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Vermicomposting of City Garbage with Earthworm Species Eisenia foetida : A Better Way of Solid Waste Management with Nutritional Enhancement

KEYWORDS: Vermicompost ,Eisenia foetida,city garbage

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ABSTRACT *When different nutrients were analyzed in the vermicompost prepared from different ratios of city garbage and cow dung and compared with only cow dung vermicompost, the percentage of N, P and K increased significantly in all the three ratios (1.48, 0.78 and 0.33) for 1:1, (1.43, 0.63 and 0.33) for 3:1 and (0.84, 0.15 and 0.27) for 3:2as compared to (1.40, 0.41 and 0.35) in control for nitrogen phosphate and potassium respectively. Percent change in micronutrients was more or less same when compared with control. Percent of C: N ratio and organic carbon decreased significantly in all the three ratios considered when compared with control. Thus composting with city garbage can be an ideal solution of solid waste management besides being healthy fertilizer of soil.*

Introduction:
In the face of burgeoning urban populations, city garbage accumulation is posing serious disposal problems. Besides posing odor problems, it also houses flies and vectors of dreadful diseases as well as contamination of the under ground aquifer by nitrate, heavy metals and bacteria. According to TIFAC (Technology Information Forecasting and Assessment Council) Delhi, Mumbai and Calcutta would be generating 5000 tons of garbage every day in about a decade, and disposal would be difficult. The existing dumping yards would create enormous pollution and health hazards. Municipal authorities would find it expensive to transport garbage and dispose it of scientifically.

The percentage of organic materials in city waste of developing countries reaches up to 80 percent which can be used for organic fertilizer production if appropriate technologies are available (Katzir, 1996). In India most of the municipal solid waste is dumped and only a fraction (less than 10 percent) is intermittently processed in mechanical compost plants (Shekdar, 1999).

Hence, vermicomposting of such a huge amount of garbage would not only solve the disposal problem in an environmentally acceptable way but also release plant nutrients blocked in city garbage for sustainable agriculture through vermicompost.

Present investigation is an attempt to utilize city garbage for vermicomposting by using exotic earthworm species Eisenia foetida.

Materials and Methods:
Stock culture of Eisenia foetida was taken from Akschat Sansthan, Nandwel, Udaipur(Rajasthan,India). City garbage was collected from nearby areas and graded in small pieces. It was sprinkled with water for softening in plastic buckets for one week. After spreading for two days garbage was mixed with already cooled and semi-decomposed cow dung in three different ratios viz., 1:1 (500 grams cow dung + 500 grams garbage), 3:1 ratio (750 grams cow dung + 250 grams garbage) and 3:2 ratio (600 grams cow dung + 400 grams garbage) while control contained one kilogram cow dung only. Each combination including control replicated three times.

After homogenous mixing of cow dung and city garbage, they were kept in plastic buckets for vermicomposting. After one week of mixing 50 mature clitellate worms of species Eisenia foetida were inoculated in each bucket and the buckets were cowered with newspaper as Eisenia foetida shows negative response to sunlight. Buckets were made porous at their sides to provide proper ventilation and drainage of excess water during vermicomposting. Proper temperature (18-25°C) and humidity (60-80 percent) were maintained by sprinkling water at regular intervals. Worms were also protected from predators.

Prepared vermicompost was sieved at the end of 12 weeks and estimation of nitrogen, phosphate, potassium, sodium, calcium, magnesium, organic carbon and C: N ratio was done adopting standard methods.

Results and Discussion:
When different nutrients were analyzed in the vermicompost prepared from different ratios of city garbage and cow dung and compared with only cow dung vermicompost, the results revealed that the percentage of N, P and K increased significantly in all the three ratios (1.48, 0.78 and 0.33) for 1:1, (1.43, 0.63 and 0.33) for 3:1 and (1.40, 0.41 and 0.35) for 3:2 as compared to (0.84, 0.15 and 0.27) in control for nitrogen phosphate and potassium respectively. Percent change in micronutrients was more or less same when compared with control i.e., 1:1 (0.48, 1.79 and 0.41), 3:1 (0.39, 1.89 and 0.43) and 3:2 (0.43, 1.50 and 0.50) for Na, Ca and Mg respectively as compared to 0.24, 1.98 and 0.68 in control. Percent of C: N ratio and organic carbon decreased significantly in all the three ratios considered when compared with control. Maximum decrease was 3.90 and 2.78 followed by 4.68 and 3.34 and 5.46 and 3.68 for 3:2, 3:1 and 1:1 ratio for organic carbon and C: N ratio respectively against control, which provided 9.45 percent and 11.25 percent of organic carbon and C: N ratio that was significantly higher than the three ratios concerned (Table-1).

The reason behind higher NPK content and low C: N ratio may be the role of added city garbage which probably provided food with enriched amount of cellulose, enzymes, vitamins and hormones for the growth of micro-flora inhabiting earthworms gut taking part in organic waste decomposition process. It is known that during digestion, decomposition and utilization of carbohydrates viz., cellulose, water soluble sugar etc. occur. Also during cell synthesis ammonium nitrogen gets converted into proteinaceous nitrogen and trapped in the cell. In a similar way N, P and K contents are also increased. Similar reports of microbial decomposition of organic waste in the earthworm gut were also confirmed by Edwards (1998) and Atiyeh et al. (2000d). According to them,

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earthworm's activity stimulates the rate of organic matter decomposition by increasing the surface area and aeration of the added substrate for further microbial colonization. During this process the important plant nutrients (N, P, K and Ca) present in feed materials are converted through microbial action in to forms that are much more available and soluble to the plants as compared to parent substrate (Ndegwa and Thompson, 2001). Further, Sharma et al. (2004) reported that during microbial activity carbon is utilized by micro-organisms for their energy requirements and cause the transformation of soluble nitrogen in to microbial protein thereby preventing the nitrogen loss. Experimental findings were further strengthened by Bityutskii et al. (2002), who reported that earthworms Lumbricus terrestris and L. caliginosa with the highest rate of ammonia excretion exerted the greatest effect on nitrification.

Table-1
Nutritional value of vermicompost prepared from mixture of cow dung and city garbage.

Nutrient content (%)	control	1:1Ratio	1:3Ratio	2:3Ratio
Nitrogen	00.84	01.48	01.43	01.40
Phosphate	00.15	00.78	00.63	00.41
Potassium	00.27	00.33	00.33	00.35
Sodium	00.24	00.48	00.39	00.43
Calcium	01.98	01.79	01.89	01.50
Magnesium	00.68	00.41	00.43	00.50
Organic carbon	09.45	05.46	04.68	03.90
Carbon/nitrogen ratio	11.25	03.68	03.27	02.78

Ammonium of earthworm is suggested to take part in the regulation of nitrification as a direct source or promoter of N-mineralization of organic matter.

Reduction in C: N ratio in all the three combinations (3.68, 3.27 and 2.78 in1:1, 3:1 and 3:2 ratios respectively) as compared to 11.25 in control was probably brought about indirectly by nitrogen fixing bacteria which decreased C: N ratio by making more nitrogen available from added organic waste as suggested by Garg et al. (2006), Hashemimajd et al. (2006), Yang et al. (2006), Hernandez et al. (2007) and Suthar (2007).

Increase in phosphate was further strengthened by Ghosh et al. (2000). They suggested that during vermicomposting of organic wastes transformation of organically bound phosphorus to inorganic forms takes place. They further reported that phosphate solubilizing bacteria (PSB) might have played a role in increased availability of phosphorus.

Increment in the potassium content may be due to conversion of non-exchangeable K into exchangeable K facilitated by the replacement of K^+ by NH_4^+ whose concentration has also been increased by earthworm activity as reported by Mulongoy and Bedoret (1989) and Rao et al. (1997).

As far as nutrient level of calcium and magnesium is concerned in different ratios (viz., 1:1, 3:1 and 3:2 ratio) decrease in both the nutrients is possibly due to the cation exchange capacity (CEC) of ingested city garbage which provided good amount of organic matter. So, fluctuation in these cations is not surprising as they provide buffering capacity to finished vermicompost. These cations fluctuation is manifested due to the ingested city garbage which probably interfere the pH of bedding materials since the availability of nutrients are maximum at optimum pH (Mitchell and Edwards, 1997; Ndegwa et al., 2000). Decreased amount of calcium and magnesium in vermicompost has also reported by Purkayastha and Bhatnagar (1997). According to them all the macro- and micro-nutrients, except calcium and magnesium were much higher in vermicompost than FYM.

Our results indicated that vermicomposting of city garbage not only provides nutritionally superior vermicompost but also disposes city garbage in an eco-friendly way, which in the face of burgeoning urban populations becoming "bone of throat" for municipal authorities to dispose of it in an ecological sound, economic, social and environmental acceptable way.

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