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Chemical and Biological Dynamics during Vermiconversion of Vegetable and Fruit Garbage Mixed with Cow Dung by *Perionyx excavatus* Perrier.

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Earthworm is a good biological element for converting organic wastes into useful fertilizer. The process is vermicomposting. In India, species are being used for this purpose mainly *Eisenia foetida* (Savigny) [1-4], *Eudrilus euginiae* Kinberg [5-6], *Lampito mauritii* Kinberg [7-9], *Perionyx sansibaricus* Michaelsen [10], *Perionyx excavatus* Perrier [11-13]. *P. excavatus* is indigenous, widely distributed, prolific breeder, having short life cycle, voracious feeders, adaptability to wide range of organic material and epigeics in nature, which provides enough scope for better management of this species for vermicomposting of suitable organic material. The objective of this study is to assess the suitability of *P. excavatus* for conversion of vegetable and fruit waste into vermicompost.

Earthworm samples collected from the soil of a nearby well. Collected wastes after cutting thinly were stored in a plastic bucket. Cow dung's were added in the waste, in a ratio of 20:1 (wastes: cow dung) for thermophilical primary decomposition. Sprinkle of water and mixing done regularly to facilitate decomposition. Decomposition process continues for 15 days. Vermibed has been developed within earthen pot (upper diameter 25.4cm, lower diameter 14cm, height 19cm) by filling with broken bricks (4 cm), followed by sand (3 cm) and a piece of fine cloth. The function of cloth is to separate compost with that of sand of vermibed and helps in easy pulling out of entire compost from the pot. One kilogram of primary decomposed waste given on top. Then twenty clitellate worms (average live weight 0.9 gm) introduced. Jute cloth used to cover the upper portion of the pot. Five replicates maintained. Regular watering done to maintain moisture level 30 percent - 35 percent and temperature level 25°C-28°C. Water management is a key factor as too much or too low watering is harmful to earthworm. Additional wastes not applied during the course of study. Vermiwash, which had been leaching through the vermibed was collected in a plastic container and again applied over the jute cover. The whole set up maintained in ambient laboratory condition. Lambda cyhalothrin 0.50 percent chalk used to control ants. Cocoons, juveniles and aclitellates sorted out with great care from culture pot by hand sorting method. Organic carbon estimated by "Rapid Titration Method" [14]. Available phosphate, available potassium, total nitrogen, available nitrogen, electrical conductivity, pH of the primary decomposes material (PDM) and vermicompost (VCOMP) determined by the standard procedure [15]. Zinc, copper, calcium and magnesium measured by atomic absorption spectrometer (Varian Techtron AA-575 ABQ) in Bose Institute, Kolkata, after oven drying at 65°C for 24 hours and acid digestion (HNO_3 and $HClO_4$) on hot plate.

PDM change into blackish spongy mass and a sweet smell found after seventeen days of inoculation of worm. Twenty worms (live biomass 18 gm) can convert one-kilogram wastes within forty-six days so the conversion rate of wastes was 1.08 gm/worm/day. Observation made that after forty-six days the rate of increase of body weight, rate of reproduction and mortality of adult worms were 9.78 mg $worm^{-1}$ day^{-1}, 0.36 juvenile $worm^{-1}$ $week^{-1}$ and 6% respectively (Table 2). Mean total number of cocoons, juveniles and aclitellates produced (Fig 1) during the course of study were 66 (6.59), 47 (9.21) and 7 (1.58) respectively (Table 2). (Table 1) shows different physicochemical parameters of PDM and VCOMP.

Vermicomposting resulted in significant decrease in pH, organic carbon and C: N ratio whereas increase in total and available N_2, available P, available K, Ca, Mg, Cu, Zn and electrical conductivity (Table 1). Similar observation was made by various authors [3], [10], [12], [16]. Whereas Chaudhuri *et al*. [17] found lowering level of N_2, K, Ca and almost static level of Mg and opined that this reduction is partly due to the leaching into the vermibed. The change in pH might be due to the CO_2 and organic acids viz. humic acid produced by earthworm and microorganisms during earthworm activity. The elevated level of N_2, P, K, Ca, Mg, Zn, and Cu in the vermicompost indicates that the nutrients, which locked up in the organic matter, mobilized into plant-available forms in the compost during passage of this plant material through the gut of the worms. Higher electrical conductivity in the compost confirmed previous observation of Joshi and Kelkar [18], this denotes an increase in the level of soluble salts. The lowering of organic carbon during this process might be due to the result of

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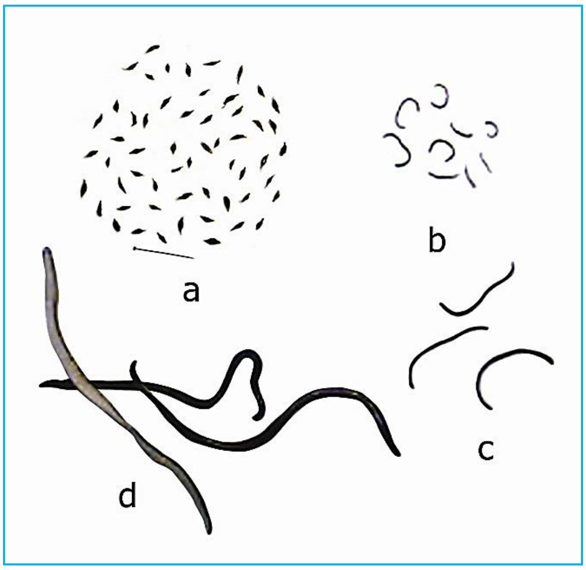
metabolism of carbon compound, which serves as energy source both by the earthworm and microorganisms present in the gut of this species [19]. On the other hand, accelerated mineralization of N_2 compound resulted in drastic reduction of C: N ratio.

Table 1 Different physicochemical characteristics of PDM and VCOMP produced by *Perionyx excavatus* (Mean ± SD)

Parameters	PDM	VCOMP
Weight of primary decomposed material (gm)	1000	
Fresh weight of compost (gm)		842 (19.13)
Dry weight of compost (gm)		288 (13.03)
pH	9.84 (1.21)	7.95 (0.69)
Electrical conductivity (dSm^{-1})	0.65 (0.05)	0.83 (0.09)
Organic carbon (percent)	17.58 (0.53)	9.46 (0.53)
Total nitrogen (percent)	0.6 (0.08)	1.22 (0.24)
Available nitrogen (ppm)	212(15.13)	460.38 (12.57)
Available P_2O_5 (ppm)	114.2(12.02)	189.8 (15.70)
Available K_2O (ppm)	3007.4(29.25)	4411.8 (29.63)
C: N ratio	25.54 (1.13)	8.91(1.61)
Calcium (percent)	1.63(0.81)	3.05(0.82)
Magnesium (percent)	0.9(0.25)	1.12(0.44)
Copper (ppm)	18(7.34)	25.66(5.44)
Zinc (ppm)	100.4(18.62)	186.88(17.69)

Table 2 Growth and fecundity of *Perionyx excavatus* in vegetable and Fruit garbage mixed with cow dung (Mean ± SD)

Number of adult worms inoculated	20
Number of adult worms after 46 days	18.8 (0.83)
Mortality of adults	6 percent
Number of cocoons produced in culture after 46 days	66 (6.59)
Number of juveniles produced in culture after 46 days	47 (9.21)
Number of aclitellates produced in culture after 46 days	7 (1.58)
Initial total live weight (gm)	18
Total live weight after 46 days (gm)	27
Maximum individual body weight (gm)	1.33
Weight gain (mg)	430
Increase in biomass	50 percent
Rate of body weight increase (mg $worm^{-1}$ day^{-1})	9.78
Rate of reproduction (Juvenile $worm^{-1}$ $week^{-1}$)	0.36



a. Cocoon, b. Juvenile, c. Aclitellate, d. Clitellate
Fig 1 Showing different stages of life history of *P. excavatus* Perrier. (Pin: 25 mm)

During gut transit, comminuting and mixing the ingested organic matter exposes to microbial action and at the same time the addition of intestinal secretion promotes microbial and enzyme activity. As a result, mineralization of ingested organic compounds is greatly stimulated. The high mineral N content in casts is due to N-containing excretory products and mucus from earthworms as well as increased mineralization [20]. Production of sweet smell might be due to the liberation of aromatic organic compound during this conversion. Further study required for identification of this compound. In this study, the rate of increase of body weight of *Perionyx excavatus* was 9.78 mg $worm^{-1}$ day^{-1} (Table 2) which is much higher than the observation of Reinecke and Hallatt [21]. Mortality of adults was very low in comparison to the observation of Chaudhuri *et al*. [17]. Rate of reproduction is also higher in this study (Table 2) than observation made by Chaudhuri et al. [17]. Chaudhuri and Bhattacharjee [13] reported encouraging results in *P. excavatus* with reference to its growth and reproduction in cow dung mixed with different bulking agents. According to Kale *et al*. [11] this species can survive well on different organic waste materials, only poultry manure found toxic for this species. They also opined that quality of food is responsible for regulating the growth and maintenance of this species. Neuhauser *et al*. [22] from their studies on growth and reproduction of *P. excavatus* reported that 13 young $worms^{-1}$ $week^{-1}$. However, present data on reproduction are not comparable with those because of differences in age of the worms, population density and food materials used. Edwards [23] while studying the life cycle and optimal conditions for growth and survival of four earthworm species viz. *Eisenia foetida*, *Dendrobaena veneta*, *Eudrilus eugeniae* and *Perionyx excavatus* in animal wastes, found laying of cocoons, percent hatch and net reproductive rates per week of *P. excavatus* was higher than other species. He also found that time for cocoons to hatch and time to sexual maturity in *P. excavatus* was lower than other species. From (Table 2) it is found that this species when cultured in vegetable and fruit wastes shows low mortality, good rate of increase in body weight, good rate of reproduction and hence suitable for culture in this medium. Being a tropical and endemic species, *P. excavatus* possesses enough potentiality for its use in vermicomposting in our country [24].

SUMMARY

The efficiency of *Perionyx excavatus* Perrier for vermicomposting evaluated by using vegetable and fruit wastes mixed with cow dung after 15 days' primary decomposition under laboratory conditions. Vermicomposting resulted in significant increase in total kjeldahl nitrogen, available nitrogen, available phosphorus, available potassium, calcium, magnesium, copper, zinc whereas decrease in pH, organic carbon as well as C:N ratio from primary decomposed material. There was a consistent trend for earthworms' growth, mean cocoon numbers and reproduction rate. This study clearly indicates that vermicomposting with this species could be an alternate low-cost technology for the better management of huge amount of vegetable and fruit wastes. Present study supports the suitability of *P. excavatus* for large-scale vermiculture operations and vermicomposting with this species could be an alternate low-cost technology for the better management of huge amount of vegetable and fruit wastes. By encouraging this method, we could also get an ideal soil conditioner and plant nutrients. Successful implementation of this process can lead to considerably cleaner urban environment.

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