Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 5, Issue, 10, pp.3016-3019, October, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

VERMICOMPOSTING OF FOOD AND HOUSEHOLD ORGANIC WASTE USING EPIGEIC EARTHWORM *(Eudrilus eugeniae)*

PuneetaDandotiya and *Agrawal, O.P.

Entomology Research Unit, School of Studies in Zoology, Jiwaji University, Gwalior, M.P. 474011

ARTICLE INFO

Article History:
Received 16th July, 2013
Received in revised form
29th August, 2013
Accepted 25th September, 2013
Published online 23rd October, 2013

Key words:
Food waste, Kitchen waste
Household waste,
Vermicompost and
Eudrilus eugeniae.

ABSTRACT

Current methods of disposal and management of nutritionally rich food and household waste are not satisfactory. They are source of foul smell, pollution, unhygienic conditions and infectious diseases. A satisfactory method could not come out from earlier studies made on vermicomposting of such waste under tropical climatic conditions. Therefore the present study was taken up. Different ratios of three waste components were used for experiments and the best results were obtained in a ratio of 35 kg of food and kitchen waste, 7 kg of sand-soil mixture and 1 kg of shredded paper (35:7:1), in which 830 % increase in worm population, 157 % increase in biomass and 58 % vermicomposting was observed. It may be concluded from the study that food and household organic waste can be recycled at home level which may have far reaching effects in environmental conservation and sustainable development.

INTRODUCTION

Problems of disposal and management of organic waste are increasing with increasing human population. Food, kitchen and household wastes are not properly disposed off and managed. They are the source of foul smell, environmental pollution, unhygienic conditions and infectious diseases. A significant amount of these wastes is consumed as food by stray animals and no care is usually taken for the remaining chunk except dumping and land filling. Such wastes are nutritionally very rich as they consist of high amounts of water, proteins, amino acids and vitamins. Anaerobic and pathogenic microorganisms rapidly grow and multiply in waste biomass resulting in foul smell, greenhouse gases and elevated temperature that attract thermophilic organisms, mostly insect vectors of diseases. Biological processes such as composting and vermicomposting of waste would be of great benefit in terms of environmental conservation and sustainable agriculture. Vermicomposting, through earthworms, is an eco-biotechnological process that transforms energy rich and complex organic substances into a stabilized end-product “vermicompost” (Benitez *et al.*, 2000). Vermicomposting is stabilization of organic material involving the joint action of earthworms and microorganisms. Although microbes are responsible for the biochemical degradation of organic matter, earthworms are the important drivers of the process, conditioning the substrate and altering the biological activity (Aira *et al.*, 2002). Earthworms, soil invertebrates, along with soil micro-organisms carry out a yeomen’s service of degrading organic waste materials and thus maintain the nutrient flux in the system. By the turn of the century, earthworms’ potential as a biological tool should be much better understood to make organic farming and sustainable development a reality with the use of selected species of earthworms.

***Corresponding author: Om Prakash Agrawal,**
Entomology Research Unit, School of Studies in Zoology, Jiwaji University, Gwalior, M.P. 474011

The most widely employed epigeic earthworm for successful management of wastes is *Eisenia foetida* (Gunadi and Edwards, 2002; Chaudhari and Battacharjee, 2002; Garg *et al*., 2003; 2004). Vermicomposting of different kind of organic wastes through different species of earthworms has been studied by a large number of workers (Edwards *et al*., 1998; Kale *et al*., 1982; Agrawal, 2005 a, b, 2008; Agrawal and Agrawal, 2006; Ranganathan, 2006; Kaur *et al*., 2010; Suriyanayanam *et al.*, 2010). It has been recommended by several workers that the epigeic earthworms can be utilized for disposal and management of organic wastes (Suthar, 2006; Benitez *et al*., 2005; Garg and Kaushik, 2005; Sinha *et al.*, 2010). Some workers have shown that the food and kitchen wastes, mixed with other waste stuffs and cattle dung, are suitable for vermicomposting (Chaudhary *et al.*, 2000; Bharadwaj, 2010; Chauhan *et al.*, 2010; Khwairakpam and Kalamdhad, 2011; Degefe *et al.*, 2012; Sunitha, 2012; Mehta and Karnwal, 2013). Therefore the present study was taken up to demonstrate the importance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture by amending kitchen and food waste with the help of vermicomposting technology.

MATERIALS AND METHODS

The study was carried out in bamboo baskets (diameter- 60cm, height- 36cm). Three different sets of baskets were maintained, in addition to one set, kept as control (dung only). Study was conducted using different combinations of soil, sand, household (food and kitchen) waste, waste paper and cattle dung as raw materials. Dung slurry in water (1:10) was used for spraying in place of water for reduction of foul smell and to increase microbial activity. Shredded waste paper was procured from two sources, (1) fruit vendors as it is used for packing of some fruits and (2) paper waste from the Department was shredded using paper shredder machine. In a preliminary experiment it was noticed that a mixture of sand and soil

(1:1) provided better results than sand or soil alone. A layer of sand-soil (1:1) was placed at bottom of the basket followed shredded paper, kitchen waste and again shredded paper with light spray of dung slurry at the top. The units were placed in shade and were covered by garden mesh. After a pre-decomposting period of two weeks, when the waste stuffs began to decay and the foul smell and heat production sub-sided, all the components were mixed and 80 earthworms weighing 70 gm were released in the mixture. Dung slurry was sprinkled as and when needed to maintain moisture and to enhance waste decomposition. Progress of vermicomposting was checked and monitored for a period of two months. Then observations on population density, biomass production and degree of composting were recorded. Data obtained were converted into percentage of parameters (% growth rate, % biomass production and degree of composting) and average of these values indicates the net percentile rank of a particular medium. Medium showing highest rank was considered to be the best suitable medium for *E. eugeniae.* According to their percentile scores the waste culture media were recognized as: (a) Highly suitable with percentile score of 100-80, (b) Moderately suitable (80-60 percentile), (c) Suitable (60-40 percentile) and (d) Un-suitable (40-0 percentile).

RESULTS

In the present study selected waste stuffs, kitchen (food) waste, sand-soil mixture and shredded paper were used in different ratios: (1:1:1), (5:2:1), (10:3:1), (15:4:1), (20:5:1), (25:6:1), (30:7:1) and (35:7:1) as shown in table-1. The weight of waste materials was so adjusted that the final weight of the lot was 45 kg. The sand-soil mixture and media containing high proportions of it were not suitable for survival and reproduction of adult worms. The number of adult worms was reduced in 1:1:1, 5:2:1 and 10:3:1 ratio of waste mixtures as compared to the initial values. Such a reduction in number of worms might be due to escape or migration or natural death of worms on account of lack of nutrients, proper aeration, in-hostile environment etc. The conditions in sand-soil enriched media were observed to be un-favorable not only for survival, as well as reproductive performance of surviving adult worms. The growth rate was low and number and weight of cocoons and baby worms were lower. By decreasing the content of sand:soil and increasing the ratio of kitchen waste, living conditions became better and improvement in all the parameters was observed. Satisfactory results of vermicompostning were observed with 25:6:1, 30: 7: 1 and 35: 7: 1 combinations of waste and dung alone (Table-2), thus these four media were further selected for detailed experiments. Number and weight of earthworms are given in Table- 3 and 4. The best results were obtained in series 3 (35:7:1; kitchen waste: sand-soil: paper waste), in which 830 % increase in worm population, 157 % increase in biomass and 58 % vermicomposting were observed. The results are shown in Table -3, 4 and Fig. 1.

Table 1. Showing suitability of epigiec earthworms in differentratios of three waste components (preliminary experiments)

S.N.	Organic mixtures	Ratio	Observations
1.	Household waste +Sand-Soil +Paper waste	1:1:1	Unsuitable
2.	Household waste +Sand-Soil +Paper waste	5:2:1	Unsuitable
3.	Household waste +Sand-Soil +Paper waste	10:3:1	Less suitable
4.	Kitchen waste +Sand-soil +Paper waste	15:4:1	Suitable
5.	Kitchen waste +Sand-Soil +Paper waste	20:5:1	Suitable
6.	Kitchen waste + Sand- Soil +Paper waste	25:6:1	Moderately suitable
7.	Kitchen waste +Sand-Soil +Paper waste	30:7:1	Moderately suitable
8.	Kitchen waste +Sand-Soil +Paper waste	35:7:1	Highly suitable

Table 2. Different combinations of culture media

S.N.	Organic Mixtures	Ratio
Series-1	Kitchen waste + Sand- Soil +Paper waste	25:6:1
Series- 2	Kitchen waste +Sand-Soil +Paper waste	30:7:1
Series- 3	Kitchen waste +Sand-Soil +Paper waste	35:7:1
Series-4	Standard Medium	Dung alone

Table 3. Showing average number of adults, juveniles and cocoons of *E. eugeniae*

(Initial no. of worms - 80)

S.N.	No. of adults (mean ±st.dev)	No. of juveniles (mean ±st.dev)	No. of cocoons (mean ±st.dev)
Series-1	96.66±1.52	306.33±4.72	236.00±3.60
Series- 2	102.66±2.08	323.66±4.16	258.66±2.51
Series- 3	122.67±2.51	345.00±9.16	277.00±7.21
Series-4	112.33±6.02	337.66±2.51	266.66±3.51

Table 4. Showing average weight of adults, juveniles and cocoons of *E. eugeniae*

(Initial wt. of worms -70 gm)

S.N.	wt. of adults	wt. of juveniles	Wt. of cocoons
Series-1	87.62±2.91	52.78±2.25	2.98±0.026
Series- 2	97.30±1.51	57.94±0.95	3.10±0.03
Series- 3	111.04±3.02	65.60±4.54	3.31±0.087
Series-4	96.95±2.01	62.99±0.09	3.24±0.04

It was further observed that the number and weight of adult earthworms and number and weight of cocoons and juveniles increased in all selected waste combinations. The values of number and weight of adult worms were 20.82 % and 25.17 % (series 1) 28.32 % and 39.00 % (series 2), 53.33 % and 58.62 % (series 3) and 40.4 % and 38.5 % (series 4) respectively. The results of population growth and biomass production of earthworms also showed variations in different culture media, 698.73 % and 104.83 %, 756.22% and 126.2%, 830.83 % and 157.07 % and 795.81 % and 133.11 % in series 1, 2, 3 and 4 respectively. On the basis of higher to lower increase in the number and weight of adult worms, population growth and biomass production the waste mixtures can be arranged in following order: Series 3 (35:7:1) > series 4 (dung alone) > series 2 (30:7:1) > series 1 (25:6:1) (Fig. 1). Thus it seems that kitchen waste, soil-sand and paper waste mixture is a suitable medium for vermicomposting. It was noticed that during predecomposting (before earthworm inoculation) period the level of composting due to action of microorganisms was more or less similar in all waste mixtures (Fig. 2 a), whereas during vermicomposting it continued further (Fig. 2 b). As compared to vermicomposting, net rate and degree of composting were lower in media, not inoculated with earthworms.

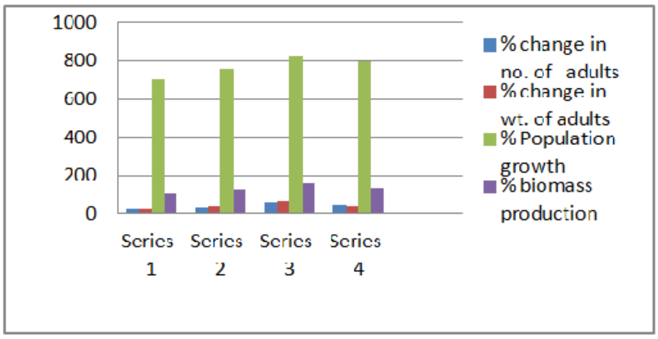

Fig.1. Percentchange in number, weight of adults, population growth rate & % biomass production in different combination

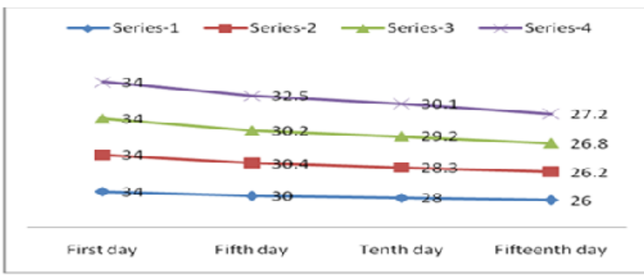

Fig. 2 (a). Showing the level of composting during decomposition of organic matter (in cms)

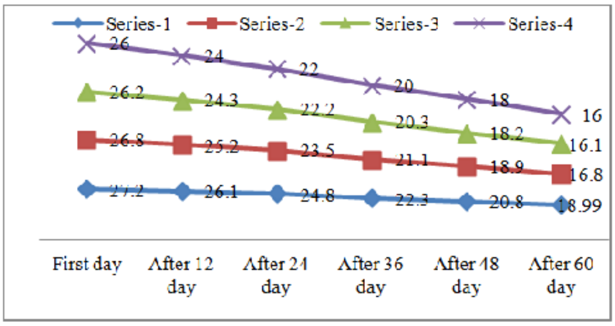

Fig. 2(b). Showing the level of composting during vermi-composting of organic matter (in cm)

DISCUSSION

Russel (1910) reported that earthworms decompose organic matter quickly and increase nitrification which becomes responsible for increasing crop yield. A variety of organic wastes, mostly in combination with cattle dung have been tested for vermicomposting. Kale and Krishnamoorthy (1978) reported that different species of earthworms have different preferences towards organic matter. Development of simple method of vermicomposting of household (food and kitchen) waste should be a welcome event as it will help in solving problems of solid waste management and in improving community health. The major problems in vermicomposting of such waste are foul smell and un-hygienic atmosphere due to high moisture and nitrogen content, high bulk density, lack of aeration, improper C/N ratio, and non-acceptability to earthworms. It has been identified that leachate, fly menace, obnoxious odors are the problems of decaying food and kitchen wastes (Sunitha, 2012). Some workers have tried vermicomposting of these wastes mixed with other waste stuffs and cattle dung.

The results of present study related increase in number of earthworms are in accordance with that of other workers (Chauhan *et al*., 2010; Shweta *et al*., 2006). Chaudhary *et al*. (2000) demonstrated that chopped and air-dried kitchen waste could be used as feed stuff for earthworms (*Perionyx excavates*) in earthen bowls by a layer of sand topped by garden soil. Bharadwaj (2010) used air dried kitchen waste material, ground into small pieces and mixed with cow dung (4:1) for vermicomposting. Chauhan *et al.* (2010) employed mixture of equal amounts (W/W) of small pieces of partially decomposed vegetable waste and partially decomposed cow dung for vermicomposting in plastic containers using *Eisenia foetida*, *Eudrilus eugeniae*, and *Perionyx excavates*. The best results were obtained with *Eisenia foetida*, followed by *Eudrilus eugeniae.* It was reported by Khwairakpam and Kalamdhad (2011) that vegetable waste was not ideal for growth and reproduction of earthworms, but when amended with cattle manure produced high quality stable compost free from pathogens using different earthworm species *Eisenia fetida*, *Eudrilus eugeniae* and *Perionyx excavates* in monocultures and polyculture set ups. In most of the studies larger amounts of dung was mixed with kitchen waste, without considering the fact that the target waste is kitchen waste, not the dung. Further, the target waste was usually subjected to cumbersome processes of chopping, air drying, powdering, mixing it with cattle dung, aerobic self-composting and finally vermicomposting (Bharadwaj, 2010; Chauhan *et al*., 2010; Khwairakpam and Kalamdhad, 2011; Degefe *et al.*, 2012; Mehta and Karnwal, 2013). Such complicated techniques are un-desirable and may become hurdle in popularization of vermecomposting. The contribution of Sunitha (2012) appears to be significant in solving the problem of leachate, fly menace and obnoxious odor by simple use of Leachate Absorbing Raw Material (LARM) like cocopith, bagasse or jute waste for complete aerobic composting and vermicomposting. But these LARM stuffs may not be easily available everywhere. In the present study attempts have been made to simplify the vermicomposting process and to eliminate or minimize the use of cattle dung because it may not be possible to manage it for some people. The findings of present study are similar to Sunitha (2012), sand-soil mixture and shredded waste paper act as LARM and serve the purpose of balancing the nutrient content, C/N ratio and bulk density of the waste medium. Un-published study from our laboratory has also revealed that a mixture dried cattle dung and vermicompost can also be used as LARM for successful vermicomposting by *E. eugeniae* (Agrawal and Dandotiya, unpublished). In place bamboo baskets, any other (earthen, plastic, metal, wooden) containers or cement tanks can be used. There is no need to cut and dry small pieces of kitchen waste. The weight of upper sand-soil layer exerts pressure on the kitchen waste so as to enhance faster release of its liquid juices (lechate) which are absorbed by paper and sand-soil mixture, hence balancing high moisture content of kitchen waste. High nitrogen content of waste is balanced by high carbohydrate content of the paper (cellulose). High bulking density and anaerobic conditions of kitchen waste are also converted to optimal bulk density and aerobic conditions in the mixture, suitable for vermicomposting. All these factors help in fast disappearance of typical putrefying odor of fermenting garbage and reduction in fly menace. The use of dung is also minimized in the form of slurry.

Conclusion

It may be concluded from experiment, that food and kitchen waste can be recycled at consumer (home) level by amending with sand-soil and waste paper shredding in container or tank units. The method is simple, efficient, inexpensive and user friendly. The large scale practice of vermicomposting may have far reaching effect in environmental conservation, sustainable development and improving community health.

Acknowledgement

We are highly thankful to Head of the department for providing laboratory facilities.We are also thankful to UGC, New Delhi for financial assistance in the form of SAP scheme and award of research fellowship to the first author.

REFERENCE

Agrawal, O.P. 2005a. Vermicomposting practice-conversion of garbage into gold. STTPP WAMR, 188-196.

Agrawal, O.P. 2005b. Vermitechnology for all-round sustainable development. Lead Paper Presented in National Seminar on Composting & Vermicomposting held at CSRTI, Mysore, October 26-27, 39-47.

Agrawal, O.P. and Dheeraj Agrawal. 2006. Vermitechnology can take care of our garbage and can solve many of our problems. Reading Manual for "Vacation training Programme on Bioresources for School Children", School of Studies in Zoology, Jiwaji University, Gwalior, 117-128.

Agrawal, O.P. 2008. Significane of Earthworms in Past, Present and Future Perspectives. Proceedings of the First National Symposium on Earthworm Ecology & Environment (NSEEE-I), MJP Rohilkhand University, Bareilly, 51-73.

Aira, M., Monroy, F., Dominguez, J. and Mato, S. 2002. How earthworm density affects microbial biomass and activity in pig manure. European Journal of Soil Biology, 38: 7-10.

Benitez, E., Nogales, R., Masciandaro, G. and Ceccanti, B. 2000. Isolation by isoelectric focusing of humic-urease complexes from earthworm (*Eisenia foetida*)-processed sewage sludges. Biology and Fertility of Soils, 31: 489–493.

Benitez, E., Sainz, H., and Nogales, R. 2005. Hydrolytic enzyme activities of extracted humic substances during the vermicomposting of a lignocellulosic olive waste. Bioresource Technolgy, 96: 785 90.

Bharadwaj, A. 2010. Management of kitchen waste material through vermicomposting. *Asian J. Exp. Biol. Sci.*, 1 (1): 175-177.

Chaudhuri, P.S., Pal, TK., Bhattacharjee, G., Dey, SK. 2000. Chemical changes during vermicomposting (*Perionyxexcavatus)* of kitchen waste. *Tropical Ecology*, 41: 107-110.

Chaudhuri, P.S., Pal, T.K., Bhattacharjee, G. and Dey, S.K. 2002. Rubber leaf litter (*Hevea brasiliensis,* var RRIM 600) as vermiculture substrate for epigeic earthworms, *Perionyx excavatus*, *Eudrilus eugeniae* and *Eisenia fetida*. Pedobiologia, 47: 796-800.

Chaudhuri, P.S and Bhattacharjee, G. 2002. Capacity of various experimental diets to support biomass and reproduction of *Perionyx excavatus.* Bioresource Technolgy, 82 (2): 147-150.

Chauhan, A., Kumar, S., Singh, A. P. and Gupta, M. 2010.Vermicomposting of vegetable wastes with cowdung using three earthworm species *Eisenia foetida, Eudrilus eugeniae and Perionyx excavatus. Nature and Science*, 8 (1): 34-42.

Degefe, G., Mengistu, S. and Dominguez, J. 2012. Vermicomposting as a Sustainable Practice to Manage coffee husk, enset waste (*Enset ventricosum*), khat waste (*Catha edulis*) and vegetable waste amended with cow dung using an epigeic earthworm *Eisenia andrei*. *International Journal of Pharm Tech Research*, 4(1):15-24.

Edwards, C. A., Dominguez, J., Neuhauser, E. F. 1998. The potential use of *Perionyx excavates* (Perr.) (Megascolecidae) in organic waste management. Biology and Fertility of Soils, 27: 155–161.

Garg, V.K. and Kaushik, P. 2003. Vermicomposting of solid textile will sludge and cow dung with the epigeic earthworm *Eisenia foetida.* Bioresource Technology, 90: 311-316.

Garg, V.K. and Kaushik, P. 2004. Dynamics of biological and chemical parameter during vermicomposting of solid textile mill sludge mixed with cow dung and agricultural residues. Bioresource Technology, 94: 203-209.

Garg, V. K. and Kaushik, P. 2005. Vermistabilization of textile mill sludge spiked with poultry droppings by an epigeic earthworm *Eisenia foetida*. Bioresource Technology, 96: 1063-1071.

Garg, V.K., Kaushik, P. and Dilbaghi, N. 2006. Vermiconversion of wastewater sludge from textile mill mixed with anaerobically digested biogas plant slurry employing *Eisenia foetida.* Exotoxiology and Environment Safety, 65(3): 412-419.

Gunadi, B., Edwards, C. A. and Arancon, Q. 2002. Changes in trophic structure of soil arthropods after the application of vermicomposts. European Journal of Soil Biology, 381: 161-165.

Kale, R.D. and Krishnamoorthy, R.V. 1978. Distribution of earthworms in relation to soil conditions in Banglore. In: *Soil Biology and Ecology in India* (Eds. Edwards, C.A. and Veeresh, G.K.) *UAS Technical Service,* University of Agricultural Sciences, Banglore, pp 63-69.

Kale, R.D., Bano, K. and Krishnamoorty, R.V. 1982. Potential of *Perionyx excavatus* for utilizing organic wastes. Pedobiologia, 23: 419 -425.

Kaur, A., Singh, J., Vig, A. P., Dhaliwal, S. S. and Rup, P. J. 2010. Composting with and without *Eisenia fetida* for conversion of toxic paper mill sludge to a soil conditioner. Bioresource Technology, 101 (21): 8192- 8198.

Khwairakpam, M. and Kalamdhad, A. S. 2011. Vermicomposting of vegetable wastes amended with cattle manure. *Research Journal of Chemical Sciences,*1(8):49-56.

Mehta, N. and Karnwal, A. 2013. Solid waste management with the help of vermicomposting and its applications in crop improvement. *Journal of Biology and Earth Sciences*, 3 (1): B 8-B16.

Ranganathan, L.S. 2006. *Vermibiotechnology: From Soil Health to Human Health.* Agrobios, Jodhpur, India.

Russel, E.J. 1910. The effect of earthworms on soil productiveness. *Journal of Agriculture Science,* 3: 246-257.

Shweta, Kumar, P., Sharma, D. and Sonal (2006). Fluctuation in biomass and cocoon production of *Eudrilus eugeniae* during the vermicomposting using different organic wastes. *Journal of Applied Zoological Researches*, 17(2): 217-220.

Sinha, R.K., Heart, A.S., Asadi, R and Carretero, E. 2002. Vermiculture technology for environmental management: study of action of earthworms *Eisenia fetida, Eudrilus eugeniae* and *Perionyx excavatus* on biodegradation of some community wastes in India and Australia. *The Environmentalist,* 22(2): 261 – 268.

Sinha R. K., Herat, S., Valani, D. and Chauhan K. 2010. Earthworms – the environmental engineers: review of vermiculture technologies for environmental management and resource development. *International Journal of Global Environmental Issues*, 10:265 – 292.

Sunitha, N.S. 2012. Larm as a Necessity during Composting and/or Vermicomposting of Kitchen Refuses. *Universal Journal of Environmental Research and Technology,* 2(1): 97-100.

Suriyanarayanan, S., Mailappa, A. S., Jayakumar, D., Nanthakumar, K., Karthikeyan, K. and Balasubramanian, S. 2010. Studies on the characterization and possibilities of reutilization of solid wastes from a waste paper based paper industry. *Global Journal of Environmental Research*, 4 (1): 18-22.

Suthar, S. 2006. Potential utilization of guar gum industrial waste in vermicomposting production. *Bioresouece Resource Technology*, 7: 2474-2477.

****