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Research Article

Vermicomposting of tea leaves waste mixed with cow dung with the help of exotic earthworm *Eisenia fetida*

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Abstract

The present study revealed the role of earthworm in converting tea leaves waste into a valuable product i.e vermicompost. The tea leaves waste was mixed with cow dung in different proportions viz. 0:100 (V_0), 20: 80 (V_{20}), 40:60 (V_{40}), 60:40 (V_{60}), 80:20 (V_{80}), 100:0 (V_{100}) on dry weight basis. The minimum morality and highest population buildup of worms was in V_{80} mixture. The pH increased from initial value in the feed mixtures 9.0 to 9.5, 8.8 to 9.2, 8.7 to 9.1, 8.3 to 9.0, 7.2 to 8.4, and 7.1 to 8.4. On the other hand Electric conductivity (EC) and Organic carbon (OC) declined in all the feed mixtures. Maximum decline in EC and OC in final product of V_0 feed mixture was 70.9% and 50.0% respectively. The results indicated that vermicomposting with *Eisenia fetida* is better for changing tea leaves waste into rich manure in a short period of time i.e 28 days.

Keywords: Vermicomposting, Earthworm, *Eisenia fetida*, Tea leaves waste, Cow dung

Introduction

India is the world leader in terms of consumption, export and production of tea. The tea production in India was 979,000 tonnes as on year 2009. It accounts for the 31% of the global production of tea. India has retained its leadership over the tea industry for the last 150 yrs. The total turnover of this is roughly Rs 10,000 crores. Over 70% of its production is consumed within India. Presently most of the industries dispose their tea waste in open dumps or land areas which results in severe pollution of land and water. Also, the tea leaves waste from the kitchens is exposed off in open areas which also causes land pollution. Proper disposal of tea leaves waste from industries and kitchens is necessary for maintaining healthy environment. Vermicomposting is the safest and cheapest way for the proper disposal of the tea leaves waste without doing any harm to the environment. Vermicomposting is a bio-oxidation process in which detrivores earthworm interacts intensively with micro-organisms and other soil fauna within the decomposer community and strongly affecting decomposition processs, accelerating the stabilization of organic matter and greatly modifying its physical and biochemical properties (Aira et al., 2007). Micro-organisms produce the enzymes that cause the biochemical decomposition of organic matter. But earthworms are crucial drives of the process as they are involved in the indirect stimulation of microbial populations through fragmentation and ingestion of fresh organic matter, which results in greater surface areas available for microbial colonization and drastically altering biological activity (Fracchia et al., 2006; Lazcano et al., 2008).

In the present work tea leaves waste was mixed with cow dung in ratio of 0:100% (V_0), 20:80% (V_{20}), 40:60% (V_{40}), 60:40% (V_{60}), 80:20% (V_{80}), 100:0% (V_{100}). Population build up of worms, appearance of clitellum, weight and physico- chemical parameters were taken as indicators of the suitability of feed mixtures for earthworms.

Materials and Methods

Eisenia fetida, Tea leaves and Cow dung

Eisenia fetida were randomly picked from the stock culture in the Department of Zoology Khalsa College, Amritsar. Cow dung was procured from the dairy farm situated in the Khalsa College, Amritsar, Punjab, India. Cow dung was spread for 10 days for air drying so that unwanted gases and heat was removed which may cause harm to earthworm. Tea leaves waste was arranged from the canteen situated in the Khalsa College, Amritsar.

Experimental design

The experiment was run in plastic tub of size 42×28 cm were filled with mixtures containing different percentages of tea leaves waste and cow dung in triplicates on dry weight basis Table 1. The total weight of feed mixture in each tub was kept 500 g. The tubs were covered with jute mat and kept in a laboratory. The mixtures were turned over manually every 24 h for 10 days in order to eliminate volatile toxic gases. After 10 days, 10 clitellated *Eisenia fetida* were introduced in each tub. The moisture content was maintained to 60-70% throughout the study period. Sampling of feed mixtures was taken at the interval of 15 days for physico-chemical analysis. At the end of experiment worms, hatchlings and cocoons were removed. The vermicompost was sieved, air dried and stored in plastic bags for physico-chemical analysis.

Physico-chemical analysis

5 g air dried sample was dissolved in 50 ml distilled water and shaken on an orbital shaker for 40 mins. Then supernatant was taken and pH and EC of the supernatant was recorded by using pH meter and EC meter. Ash content and organic carbon was determined by the method of Nelson and Sommers (1996). 0.5 g of air dried sample was taken in a pre -weighted silica crucible. The sample was ignited in a muffle furnace at 550°C for 60 min. The furnace was allowed to cool and the ash produced was weighted.

Results and Discussion

Growth and Fecundity of *Eisenia fetida*

The earthworms were able to survive in different proportions of tea waste and cow dung (Fig. 1 and 2).

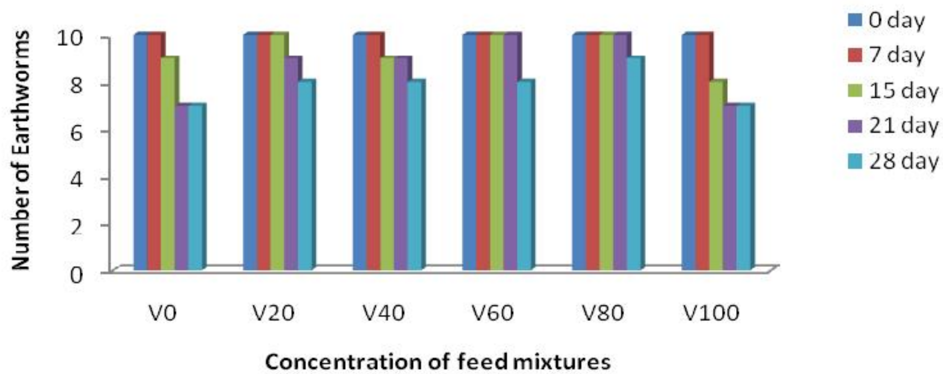

Fig. 1 Number of earthworm in different feed mixtures of tea waste and cow dung

Table. 1 Different proportions of tea leaves waste and cow dung

Feed Mixtures	Tea leaves waste	Cow dung
V_0	0%	100%
V_{20}	20%	80%
V_{40}	40%	60%
V_{60}	60%	40%
V_{80}	80%	20%
V_{100}	100%	0%

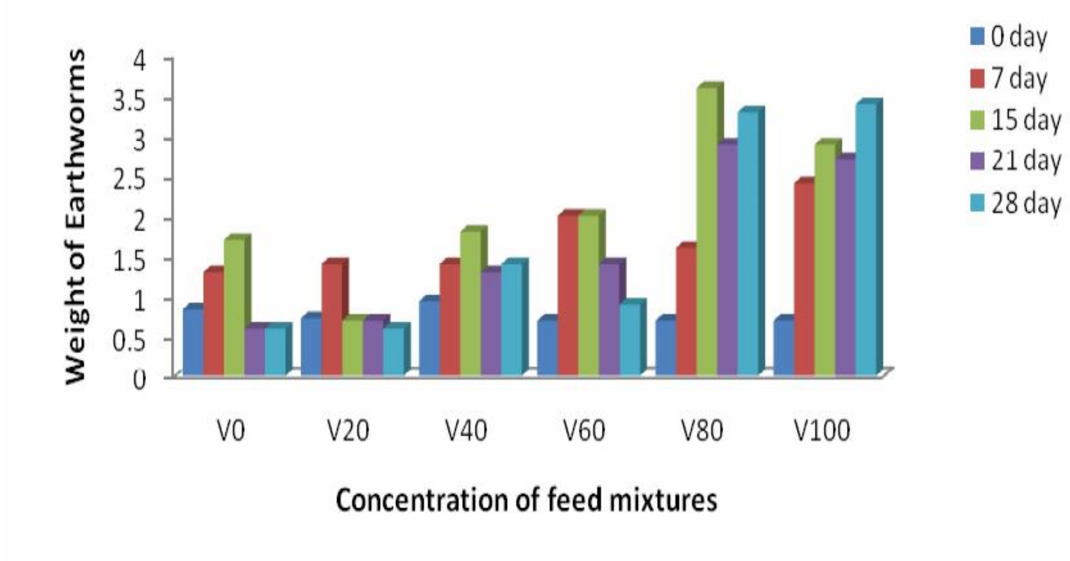

Fig. 2. Weight of earthworm in different feed mixture of tea waste and cow dung

The earthworm's survival increased with the increasing concentration of tea waste. On the other hand the survival rate of earthworms was less in the 100% tea waste. The number of earthworm was maximum in V_{80} feed mixture at the end of the experiment. Food availability, type of food, population density and temperature determine the time of sexual maturation in earthworm (Neuhauser et al., 1980). The growth rate of earthworms slow down at higher temperature above the optimum for growth decreased the incubation period of earthworm. Biochemical quality of the feed is an important factor in determining the time taken to reach the sexual maturity, on set of reproduction and cocoon produced (Edwards *et al*., 1998). The most rapid maturation in earthworm was at 25^0C and degree of hatching success increased with increase in temperature and it occurred in 17.8 days at 25^0C and 15.3 days at 25-27^0C (Edwards, 1998; Reinecke *et al*., 1992; Edwards *et al*., 1998). Reinecke and Venter (1987) observed that the first and last cocoon produced by *Eisenia fetida* were less viable than those produced between days 30 and 120 during degradation of waste. Incubation period was 23 days with 2.7 hatchlings per cocoon. The weight of earthworm was very less in V_{20} feed mixture. The weight of earthworms started increasing from 15^{th} day onwards in V_{40}, V_{60}, V_{80} and V_{100} in feed mixture. The weight of earthworm increased on 15^{th} day of experiment in V40% feed mixture, while it showed maximum increase in V_{80} feed mixture. On 28^{th} day the maximum weight of earthworm was in V_{100} feed mixture and was lowest in V_0 feed mixture.

The number of earthworm's remains constant in 0 and 7 days of experiment in all the feed mixture. Number of earthworms then started Decline on 15 and 21 days in V_0, V_{20} and V_{40}. The decreased in number can be attributed to the exhaustion of food. Number of earthworms remains constant in 60%, 80% and 100% feed mixtures on 15 and 21 days. On 28^{th} day of experiment the number of earthworms was maximum in V_{80} feed mixture. The earthworm grow best in easily metabolizable organic matter and non assimilated carbohydrates these also favour their reproduction (Flack and Hartenstein 1984). Growth and reproduction were found to be positively correlated to the volatilable solid content of the waste (Edward 1998). Earthworm growth slows down when C:N ratio and temperature is high. The biomass gain by *Eisenia fetida* was found to depend on population density and food type with particle size playing a significant role in vermicomposting (Watanabe and Wsukamoto 1976) Viljoen and Reinecke (1989) observed that single raised worm began to gain biomass at a higher rate than those raised in batches (after 230 days). The population density of worms per unit volume or weight of a waste is very important in determining the rate of earthworm growth and reproduction so the factors relating to the growth of earthworm may be considered in terms of physiochemical and nutrient characteristics of waste along with temperature, pH and moisture contents of feed stocks. Pure cellulose, news paper or wood shaving as substrate were ingested *by Eisenia fetida* but failed to result in weight gain.

Physico-chemical parameters

The Physico-chemical parameters showed significant differences in different feed mixtures (Fig. 3). The pH increased significantly from initial value and was positively corelated with increasing tea waste concentration. The increase in percent value of pH was in the order of $V_{100}>V_{80}>V_{60}>V_0>V_{20}>V_{4O}$ feed mixture during vermicomposting. An increasing pH of final vermicompost may be due to excess of organic nitrogen not required by microbes is released as ammonia, which gets dissolved in water and increasing the pH of the vermicompost. The EC decreased significantly with increasing tea waste concentrations. The percentage decrease in EC was in the order of $V_0>V_{20}>V_{40}>V_{60}>V_{80}>V_{100}$. The decrease in EC was due to loss of organic matter and release of different mineral salts in available forms such as phosphate, ammonium and potassium etc. The increased in ash content of the feed stock was noticed during the vermicomposting and was in the order of $V_0>V_{20}>V_{40}>V_{60}>V_{80}>V_{100}$. The increase in ash content indicates organic matter stabilization in the substrate (Gupta et al, 2006). The organic carbon decrease significantly from initial value and increase with increasing tea waste concentration and remarkably reduced at the end of experiment. The percentage decreased in total organic carbon content was in the order of $V_0>V_{20=}V_{40}>V_{60}>V_{80}>V_{100.}$ The decrease in total organic carbon content after vermicompost indicates organic matter stabilization in the substrate due to combined action of earthworms and micro-organisms. It has been reported that earthworms modify the substrate conditions, which subsequently enhance the carbon losses through microbes respiration in the form of CO_2 (Tognetti et al, 2007). The differences in the pH of vermicompost are directly dependent on the raw materials used for vermicomposting. Different substrates could result in different intermediates and hence show a different behaviour in pH shift. The neutral pH recorded throughout the bed profile is optimal for the growth of *Eisenia fetida* (Kaplan *et al.*, 1980). The highe pH of the final vermicomposts might due to be excess of organic nitrogen not required by microbes is released as ammonia, which gets dissolved in water of different substrates in the feed mixture. The occurrence of acidic environment may be attributed to the bioconversion of organic acids or higher mineralization of the nitrogen and phosphorus into nitrites/nitrates and orthophosphate respectively. The lower pH of the final vermicomposts might be due to production of CO_2 and organic acids by microbes during the process of bioconversion of different substrates in the feed given to earthworms (Yadav and Garg, 2010). The decline in pH may be directly related to reduction in volatile solids and to the growth of earthworm's biomass. The larger the increase in biomass growth, the greater the reduction in volatile solids and the more shift towards the acidic condition (Ndegwa *et al*., 2000). Electrical conductivity during vermicomposting process are contradictory, some workers reported decrease in electrical conductivity (Garg *et al*., 2006; Singh *et al*., 2010) and others an increase in electrical conductivity (Hait and Tare, 2011). The decrease has been attributed to a decrease in ions after forming a complex whereas the increase has been attributed to the degradation of organic matter to release cations and release of different mineral salts in available forms such as phosphate, ammonium and potassium (Guoxue *et al*., 2001). There is an increase in the ash content of the feed stock during vermicomposting. Increase in ash content can be attributed to the enhanced mineralization in the presence of earthworms (Gupta et al, 2006). They have reported an increase in the ash content of water hyacinth and cow dung mixed feed stock in range of 16.3 to 56.5%. Earthworms modify the soil through their feeding, casting, and burrowing activities, which may lead to more decomposition and respiration in aerobic microsites and more denitrification in anaerobic microsites. Earthworms also increase CO_2 and N_2O fluxes from unfertilized agro-ecosystems. Better control of earthworm populations in the field is required to fully assess the impact of earthworms on CO_2 and N_2O fluxes from temperate agro-ecosystems**.** (Tognetti *et al.* 2007) also found that the rate of CO_2 production from vermicompost piles was much higher than that of traditional compost. During vermicomposting period faster decline in C: N ratio (from 17.92 to 10.15%) as compared to compost without earthworm was also observed by (Cabrera *et al.* 2005). The ash and nitrogen contents increased largely for a few weeks after the introduction of earthworms, reflecting a rapid breakdown of carbon compounds and mineralization by earthworms. CO_2 evolution decreased rapidly indicating increased stability of the organic matter. The faster reduction in carbon and lowering of C/N ratio during vermicomposting, could be achieved either due to higher loss of CO_2 by respiratory activity of earthworms and microorganism or due to an increase

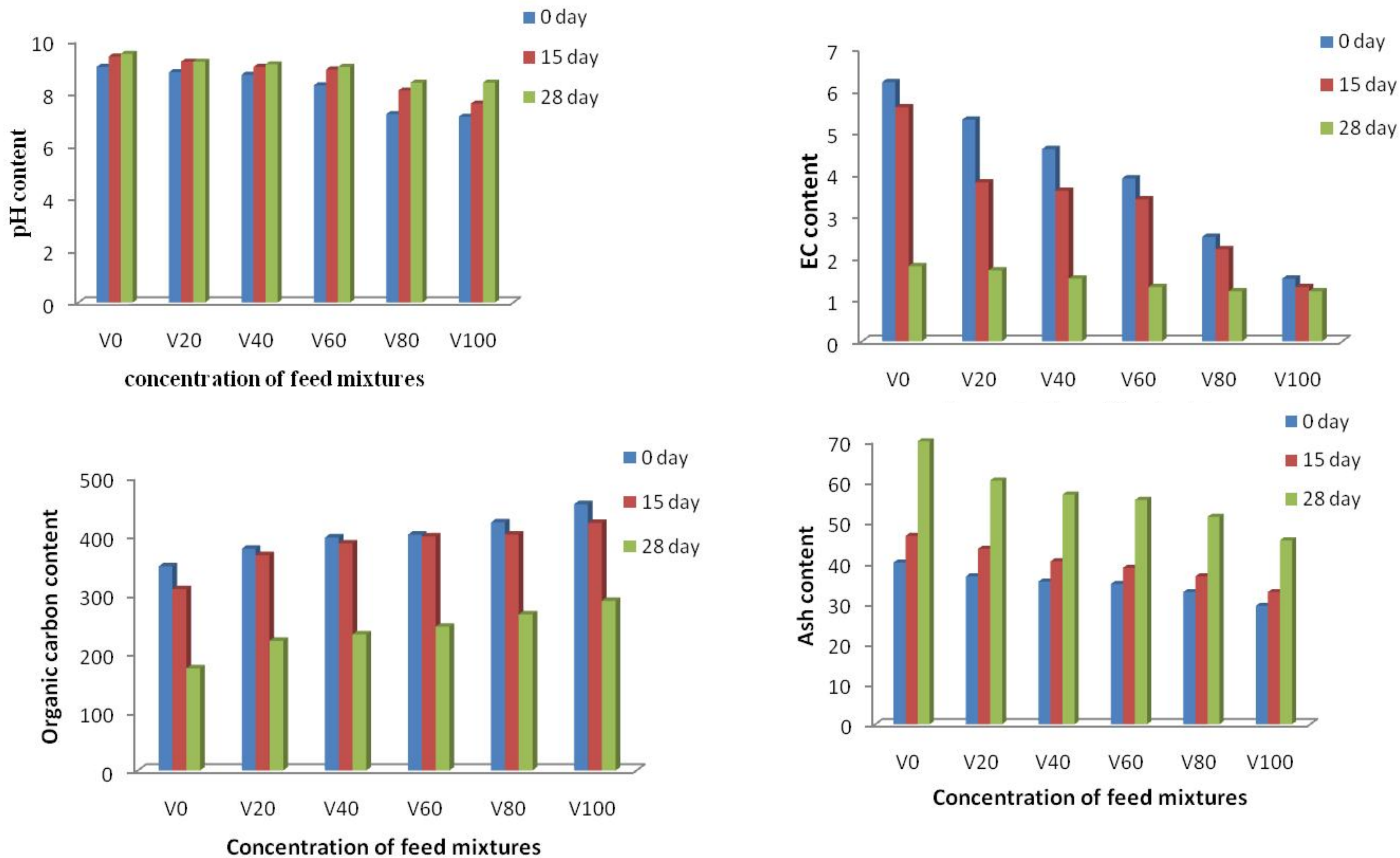

Fig. 3 Physico-chemical parameters pH (A), EC (B), Ash content (C) and Organic carbon (D) content in various feed mixtures.

in nitrogen brought by microbial mineralization of organic matter in combination with the addition of nitrogenous wastes by worms.

Conclusion

It is concluded that tea waste can be stabilized with vermicomposting in a short period of approximately 28 days, compared with a longer duration for microbial stabilization, but its needs to be mixed with cow dung. Results also showed that Vermicompost produced by *E. fetida* possessing lower electric conductivity and lower organic carbon. So it can be used as valuable manure. Study also highlights that even 80% feed mixture of tea waste with cow dung can be degraded in this stipulated time and gives the best quality product or Vermicompost. In the present study it was proved that vermicomposting could be introduced as an effective technology to convert the tea leaves waste into a valuable product.

References

Atiyeh R.M., Arancon N.Q., Edwards C.A., Metzger J.D., 2000. Influence of earthworm-processed pig manure on the growth and yield of green house tomatoes. Bioresour. Technol. 75, 175–180.

Dominguez J. 2004. State of the art and new perspectives on vermicomposting research. In Edwards CA (Ed) Earthworm Ecology, 2nd ed. Boca Raton, pp.401-424.

Edwards C.A., Bohlen P.J., 1996. Biology and Ecology of Earthworm third ed. Chapman and Hall, New York, London.

Garg V. K., Kaushik, P., 2005. Vermistabilization of textile mill sludge spiked with poultry droppings by an epigeic earthworm *Eisenia fetida*. Bioresour. Technol.96, 1063–1071.

Hait S., Tare, V., 2011. Vermistabilization of primary sewage sludge. Bioresour. Technol. 102, 2812–2820

Hartenstein R., 1981. Production of Earthworm as a potentially economic source of protein. Biotechnol Bioeng 23:1797-1811

Kaushik P., Garg V. K., 2003. Vermicomposting of mixed tea waste and cow dung with the epigeic earthworm *Eisenia fetida*. Bioresource Technol 90: 311-316

Kaushik P., Garg V. K., 2004. Dynamics of biological and chemical parameters during vermicomposting of solid textile mill sludge mixed with cow dung and agricultural residues. Bioresour. Technol. 94, 203–209

Lazcano C, Gomez-Brandon M., Dominguez J., 2008. Comparison of the effectiveness of composting and vermicomposting for the biological stabilization of cattle manure. Chemosphere 72:9013-1019.

Lee K.E., 1985 Earthworm: their ecology and relationship with sail and land use, Academic Press, Sydney.

Ndegwa P. M., Thompson, S. A., 2000. Effects of stocking density and feeding rate on vermicomposting of biosolids. Bioresour. Technol. 71, 5–12.

Nelson D.W., Sommers, L.E., 1996. Total carbon and organic carbon and organic matter. In: Page, A.L., Miller, R.H., Keeney, D.R. (Eds.), Method of Soil Analysis.Am. Soc. of Agronomy, Madison, Wilcosin, pp. 539–579.

Neuhauser E.F., Hartenstein R., Kaplan D. L., 1980. Growth of the earthworm *Eisenia fetida* in relation to population density and food rationing. Oikos 35:93–98

Nogales R., Elvira C., Benitez E., Thompson R., Gomez M., 1999. Feasibility of vermicomposing dairy biosolids using a modified system to avoid earthworm mortality. J. Environ. Sci Health B 34:151-169

Orozco F.H., Cegarra J., Trujillo L. M., Roig 1996. Vermicomposting of coffee pulp using the earthworm *Eisenia fetida*: effects on Cand N contents and the availability of nutrients. Biol Fertil Soils22:162–166

Singh J., Kaur A., Vig A.P., Rup P.J., 2010. Role of *Eisenia fetida* in rapid recycling of nutrients from bio sludge of beverage industry. Ecotoxicology and Environmental Safety 73, 430–435.

Tiunov A.V., Scheu S., 2004. Carbon availability controls the growth of detritirvores (Lumbricidae) and their effect on nitrogen mineralization. Oecologia 138: 83-90.

Tognetti C., Laos F., Mazzarino M. J., Hernandez M. T., 2005. Composting vs.Vermicomposting: a comparison of end product quality. Compost Science Utility : 6–13.

Tognetti C., Mazzarino M. J., Laos F., 2007. Improving the quality of municipal organic waste compost. Bioresour. Technol. 98, 1067–1076

Tripathi G., Bhardwaj P., 2004. Comparative studies on biomass production, life cycles and composting efficiency of *Eisenia fetida* (Savigny) and *Lampito mauritii* (Kinberg). Bioresour Technol 92:275–278

Yadav A., Garg V.K., 2011. Recycling of organic wastes by employing *Eisenia fetida*. Bioresour. Technol. 102, 2874–2880.