Harnessing *Eisenia foetida*: A Dual-Weed Comparison of Vermicomposting Efficiency

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ABSTRACT

Weeds is the most common problem encountered by the farmers throughout the world. We studied the ability of the epigeic earthworm Eisenia foetida to transform weeds into value added product i.e., vermicomposting. Biological activity of the earthworm was monitored in a range of different feed mixture for 18 weeks under laboratory condition.

INTRODUCTION

A weed may be defined as "any plant growing where it is not wanted." It is one of the most common problems encountered by the farmers throughout the world, which interfere with agricultural operations, increase labor, add to the cost of cultivation, reduce the yield of crops and kill and reduce the thriftiness of domestic animals. Eradication of weeds has been proved to be impossible in spite of the sincere efforts of the scientists and technologists. Therefore, there is a need to divert research activities towards their utilization and it is essential to design a national level policy for their proper utilization. There is a good evidence that organic matter that pass through the gut of earthworm and deposited on or in the soil in the form of casts possessed higher amounts of nutrients than that of the substrates or soil on which the earthworms feed (Edward and Burrows, 1989; Reddy *et al.,* 1997). Moreover, the nutrients are changed to assimilable forms in the gut, that are more rapidly taken up by plants (Edward and Lofty, 1974; Lee, 1985).

Chemical substances present in the food attract and elicit feeding responses in many invertebrates. Flavour potentiators or modifiers in food exert gustatory effect not only in man but also in other animal. The existence of such cues in earthworm can be deduced as they show preference to the nature of organic matter (Kale and Krishnamurthy, 1981). Carbon and nitrogen content of the organic matter determine the abundance and diversity of earthworm species. By using different weeds as raw material for vermicomposting their order of preference by earthworms can be determined.

Considerable work has been carried out on the use of earthworms to recycle various organic wastes such as leaf litter, city garbage, rabbit dropping, pig and cattle solid sludge, water hyacinth, agricultural wastes etc. However, there is not much published report available regarding the

vermicomposting of weed *Chenopodium murale*. It is in view of this lacuna and for better understanding of the process of vermicomposting, work on the present problem has been selected.

MATERIALS AND METHODS

To fecundity study of earthworm species *Eisenia foetida* during vermicomposting of selected weeds and its different parameters was carried out as followed:

Experimental design

300 gm of feed mixture was taken in plastic containers of 500 mg capacity. All the treatments were kept in triplicate and same setup without earthworm were also maintained which served as control. All the treatment containers were left for 15 days prior to experimentation for thermal stabilization & softening of wastes for easy ingestion by the earthworms .The water was sprinkled over the feed mixture on alternate day to hold moisture content of about 60 to 80%. After 15 days, 10 healthy non-clitellated earthworm weighing 150 to 300 mg were selected form stock culture and introduced in each container. To prevent moisture loss the containers were covered with wet gunny begs. All containers were placed in darkness at room temperature. No additional food was added at any stage during the study period.

Table 1: Content of weed with cow dung in initial feed mixture

Feed composition	Weed %	Cow dung %
T_1	0	100
T_2	20	80
T_3	40	60
T_4	60	40
T_5	80	20

Materials for experiment

i. *Eisenia foetida*

Eisenia foetida specimens of the earthworm commonly known as red wrigglers were used in this study. Young, healthy clitellated earthworms or hatchlings (as per requirements) were randomly picked from several different cultures (each containing 500-2000 earthworms) maintained in the department of botany, Sri Guru Nanak PG Khalsa College, Sri Ganganagar, Rajasthan using cow dung as the culturing material

ii. Cow dung

Fresh CD was procured from 4Z village, Sri Ganganagatr, Rajasthan. The main characteristics of CD were: pH :7.73, organic carbon (OC): 362.31g/kg, total kjeldhal nitrogen (TKN): 6.5 g/kg, total phosphorus (TP): 4.2 g/kg, total potassium (TP): 5.11 g/kg, C:N ratio: 55.65, calcium (Ca): 3.2 g/kg, and C:P ratio: 84.65.

iii. Weeds selected for experiment

Two weeds are selected for this experiment named *Chenopodium murale* and *Parthenium histerophorus*. These weeds are collected from gardens, waste places, road sides and rural habitats.

Growth and fecundity study

Growth and cocoon production in each mixture was recorded weekly for 18 weeks. The feed in the containers was turned out and earthworms and cocoons were separated from the feed by hand sorting, after which they were counted and weighed after washing with water and drying them by paper towels. The worms were weighed without first voiding them, since it has been reported that the gut content would lie around 10% of live weight, where as larger differences are expected in relation to feed (Neuhauser et al., 1980). Corrections for gut content were not applied to any of the data in the study. Then all measured earthworm and feed (but not cocoons) were returned to the containers.

At the end of vermicomposting period the earthworms and cocoons were separated and final compost from each reactor was air dried at room temperature. Homogenized samples of final compost were ground in a stainless steel blend, stored in airtight plastic vials for further chemical analysis.

Results and Discussion

The change in biomass and cocoon production differed depending on the substrates. The changes in worm biomass for all the feed mixtures over the observation period illustrated in table 2 for *Chenopodium murale* weed and in table 3 for weed *Parthenium histerophorus*.

In *Chenopodium murale* the maximum biomass (1149 ± 4.15 mg) after 120 days was observed in T_2 treatment and minimum biomass (993 ± 5.19 mg) in 100% cow dung. But in *Parthenium histerophorus* treatment T_5 was not favourable for the growth of the *Eisenia foetida*. Worms started to die after 3rd week and 100% mortality was observed in 9th week of the experiment time. Table 3 shows that the maximum biomass of earthworm was (1146 ± 3.12 mg) after 120 days in T_2 treatment and minimum biomass (993 ± 5.19 mg) in 100% cow dung.

The maximum growth rate of *Eisenia foetida* in feed mixture with *Chenopodium murale* was registered between the range of 8 ± 0.05 earthworm^{-1} day^{-1} (in T_4 treatment) to 11 ± 0.10 earthworm^{-1} day^{-1} (in T_3 treatment). The net weight gain by worm was highest in T_4 treatment (834 ± 6.29 mg worm^{-1}) and lowest in T_1 treatment (777 ± 7.21 mg worm^{-1})) and the maximum weight of earthworm was attained in 11th - 14th week in all the treatments.

Table 2: Earthworm growth of *Eisenia foetida* in different feed mixtures of cow dung with *Chenopodium murale* weed

Feed no.	Mean initial wt.worm^{-1} (mg)	Maximum wt. achieved worm^{-1} (mg)	Maximum wt. achieved in	Net wt. gain worm^{-1} (mg)	Growth rate worm^{-1} day^{-1} (mg)
T_1	216 ± 3.96	993 ± 5.19	12th Week	777 ± 7.21	9 ± 0.08
T_2	226 ± 3.96	1049 ± 4.15	11th Week	823 ± 7.67	10 ± 0.09
T_3	207 ± 3.46	1038 ± 5.27	11th Week	831 ±8.60	11 ± 0.10
T_4	212 ± 3.22	1046 ± 3.10	14th Week	834 ± 6.29	8 ± 0.05
T_5	227 ± 2.94	1021 ± 4.38	14th Week	794 ± 7.22	8 ± 0.06

Table 3: Earthworm growth of *Eisenia foetida* in different feed mixtures of cow dung with *Parthenium hysterophorus* weed

Feed no.	Mean initial wt.worm^{-1} (mg)	Maximum wt. achieved worm^{-1} (mg)	Maximum wt. achieved in	Net wt. gain worm^{-1} (mg)	Growth rate worm^{-1} day^{-1} (mg)
T_1	216 ± 3.96	993 ± 5.19	12th Week	777 ± 7.21	9 ± 0.08
T_2	204 ± 6.99	833 ± 5.43	11th Week	629 ± 8.25	8 ± 0.10
T_3	202 ± 8.95	809 ± 8.33	12th Week	607 ±17.24	7 ± 0.20
T_4	198 ± 8.10	686 ± 10.45	10th Week	488 ± 14.89	7 ± 0.20
T_5	205 ± 7.64	373 ± 9.58	4th Week	169 ± 5.70	6 ± 0.19

The maximum growth rate of *Eisenia foetida* in feed mixture with *Parthenium hysterophorus* weed was registered between the range of 8 ± 0.04 earthworm^{-1} day^{-1} (in T_5 treatment) to 10 ± 0.08 earthworm^{-1} day^{-1} (in T_2 treatment). Increasing proportion of weed in the feed mixture promoted a decrease in biomass of *Eisenia foetida.* The maximum weight by earthworm was attained in 12th - 13th week in all the treatments except T_3 treatment (14th week). Total mortality was observed in T_5 treatment.

After the initial biomass gain, a stabilization and, later, weight loss was observed in all the feed mixtures tested. The loss in worm biomass can be attributed to the exhaustion of food. The fastest growth rate was observed in 100% CD (9 ± 0.08 mg worm^{-1} day^{-1}) whereas T_4 treatment supported the least growth (6 ± 0.19 mg worm^{-1} day^{-1}) in *Parthenium hysterophorus* weed.

In feed mixture with *Chenopodium murale* weed, figure 1 shows that all the compositions showed decline in biomass at all the time periods with respect to control. But it is interesting to note that the biomass in all the treatment increased with increase in time. The increase was linear up to 12 months but after that it showed a decline trend.

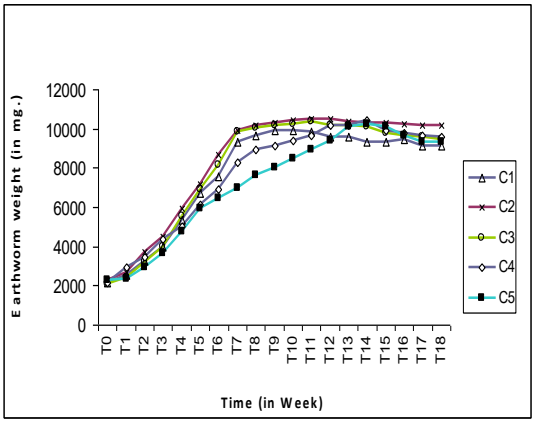

Fig 1: Growth pattern of *Eisenia foetida* in different feed mixtures of *Chenopodium murale hysteriphorus* with cow dung

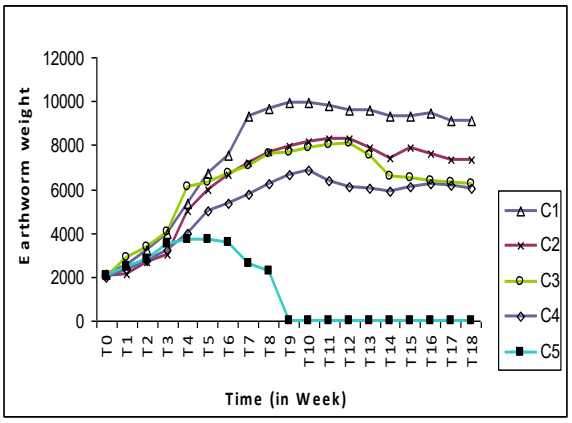

Fig 2: Figure 21 Growth pattern of *Eisenia foetida* in different feed mixtures of *Parthenium* with cow dung

In feed mixture with *Parthenium hysterophorus* weed, figure 2 shows that all the compositions showed decline in biomass at all the time periods with respect to control. But it is interesting to note that the biomass in all the treatment increased with increase in time except in T_5 treatment because of total mortality of worms. The increase was linear up to 12 months but after that it showed a decline trend except in T_5 treatment.

COCOON PRODUCTION

The cocoon production of all the studied feed mixtures with *Chenopodium murale* over the observation period is illustrated in Fig. 3. The table 4 shows that cocoon production was started in 6th week in 100% cow dung ; in 7th week in other feed mixtures except T_5 treatment (6th week). After 120 days maximum cocoons (170 ± 0.46) were counted in T_3 treatment and minimum (120

± 1.40) in T_5 treatment. The mean number of cocoon production was between 12.0 ± 0.13 (in T_5 treatment) and 17.0 ± 0.05 (in T_3 treatment) cocoons earthworm^{-1} for different feed mixtures tested. Cocoon production fluctuated with time. Initially cocoon production rate was high. The range of mean number of cocoons produced per worm per day was 0.34 ± 0.004 in cow dung to 4.86 ± 0.005 in T_3 treatment.

Table 4: Cocoon production by *Eisenia foetida* in different feed mixtures of *Chenopodium murale*

Feed no.	Cocoon production tarted in	Total nos. of cocoons after 11 weeks	Nos. of cocoons produced earthworm^{-1}	Nos. of cocoons produced earthworm^{-1} day^{-1}
T_1	6th Week	143 ± 1.40	14.3 ± 0.13	0.34 ± 0.004
T_2	5th Week	137 ± 0.94	13.7 ± 0.09	3.91 ± 0.02
T_3	5th Week	170 ± 0.46	17.0 ± 0.05	4.86 ± 0.005
T_4	5th Week	159 ± 0.46	15.9 ± 0.05	4.54 ± 0.002
T_5	6th Week	120 ± 1.40	12.0 ± 0.13	2.85 ± 0.02

Table 5: Cocoon production by *Eisenia foetida* in different feed mixtures of *Parthenium hysterophorus*

Feed no.	Cocoon production tarted in	Total nos. of cocoons after 11 weeks	Nos. of cocoons produced earthworm^{-1}	Nos. of cocoons produced earthworm^{-1} day^{-1}
T_1	6th Week	143 ± 1.40	14.3 ± 0.13	0.34 ± 0.004
T_2	6th Week	80 ± 0.94	8.0 ± 0.08	0.19 ± 0.001
T_3	7th Week	98 ± 0.46	9.8 ± 0.04	0.20 ± 0.0006
T_4	7th Week	72 ± 0.46	7.2 ± 0.04	0.15 ± 0.0006
T_5	7th Week	2 ± 0.46	0.2 ± 0.04	0.004 ± 0.0006

The table 5 summarizes the cocoon production by *Eisenia foetida* in different feed mixtures of *Parthenium hysterophorus*. Cocoon production was started in 6th week in 100% cow dung ; in 7th week in other feed mixtures except T_2 treatment. After 120 days maximum cocoons (143 ± 1.40) were counted in 100% cow dung and minimum (2 ± 0.46) in T_5 treatment. The mean number of cocoon production was between 14.3 ± 0.13 (in 100% cow dung) and 0.2 ± 0.04 (in T_5 treatment) cocoons earthworm^{-1} for different feed mixtures tested of *Parthenium hysterophorus*. Fig. 4 shows that cocoon production fluctuated with time. Initially cocoon production rate was high. The range

of mean number of cocoons produced per worm per day was 0.34 ± 0.004 in cow dung to 0.004 ± 0.0006 in T_5 treatment.

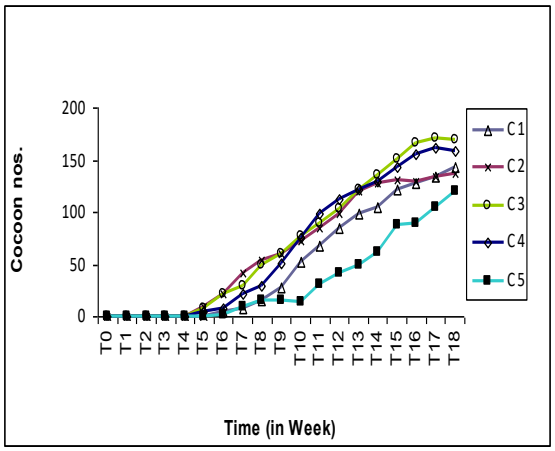

Figure 3 Cocoon production of *Eisenia foetida* in feed mixture of *Chenopodium murale* with cow dung

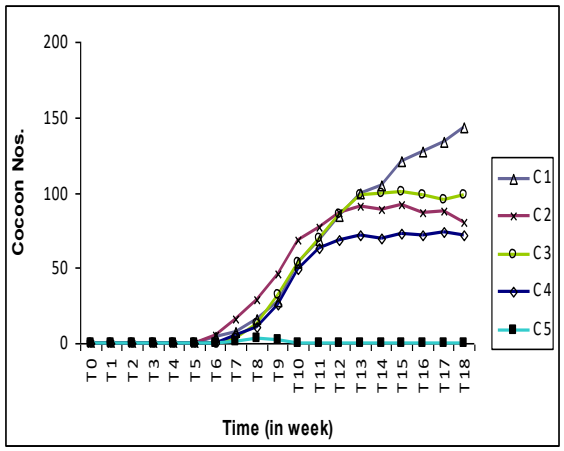

Figure 4 Cocoon production of *Eisenia foetida* in feed mixture of *Parthenium hysterophorus* with cow dung

Cocoon production fluctuated with time. Initially cocoon production rate was high. The range of mean number of cocoons produced per worm per day was 0.34 ± 0.004 in cow dung to 4.86 ± 0.005 in T_3 treatment.

Eisenia foetida is an epigeic earthworm species which live in organic waste and requires high moisture content, adequate amounts of suitable organic material. And dark conditions for proper growth and development (Chaudhary and Bhattacharjee, 2002). Parthasarathi, K. (2007) examined the growth and reproduction of indigenous *Lampito mauritii* in comparison with exotic *Eudrilus eugeniae* cultured on three feed substrates-clay loam soil, cowdung and press mud (filter cake) have been studied over a period of 360 days under laboratory conditions. The decrease of worm length and biomass observed slightly on 63-70th days in *Lampito mauritii* and 42-49th days in *Eudrilus eugeniae* cultured on three fed substrates are the results of the onset of cocoon production. After 270 days both worms in all these fed substrates show decreasing trends of length and biomass, which are due to, continued reproduction and aging.

The growth, fecundity and mortality of *Eisenia foetida* was studied by Gunadi and Edwards (2003) in a range of different wastes (cattle manure solids, pig manure solids and super market waste) for more than one year. Worms could not survive in fresh cattle solids, pig solids, fruit wastes and vegetable wastes. The growth of *Eisenia foetida* in pig wastes was faster than in cattle solids.

Chan and Griffiths (1988) studied the vermicomposting of pretreated pig manure in Hongkong using the earthworm species *Eisenia foetida*. The results showed that fecund earthworm species such as *E.Foetida* is suitable for biorecycling pretreated pig manure, the worms grew rapidly and reproduced a humus rich worm cast which was odour free. Loh et al. (2004) reported that biomass gain and cocoon production by *Eisenia foetida* was more in cattle waste than goat waste. The potential of *Perionyx excavates* to vermicompost different wastes (sheep dung, cow dung, biogas sludge and poultry manure and sand as control). The worms readily accepted cow and horse waste. Sheep waste was consumed 3 or 4 days after it was added. (Kale et al (1982).Singh et al (2004) studied the optimum moisture requirement during vermicomposting by *Perionyx excavates.* The study showed that a moisture content of 80 was optimum for stabilization of waste in minimum processing time.

CONCLUSION

The table 2 and 4 showed that all the treatments were suitable growth medium for *Eisenia foetida.* Greater percentage of *Chenopodium murale* weed in the feed mixture significantly affected the biomass gain and cocoon production.

Greater percentage of *Parthenium hysterophorus* weed in the feed mixture significantly affected the biomass gain and cocoon production. The table 3 and 5 showed that addition of at least 80% cow dung in *Parthenium hysterophorus* weed was essential for the survival of *Eisenia foetida.* Finally these results suggested that treatment no. 2, 3, 4 and 5 cannot be used as substrate for vermicomposting by *Eisenia foetida*

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