

## Effect of soil and cow dung proportion on vermi-composting by deep burrower and surface feeder species

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Use of earthworm species to biodegrade various substrates (industrial wastes, agricultural residues, etc.) for composting has proven to be successful after initial stabilization of vermi beds. This study presents optimization of vermi beds (soil + cowdung) for culturing of earthworms (*Eisenia fetida*, *Eudrilus eugeniae*, and *Megascolex megascolex*). Optimum proportion of soil + cowdung (1:3) for culturing of earthworms has shown highest number of earthworms hand sorted in all the three species. Among three species, *E. eugeniae* showed highest number of earthworms after 32 days. In compost preparation, earthworms reduced pH as follows: *E. fetida*, 6.7 to 6.1; *E. eugeniae*, 6.7 to 6.0; and *M. megascolex*, 6.7 to 6.4.

**Keywords:** *Eisenia fetida*, *Eudrilus eugeniae*, *Megascolex megascolex*, Soil aggregation

### Introduction

Vermi-composting utilizes earthworms as bioreactors to biodegrade organic wastes to humus. Substrates as solid wastes<sup>1-7</sup> derived from agro based and food processing industries and agricultural residues<sup>8-10</sup> have been tried for vermi-composting. These waste are recalcitrant to biodegradation<sup>11,12,13</sup>. Cowdung<sup>7,8,14-17</sup> has been employed as a medium substrate to initiate and acclimatize earthworms first to local conditions and then initiate vermi-composting of chosen industrial substrates. A similar experiment<sup>8</sup> carried with *plerotus* harvested on spent straw and spent straw with cow dung with *Eudrilus euginae*. Cowdung, kitchen waste, leaf litter were used individually<sup>2,18,19</sup> and / or in combination utilizing two different types of earthworms, *Eisenia fetida* and *Lampito mauritii*. *E. eugeniae* was mass cultured on different feed formulae [mixing cow, sheep and horse dung with other organic wastes (rice polish, wheat barn, green gram bran, vegetable waste and egg shell powder) in various combinations] and worm casts recorded slightly acidic to neutral pH<sup>20-25</sup>.

This study has been conducted to optimize soil-cowdung proportion by using deep burrower and surface feeder species. The soil used was passed through

850 $\mu$ , which facilitated in compiling properties of soil and oven dried vermi-composts of cowdung, along with particle size distribution of industry soil.

### Materials and Methods

#### Soil and Earthworms

Soil samples were collected from proposed vermi-processing plant site of Sanjeevani Sugar Factory Dayananad Nagar, Goa at three different points marked on the ground at each selected point by excavating soil (depth 60 cm, diam 60 cm). Excavated soil was thoroughly mixed and representative sample was taken in a fresh plastic container. Samples (3) were used for further work.

Earthworm inoculums surface feeder species (*E. fetida* and *E. eugeniae*) were procured from Indian Natural Organic Agriculture, Pune and University of Agricultural Science, Dharwad. Deep burrower species (*Megascolex megascolex*) was procured from local cashew plantation farm in Verna, Goa. Rectangular plastic tanks (60 cm x 45 cm x 45 cm) were used for maintaining cultures of surface feeders. From the bottom of tank, 5 cm thick layers each of dry leaves, followed by industry soil and then cowdung was spread. This system was kept at moisture level of 70 % by sprinkling water daily. Cowdung (7 days old) was procured from a local dairy.

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<i>Eisenia fetida</i> (ef1)	<i>Eisenia fetida</i> (ef2)	<i>Eisenia fetida</i> (ef3)	<i>Eisenia foetida</i> (ef4)
Proportion 1 : 6	Proportion 1 : 4	Proportion 1 : 3	Proportion 1 : 2
Soil : Cowdung	Soil : Cowdung	Soil : Cowdung	Soil : Cowdung
50g :300g	75g :300g	100g :300g	150g :300g
<i>Eudrilus eugeniae</i> (eu1)	<i>Eudrilus eugeniae</i> (eu2)	<i>Eudrilus eugeniae</i> (eu3)	<i>Eudrilus eugeniae</i> (eu4)
Proportion 1 : 6	Proportion 1 : 4	Proportion 1 : 3	Proportion 1 : 2
Soil : Cowdung	Soil : Cowdung	Soil : Cowdung	Soil : Cowdung
50g :300g	75g :300g	100g :300g	150g :300g
<i>Megascolex megascolex</i>	<i>Megascolex megascolex</i>	<i>Megascolex megascolex</i>	<i>Megascolex megascolex</i>
Proportion 1 : 6	Proportion 1 : 4	Proportion 1 : 3	Proportion 1 : 2
Soil : Cowdung	Soil : Cowdung	Soil : Cowdung	Soil : Cowdung
50g :300g	75g :300g	100g :300g	150g :300g

Fig. 1—Soil cow dung proportion and earthworm species

#### Optimization of Soil Cowdung Proportion and Selection of Earthworm Species

Experimental set up for choosing best proportion of soil and cowdung was tried with four different proportions (1:6, 1:4, 1:3, 1:2). Selected proportion was added in different culture boxes (21 cm x 14 cm x 11 cm) and in each box, 10 earthworms of *E. fetida*, *E. eugeniae*, and *M. megascolex* were added. Experimental set up was covered with gunny bag and an average of water content of 70% was maintained. Number of earthworms was counted at the end of 32 days (Fig. 1). Aggregation and grinding characteristics of earthworms is demonstrated by using samples drawn from vermi composts of selected species. Samples were oven dried analyzed for particle size distribution using Indian Standard set of sieves. Identification of soil type was carried out in accordance with IS: 1498 – 1970 by visual observation and based on the results of the sieve analysis<sup>26</sup>.

#### pH

Soil (30 g) was mixed with distilled water (100 ml) and stirred, and pH recorded after 30 min using a digital pH meter in accordance with IS: 2720 (Part 26).

#### Results and Discussion

Optimum proportion of soil + cowdung (1:3) for culturing of earthworms has shown highest number of

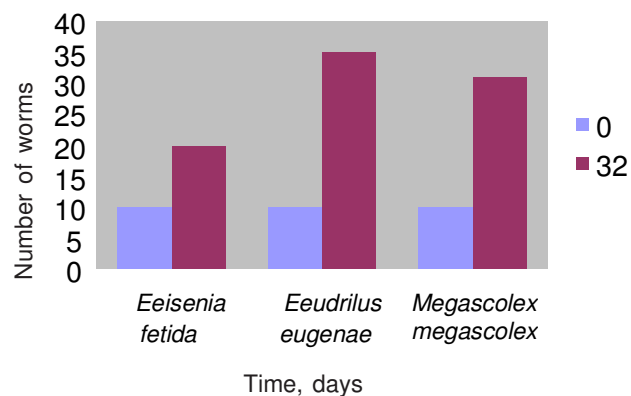


Fig. 2—Increase in number of earthworms for soil + cow dung (1:3)

earthworm hand sorted in three earthworms [*E. fetida* (20), *E. eugeniae* (35) and *M. megascolex* (32)] after 32 days (Fig. 2). There was marginal increase in worm's length whereas weight gain was significant in all three species of earthworms. Reduction in pH values in case of composts prepared from three earthworms was found as follows: *E. fetida*, 6.7 to 6.1; *E. eugeniae*, 6.7 to 6.0; and *M. megascolex*, 6.7 to 6.4. A decrease in pH from 9 to 8.3 of alkaline soils is reported<sup>25</sup> in pot experiment on vermiculture. Earthworms are sensitive to hydrogen ion concentration, so it is observed that pH is a significant factor that limits the distribution, number of earthworms

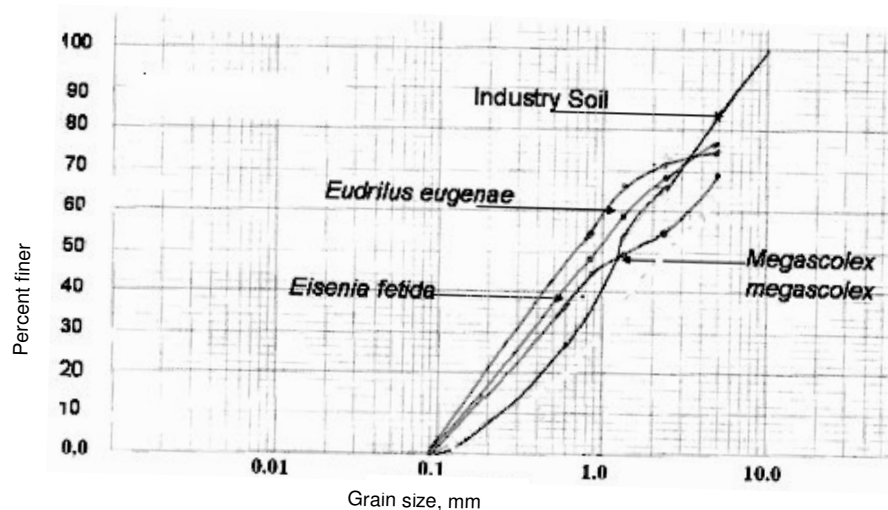


Fig. 3—Grain sized distribution curves for industry soil, and vermi-composts prepared from *Eisenia fetida*, *Eudrilus eugeniae*, *Megascolex masgcolex*

Table 1—Cumulative percent finer for soil, and vermi-composts

IS sieve size	Soil cumulative % finer (N)	<i>Eisenia fetida</i> , %	<i>Eudrilus eugeniae</i> , %	<i>Megascolex masgcolex</i> , %
4.75 mm	83.50	76.2	74.40	69.1
2.36 mm	66.50	69.24	70.83	53.82
1.40 mm	52.00	59.84	66.07	49.77
1.18 mm	46.00	-	-	-
850 $\mu$	39.00	49.94	54.77	45.15
600 $\mu$	27.00	-	-	-
425 $\mu$	11.00	-	-	-
300 $\mu$	9.50	-	-	-
150 $\mu$	1.50	-	-	-
90 $\mu$	0.50	0	0	0
70 $\mu$	0	0	0	0

and species of earthworm live in a particular type of soil pH of about 7.0<sup>27-31</sup>

Soil used for experimentation was  $\leq 850 \mu$ . But soil has been retained  $> 850 \mu$  (Table 1) by three earthworms as follow: *E. fetida*, 50.06; *E. eugeniae*, 45.23; and *M. masgcolex*, 54.85 %. Therefore, aggregation is more in *M. masgcolex*. Comparison of particle size distribution of vermi-composts (Fig. 3) reveals that earthworms are responsible for grinding of substrate, which makes particle size distribution finer. Grinding capabilities of *E. eugeniae* is more than *E. fetida* and *M. masgcolex*. *M. masgcolex* has highest aggregation capabilities as compared to other two species.

## Conclusions

Optimum soil-cowdung proportion has been found 1:3 for all tested species. Maximum increase was with *Eudrilus eugeniae*. Best aggregation was seen with *Megascolex masgcolex*. Therefore, soil-cowdung proportion, growth of earthworms with soil aggregation properties advocates the use of this technology especially for industries generating organic wastes.

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