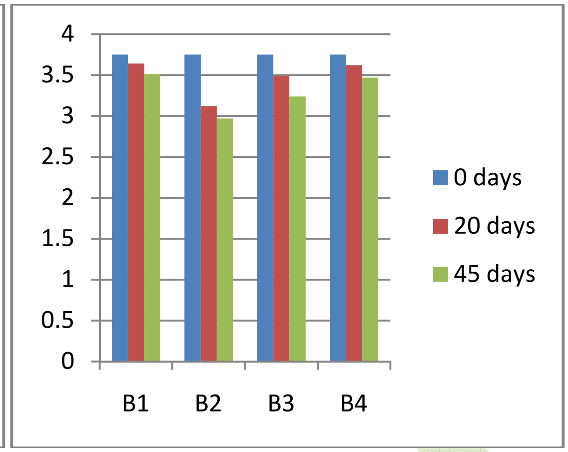
2. Electrical conductivity:

The electrical conductivity of all the bed was considerably decreasing during the vermicomposting process. The reduction of EC in all beds shows the reduction of salinity (mineral salt) considerably. The lower level of salinity is the essential character of good bio-compost which is better for crop growth. The low value Electrical conductivity shows the greater the decomposition rate. A decrease in the electrical conductivity values in vermicompost may be due to the presence of exchangeable Ca, Mg, and K.

The initial EC value of all pits is 3.75. While after 20 days, value of B1, B2, B3 and B4, is 3.64, 3.12, 3.49 and 3.62, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 3.51, 2.97, 3.24, and 3.47. The variation of EC is as shown below in table No.11. The variation in EC with respect time days is as shown in graph No.2.



Graph No.1.



Graph No.2.

3. Organic Carbon:

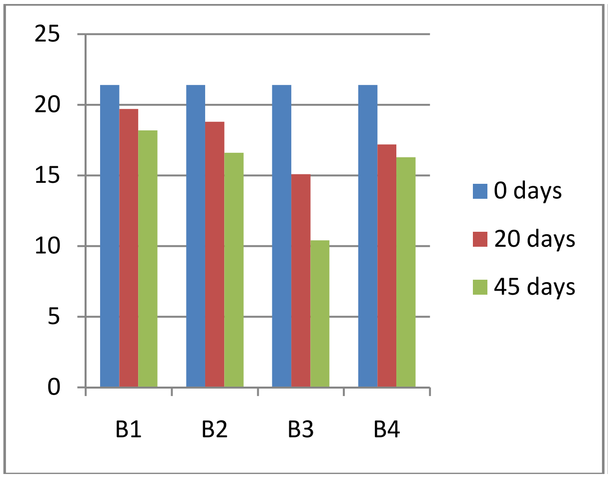
In general, Organic Carbon loss has been observed during the vermicomposting process. Earthworm modifies substrate conditions, which consequently affects carbon losses from the substrates through microbial respiration in the form of CO2 and even through mineralization of organic matter. A large fraction of organic matter in the initial substrates was lost as CO2 by the end of the vermicomposting period.

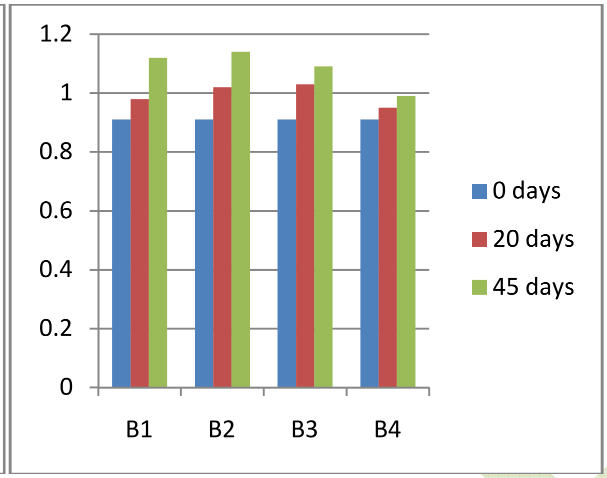
The initial OC value of all pits is 21.4. While after 20 days, value of B1, B2, B3 and B4, is 19.7, 18.8, 15.1, and 17.2, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 18.2, 16.6, 10.4, and 16.3. The variation of OC is as shown below in table No.12. The variation in OC with respect time days is as shown in graph No.3.

4. Total Nitrogen:

The Total Nitrogen present in the vermicompost is depending upon the nitrogen content of waste used. The Total Nitrogen is increasing about 12% to 16% due to the recycling of Nitrogen in the process. The TN in the graph shows increase during every interval. The involvement of nitrogen also depends on number of earthworm and types of earthworm used in compost. The inoculation of worms in waste material considerably enhances the amount of N due to earthworm mediated nitrogen mineralization of wastes. It also suggested that the earthworm enhances the nitrogen levels of the substrate by adding its excretory products, mucus, body fluid, enzymes and even through the decaying tissues of dead worms in vermicomposting sub-system.

The initial TN value of all pits is 0.91. While after 20 days, value of B1, B2, B3 and B4, is 0.98, 1.02, 1.03, and 0.95, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 1.12, 1.14, 1.09, and 0.99. The variation of TN is as shown below in table No.13. The variation in TN with respect time days is as shown in graph No.4.





Graph No.3. **Graph No.4.**

5. Total Phosphorous:

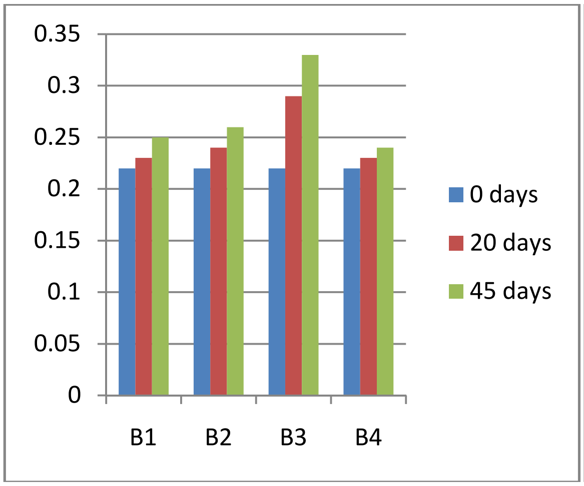
The TP in the graph shows increase during every interval. The passage of organic residue through the gut of earthworm, results in phosphorous converted to forms, which are available to plants. The release of phosphorous in available form is performed partly by earthworm gut phosphates, and further release of P might be attributed to the P-solubilizing microorganisms present in worm casts. The earthworm responsible for increase in phosphorous in soils. The increase in Total Phosphorus content reveals that the vermicomposting process is in order.

The initial TP value of all pits is 0.22. While after 20 days, value of B1, B2, B3 and B4, is 0.23, 0.24, 0.29, and 0.23, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 0.25, 0.26, 0.33, and 0.24. The variation of TP is as shown below in table No.14. The variation in TP with respect time days is as shown in graph No.5.

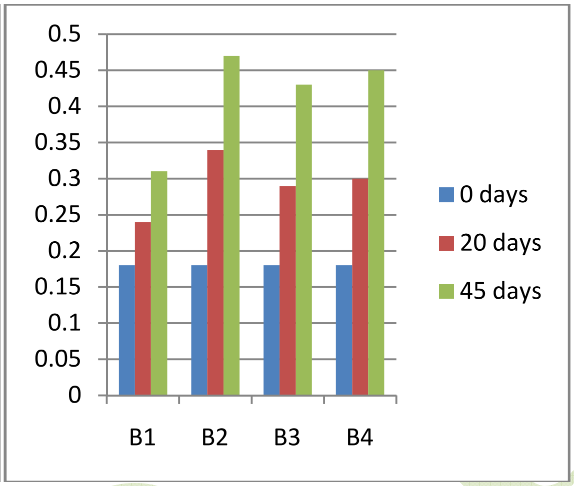
6. Total Potassium:

The concentration of Total Potassium in the vermicomposting manure is as shown in graph. The amount of potassium is increases gradually which is also depend on the amount of raw organic waste used. The increasing of content of total Potassium shows that the composting is taking place in well order.

The initial TK value of all pits is 0.18. While after 20 days, value of B1, B2, B3 and B4, 0.24, 0.34, 0.29, and 0.30, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 0.31, 0.47, 0.43 and 0.45. The variation of TK is as shown below in table No.15. The variation in TK with respect time days is as shown in graph No.6.



Graph No.5.

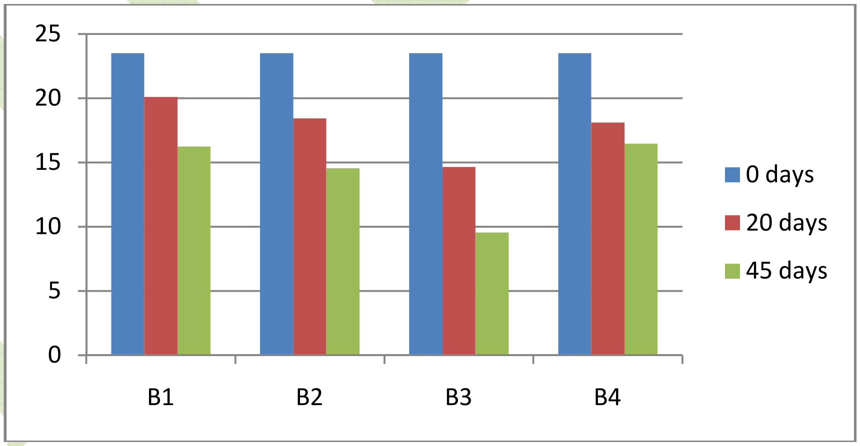


Graph No.6.

7. C:N Ratio:

The C/N ratio gradually deceases. The carbon content present in the organics was utilized as source of energy for earthworms. And simultaneously, the Nitrogen is being recycled in the compost. During this process, the casting of earthworms in turn enriches the macronutrients such as N, P, and K and hence bio compost will become as an organic fertilizer. The C/N ration is about 15 to 20:1 for good compost. But the C/N ratio is depends upon the quality of raw organic waste used.

The initial C:N value of all pits is 23.51. While after 20 days, value of B1, B2, B3 and B4, 20.10, 18.43, 14.66, and 18.10, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 16.25, 14.56, 9.54, and 16.46. The variation of C:N is as shown below in table No.16. The variation in C:N with respect time days is as shown in graph No.7.



Graph No.7. The variation in C:N with respect time (days)

CONCLUSION:

In General, waste mainly consists of organic and inorganic in nature. The organic substance such as food, vegetable, fruit, paper, and agricultural etc such organic substance is biodegradable in nature. Now a day's generation of large amount of organic solid waste so there is provides conventional solid waste management system. However, for isolated institutional complex it is very difficult to provide conventional solid waste management system. Following are some conclusions of the present study:-

1. Technology Department is located faraway from main University campus. Discharge of solid waste from Technology Department to main University campus proves to be uneconomical, so to overcome this problem onsite solid waste management system is necessary.
2. In present work, Eisenia fetida is the most commonly species of earthworms are placed in all pits and different type of solid waste are placed in B1, B2, B3, and B4 respectively. The study shows that the good quality of bio-compost was obtained from B2 (vegetable + fruit waste) Hence E fetida earthworm mainly applicable for vegetable and fruit waste.
3. The important characteristics such as N, P, and K, Ratio showed the increasing order in all treatment. But more in B2 as compare to the B1, B3, and B4.
4. The study area is totally based on natural process; it is quite economical in construction and maintenance.
5. From the present study, it can be concluded that Earthworms are potentially important creatures that are capable of transforming garbage into gold.
6. Now a day in Kolhapur city there is generation of huge amount of municipal solid waste; out of that 70-80% of waste is organic waste. It mainly consists of vegetable, food and fruit waste so this vermicomposting technology applicable for MSW.
7. It promotes environmental sustainability by converting a waste to a value-added product that improves our environment.
8. In the present study testing key parameters like N, P, K, EC, OC, and C:N, pH showed, the E Fetida is helpful in improving the soil quality.

Advantages of vermicomposting system with Eisenia fetida:

1. Systems work naturally.
2. Due to rapid growth rate of E Fetida decomposition efficiency increases.
3. No external energy as electricity is required in the operation of system.
4.

Disadvantages of vermicomposting system with Eisenia fetida:

1. This system requires large area.
2. Temperature variation affects the working efficiency.

FUTURE SCOPE OF STUDY

The potential areas of further study and research are listed below,

- Performance of Vermicomposting by variation in the quality and quantity of the solid waste contents can be studied in future.
- Performance of Vermicomposting by variation in the earthworm species can be studied in future.
- Utilization of vermicompost as a fertilizer for different types of crops can be studied.

BIBLIOGRAPHY

1. Sonukumari.,. "Solid waste management by vermicomposting", *International Journal of Scientific & Engineering Research,* Volume 4, Issue 2,(2013),1-5
2. Manyuchi. M .M. and Phiri. A.,"Vermicomposting in Solid Waste Management: A Review", *International Journal of Scientific Engineering and Technology,* Volume No.2, Issue No.12,(2013), pp : 1234-1242.
3. NanditaMehta,andArunKarnwal.,"Solid waste management with the help of vermicompostingand its applications in crop improvement" *Journal of Biological EarthScience,*Vol No.3,Issue No.1,(2013),pp:8-16.
4. G.Subbulakshmi, and R.Thiruneelakandan,"Vermicomposting is valiant in vandalizing the waste material" *International Journal of Plant, Animal and Environmental Sciences,* Volume-1, Issue-3,(2013),pp 134-140.
5. J.Sudhir Kumar., VenkataSubbiah.K., PrasadaRao.P.V.,"Management of municipal solid waste by Vermicompost-A case study of Eluru"*International journal of Environmental Science,* Volume 1,(2010), pp 82-90.
6. Walkey, J.A. and Black, I.A., (1934), "Estimation of organic carbon by the chromic acid titration method", *Soil Science*, 37, pp-29–38.
7. CPCB,"Central Pollution Control Board (CPCB)," Management of Municipal Solid Wastes", *Ministry of Environment and Forests*, New Delhi, India,(2000).
8. Mall, A.K., Dubey, A. and Prasad, S.,"Vermicompost: an inevitable tool of organic farming for sustainable agriculture", *Agrobios Newsletter*, 3(8),(2005), 10-12.
9. Singh, R., Pradhan, K., "Determination of nitrogen and protein by Kjeldahl method", In: *Forage Evaluation Science. Pvt. Publishers Ltd*., New Delhi,(1981), p. 23-25.
10. Ghatnekar, S.D., Mahavash, F.K., Ghatnegar, G.S., Management of solid waste through vermiculture biotechnology, *Ecotechnology for pollution control and Environmental Management*,(1998), pp 58- 67.
11. Benitez, E., Nogales, R., Masciandro, G. &Ceccanti, B., Isolation by isoelectric focusing of humic–urease complexes from earthworm (*Eiseniafetida*) processed sewage sludges. *Biology and Fertility of Soils,* 31,(2000), 489–493.
12. Munroe,G., Manual of on-farm vermicomposting and vermiculture. [Online]Available:http://www.organicagcentre.ca/DOCs/Vermiculture_FarmersManual_gm.pdf,(2004), (September 15, 2007).

13. Martin, A. and Lavelle, P., (1992), Effect of soil organic matter quality on its assimilation by *Millsoniaanomala*, a tropical geophagous earthworm. *Soil Biology and Biochemistry*, 24, 1535-1538.
14. Hansen,D.,(2007),Vermicomposting: innovative kitchen help. [Online] Available:http://www.dnr.mo.gov/env/swmp/docs/vermicomposting.pdf (April, 12 2008).
15. Mishra, M. M., Kukreja, K., Kapoor, K. K. &Bangar, K. C., (1989), Organic recycling for plant nutrients. In L. L. Somani, & C. S. Bhandari (Eds.), *Soil Microorganisms and Crop Growth*. Jodhpur: DivyajyotiParkashan. Pp 195–232.
16. Bhide A D and Sunderesan B.B., (1983), Processing method for future solid waste management in developing countries. Indian National Science Documentation Centre, New Delhi. pp.124–134.
17. Salvato J.A., (1992), Environmental Engineering and Sanitation. 4th Ed. Wiley. New York.
18. Middleton, Marc., (2005), Local recycler ignites Euro fuel market. Waste Management & Environment Media Pty Ltd.
19. Varma and Dileep, (2004), Handbook on MSW management. Clean Kerala Mission. Govt. of Kerala. p. 78.
20. Wood, T. G., (1974), The distribution of earthworms (Megascolecidae) in relation to soils, vegetation and altitude on the slopes of Mt. Kosciusko, Australia. *J. Anim. Ecol.,* 43: 87-106.
21. ICRISAT and APRLP**.,** **(**2003), Vermicomposting: Conversion of organic wastes into valuable manure. Andhra Pradesh, India: ICRISAT and APRLP. 4 pp.
22. Asha Aalok.et al.,(2008), “Vermicomposting: A better option for organic solid waste management”, *Ecology and Environment Division, Forest Research Institute (FRI), P.O. New Forest, Dehradun 248 006, Uttaranchal, India,* 24(1), 59-64.
23. K.Muthukumaravel.et al.,(2008), “Vermicomposting of vegetable waste using cow dung”, *E-journal of chemistry,* Vol 5, No.4, pp.810-813.
24. Jorge.D. and Clive. A.,(2011), “Biology and ecology of earthworm species used for vermicomposting”, *Taylor and Francis group,LL,* pp.27-40.
25. Ansari.A.A. and Ismail.S.A.,(2001), “Earthworm and vermiculturebiotechnology”,*Journal of soil biology and ecology.*