Recycling of Kitchen waste and Effect on Nutrient changes by *Eisenia fetida*

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ABSTRACT

The proposed investigation is designed to elicit a detailed study on Nutrient changes during vermicomposting of house hold kitchen wastes by *Eisenia fetida.* Vermicomposting is the eco-friendly technology to accomplish the conversion of organic wastes into natural manure. Vermicomposting has been proposed as an alternate method of transforming house hold kitchen waste into useful compost. The kitchen waste processed by *Eisenia fetida* were analysed for carbon, total nitrogen, phosphorus, calcium and magnesium every 10 days for a total period of 40 days and compared with the same in absence of earthworms. The carbon content decreased and the nitrogen, phosphorus and calcium content increased during the process of vermicomposting. The magnesium level reminds almost static during composting of kitchen waste with or without earthworms.

Key Words: *Eisenia fetida*, kitchen wastes and Vermicomposting

INTRODUCTION

Earthworms are most important soil dwelling organisms involved in the process of soil formation and maintanence of soil fertility They represent a major fraction of the soil invertebrate biomass (>80%). Earthworms with their peculiar food ,feeding habits and burrowing activities in the soil are considered to be the natures best ecosystem engineers . They convert organic waste to useful fertilizer and modify the physical , chemical and biological properties of soil to support above ground vegetation . Earthworm casts are usually enriched in nutrients such as C , N and P (Aira et al .,2003,2007).Vermicomposting has also shown impressive effects on the growth of different crops under field conditions (Mamta *et al* .,2012). Various physical ,chemical and microbiological methods of disposable of organic solid waste are currently in use ,these methods are time consuming and involved high costs . Therefore, there is a pressing need to find out costs effective alternative methods of shorter duration particularly suited to Indian condition. The use of *Eisenia fetida* for vermicomposting of garden waste , cow dung and kitchen waste on the basis of nutrient content is an important indication that this technology will reduce the burden of synthetic fertilizers and may also act as a good soil conditioner and a source of plant nutrients in agriculture (Wani *et al* .,2013) . The biological activities of earthworm provide nutrient rich vermicompost for plant growth thus facilitating the transfer of nutrients to plants (Ismail , 2000) . The various industrial waste which have been already vermicomposted and turned into nutrient rich manure include paper waste (Kaur *et al.*,2010). Primary sewage sludge (Hait and Tare, 2011) and Tannery industries (Ravindran and Sekaran ,2011). Despite various contributions made by a good number of vermicologists in role of earthworm in nutrient cycling ,seldom plausible information have been available concerning vermicomposting base on composting earthworms. The proposed investigations are therefore designed to elicit a detailed study on nutrient changes during vermicomposting of household kitchen waste by exotic worm *Eisenia fetida*

Materials and methods

Six large earthen bowls (3 control ,3 experimental) 60 cm in diameter were used as containers for compositing of kitchen wastes . Four to Five minute holes were made at the base of the bowls to avoid water logging. In each earthen bowl, bedding of 10 cm thickness was prepared with a layer of sand of 5 cm thick topped with 5 cm of sieved garden soil, to make an initial support medium for earthworms. Two hundred adult earthworms Eisenia fetida having cumulative live weight 100 gm were collected from the stock culture maintained at well ventilated laboratory and inoculated into each of the 3 experimental sets. The remaining 3 sets were kept as control having no earthworms Household kitchen wastes were collected from local sources. The waste were dried for 10 days. Kitchen waste were mixed properly before loading. After 2 days of earthworm inoculation 3 kg of kitchen waste were spread uniformly over the bedding material in each of the containers (control and experimental). The µ composting was continued upto 40^{th} day under laboratory condition (28^0C). Samples were collected on initial and every 10^{th} day from both control and experimental sets. Samples were dried at 40^0C and finely powdered.

Moisture content was determined by drying 105^0C (Gravimetric method), Total nitrogen (N) by Kjeldahl method and organic carbon (C) by the rapid titration method of Walkley and black (1934). The pH was measured by ELICO pH meter (Digital) using suspension of the material in water in the ratio of 1:5 (W:V). Chemical analyses of total P,K,Ca and Mg of kitchen waste from both control and experimental sets and available P,K,Ca and Mg of the soil bed were carried out following standard methods (Jackson 1973, Singh 1988)

Significant differences in nutrient content between the data from control and experimental sets were determined by student 't' test at 5% level of significance.

RESULT AND DISCUSSION

Earthworm activity was absent during first 10 days of experiment. After 20 to 30 days foul odour disappeared from the worm worked waste with the appearance of dark brown loose granular casts. Disappearance of foul odour following 20 days of vermicomposting is probably linked with the activity of earthworms that decrease the proportion of anaerobic to aerobic decomposition resulting in a decrease of methane and volatile sulphur compounds (Waugh and Mitchell, 1981).

pH decreased slowly with a lower trend in the experimental set (>7.5) in comparison to control (>8.0) upto 40 days. On 10th,12th and 40th day the lowering pH was statistically significant (t test, $p<0.05$) in the experimental sets compared to the control sets. A significant difference ($P>0.05$) in the value of ph was found between the values of garden waste and kitchen waste (Wani et al .,2013). The mineralization of nitrogen and phosphorus into nitrites /nitrates and orthophosphates and bioconversion of the organic material into intermediate species of organic acids may have decreased the pH (Ndegwa and Thompson,2000).

The difference in C level between control and experimental sets during the first 30 days was not statistically significant($P>0.05$). Decreases in the content of C in the 40th day(Table1) when compared to control was statistically significant($P<0.05$). Lowering of C during vermicomposting of kitchen waste is due to both microbial and earthworm respiration. Aira et al ., 2008 state that the proximate activity of earthworms significantly enhanced the mineralization of both carbon and nitrogen in the substrate. The cumulative C mineralization from Mesocosms was significantly affected by earthworm density.

N content was reduced significantly($P<0.05$) during both composting and vermicomposting for 40 days. The level of total N was however significantly higher($P<0.05$) on 20th and 30th days of vermicomposting compared to control(Table 1). Reduction of N content of the initial substrate during vermicomposting probably due to NH3 volatilization and incorporation into earthworm tissue besides their leaching into the bedding material (Atiyeh *et al* 2000). The total nitrogen of garden compost showed significant positive correlation with total phosphorus, where as it exhibited negative correlation with potash (Wani *et al* ,2013).

P and Ca content increased in fluctuating level while K decreased and Mg level remained almost static during composting with and without earthworms (Table 1). The level of most of the macronutrients viz..total N,P and Ca in the worm worked waste was higher than control one. The macronutrients however, increased to a greater degree (except K) in the bed soil with earthworm compared to control after 40 days (Table 2). There was a significant rise($P<0.05$) in available P level in the experimental soil bed on the 40th day compared to the worm less soil bed. Mansell *et al* (1981) observed that plant litter was found to contain more available P after ingestion by earthworm, which may be due to the physiological breakdown of the plant material by worms.

Basker *et al* (1994) reported that earthworms reduce concentration of potassium in the soil. Elvira *et al* (1998) also reported that significant decrease of total K by the end of vermicomposting period. There are reports on the significant increase in the level of total N,P and K in the fresh earthworm casts during vermicomposting of leaf litters (Daniel and Karmegam 1999), weeds (Karmegam and Daniel 2000 a) and press mud (Ramalingam and Ranganathan 2001).

The lowering of C:N ratio observed in the present study could be achieved on one hand by combustion of carbon during worms respiration and worms gut microbial utilization and on the other hand increase of nitrogen by microbial mineralization combined with the addition of the nitrogenous waste through excretion and mucous secretion. Reduction in C:N ratio was also reported by many investigators (Nogales et al 1999, Talashilkas *et al* 1999, Ramalingam and Ranganathan 2001). The use of earthworm for the conversion of different types of waste into vermicomposting can truly bring in ‘economic prosperity’ for the farmers and nation with environmental security for the earth. The use of *Eisenia Fetita* for vermicomposting of kitchen waste seems to be advantageous over conventional process of composting may not only reduce the burden of synthetic fertilizer but may also act as soil conditioners and a source of plant nutrients in agriculture .

Table 1. Physiochemical analysis of composted kitchen waste with and without earthworms (*Eisenia fetida.*) at different time intervals

Parameters	0 day	Without worms (Control)				With worms (Experimental)			
	Days	10	20	30	40	10	20	30	40
pH	10.0	9.85	9.24	8.67	8.27	9.54	8.97	8.55	7.59
	± 0.003	± 0.03	± 0.02	± 0.05	± 0.03	± 0.03	± 0.03	± 0.05	± 0.15
Organic carbon (%)	36.8	31.1	22.8	18.7	15.2	31.50	25.66	18.74	10.48
	± 0.71	± 0.47	± 0.84	± 0.02	± 0.95	± 0.57	± 0.33	± 0.33	± 0.32
Total N (%)	3.49	3.14	2.33	2.00	1.78	3.02	2.57	2.28	1.67
	± 0.06	± 0.06	± 0.04	± 0.07	± 0.07	± 0.05	± 0.01	± 0.06	± 0.13
Total P (%)	0.89	1.07	1.10	1.07	1.38	1.12	0.99	1.46	1.09
	± 0.02	± 0.04	± 0.03	± 0.02	± 0.05	± 0.06	± 0.01	± 0.22	± 0.02
Total K (%)	2.18	2.27	1.85	1.52	1.22	2.02	1.46	1.16	0.85
	± 0.02	± 0.15	± 0.04	± 0.02	± 0.02	± 0.09	± 0.05	± 0.04	± 0.02
Total Ca (%)	4.73	5.57	5.06	4.52	4.30	5.41	4.97	4.65	2.83
	± 0.26	± 0.21	± 0.35	± 0.21	± 0.20	± 0.40	± 0.24	± 0.13	± 0.16
Total Mg (%)	0.54	0.68	0.59	0.59	0.61	0.60	0.52	0.50	0.40
	± 0.01	± 0.07	± 0.005	± 0.005	± 0.01	± 0.01	± 0.02	± 0.01	± 0.01

Table 2. Physiochemical analysis of soil bed with and without earthworms (*Eisenia fetida.*) following 40 days of composting of kitchen waste

Parameters	Initial day	After 40 days	
		Without worms	With worms
pH	5.4	8.1 ± 0.04	7.86 ± 0.12
Organic carbon (%)	1.69	3.21 ± 0.66	3.37 ± 0.16
Total N (%)	0.14	0.28 ± 0.06	0.31 ± 0.02
Av. P (mg 100^{-1}g)	1.83	36.7 ± 6.4	58.61 ± 8.9
Av. K (mg 100^{-1}g)	6.0	102.4 ± 11.03	89.0 ± 0.7
Av. Ca (mg 100^{-1}g)	167.7	236.6 ± 48.1	297.1 ± 26.4
Av. Mg (mg 100^{-1}g)	22.5	38.8 ± 2.3	42.0 ± 0.7
C:N	12.0	11.28 ± 0.07	10.76 ± 0.26

Reference

1.Aira, M., Monroy, F., Domınguez, J., 2003. Effects of two species of earthworms (Allolobophora sp.) on soil systems: a microfaunal and biochemical analysis.Pedobiologia 47, 877–881.

2.Aira, M., Sampedro.L., Monroy, F and Dominguez, J., 2008. Detritivorous earthworms directly modify the structure, thus altering the functioning of a micro decomposer food web. Soil Biology & Biochemistry 40 , 2511–2516.

3. Aira, M., Monroy, F., Dominguez, J., 2007. Earthworms strongly modify microbial biomass and activity triggering enzymatic activities during vermicomposting independently of the application rates of pig slurry. Sci. Total Environ. 385, 252–261

4.Atiyeh, R.M., Dominguez J., Subler, S., Edwards, C.A., 2000.Changes in biochemical properties of cow manure during processing by earthworms (Eisenia andrei Bouche) and the effects on seedling growth. Pedobiologia 44, 709–7.

5. Basker,A.,Kirkman,J.H.and Macgregor,A.N1984.Changes in potassium availability and soil properties due to soil ingestion by earthworms.Biol.Fertil.Soils 17:154-158.

6.Daniel,T and Karmegam, N.1999. By conversion of selected leaf litters using an African epigeic earthworm *Eudrilus eugeniae*.Ecol.Env.and Cons.5(3):271-275.

7.Elvira, C., Sampedro, L., Benitez, E., Nogales, R., 1998. Vermicomposting of sludges from paper mill and dairy industries with Eiseniaandrei: a pilot scale study. Bioresour. Technol. 63, 205–211.

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

9.Ismail, S.A., 2000. Organic waste management. In: Technology Appreciation Programme on Evaluation of Biotechnological Approaches to Waste Management held on 26th October 2000. Industrial Association-ship of IIT, Madras, pp. 28–30.

10. Jackson,R.D.1973.Soil chemical analysis.Prentice Hall Pvt.Ltd.,New Delhi.

11.Karmegam, N and Daniel,T .2000a. Abundance and population density of three species of earthworms(Annelida:Oligochaeta) in foot hill of sirumalai (Eastern ghats) India.Indian J.Environ and Ecoplan 3 (3)461-466.

12.Kaur, A., Singh, J., Vig, A.P., Dhaliwal, S.S., Rup, P.J., 2010.Cocomposting with and without Eisenia fetida for conversion oftoxic paper mill sludge into soil conditioner. Bioresour. Technol.101, 8192–8198

13.Mamta, Wani, KA., Rao, R.J., 2012. Effect of vermicompost on growth of brinjal plant (Solanum melongena) under field conditions.J. New Biol. Rep. 1 (1), 25–28

14.Mansell, G.P., Syers, J.K., Gregg, P.E.H., 1981. Plant availability of phosphorous in dead herbage ingested by surface-casting earthworms.Soil Biol. Biochem. 13, 163–167.

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

16.Nogales,R.,Melgar,R.,Guerrero,A.,Lozada,G.,Benitez,E.,Thompson and Gomez,M.1999.Growth and reproduction of *Eisenia Andrei* in dry olive cake mixed with other organic wastes.Pedobiologia 43:744-752.

17.Ravindran, R., Sekaran, G., 2011. Bacterial composting of animal fleshing generated from tannery industries. Waste Manage. 30,2622–2630.

18.Ramalingam ,R and Ranganathan L.S.2001.Vermicomposting of pressmud boosts nutrient quality of compost.Ecol.Env.and Cons. 7(3):279-299.

19.Singh,L.1988.Practical agricultural chemistry and soil science.Dehradun,India.

20.Talashilkar,S.C. Bhangarath, P.P and Mehta,V.B.1999.Changes in chemical properties during composting of organic residues as influenced by earthworm activity.J.Indian Soc.Soil Sci.47 (1):50-53.

21. Wagh,J.M and Mitchell,M.J.1981.Effect of the earthworm ,*Eisenia foetida* on sulphur speciation and decomposition in sewage sludge.Pedobiologia 22:268-275.

22. Wani ,K.A , Mamta , R.J. Rao 2013. Bioconversion of garden waste, kitchen waste and cow dung into value-added products using earthworm Eisenia fetida. Saudi Journal of Biological Sciences 20, 149–15.

23.Walkely,A and Black,I.A.1934. Determination of organic carbon in soil.Soil Science 37:29-38.