



Influence of different media and temperature on the growth and reproduction of composting earthworms *Eisenia fetida* and *Eudrilus eugeniae*

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Abstract : *The influence of different organic media and temperature on the growth and reproduction potential of epigeic earthworm species; Eisenia fetida and Eudrilus eugeniae were studied. The four different types of culture media namely: kitchen waste+cowdung (KW+CD), water hyacinth+cowdung (WH+CD), leaf litter+cowdung (LL+CD) and soil+cowdung (S+CD) as control were used. The result showed that the body weight, cocoon production and hatchling number of Eisenia fetida and Eudrilus eugeniae were significantly higher ($P<0.05$) in KW+CD and WH+CD as compared to LL+CD and S+CD. Temperature, ranging between (28-30°C), affect the incubation period of cocoon. It*

has been concluded that KW+CD and WH+CD are better organic media for growth and reproduction of Eisenia fetida and Eudrilus eugeniae.

Keywords : *Eisenia fetida, Eudrilus eugeniae, Organic media, Temperature, Growth, Reproduction.*

Introduction :

Earthworms play an important role in the sustainable management of municipal solid wastes (MSW), and remediation of chemically contaminated soils, and thus are powerful plant growth promoters. Sir Charles Darwin called earthworms “unheralded soldiers of mankind” and the Greek philosopher Aristotle called them the “Intestine of earth”, meaning digesters of a wide variety of organic wastes present in soil. Earthworms can be used as a source of raw materials for promoting piggery, poultry, fishing and dairy developments. They are valuable sources of bioactive compounds for producing modern medicines for various diseases.

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Growth, maturation, cocoon production and reproductive potential of earthworms are, not only influenced by environmental conditions alone, but are also strongly affected by the quality and availability of food. Growth, reproduction, life cycle and environmental requirements were studied (Neuhauser et al.1979), using a mixture of animal and vegetable waste materials, (Bano and Kale 1988) and using cow dung (Viljoen and Reinecke 1992). Animal dung is recognized as suitable earthworm culture media, but other organic waste materials from agriculture and industry have also proved successful. It is well understood that the quality and amount of food material influences, not only the size of population, but also the species present and their rate of growth and cocoon production. Temperature relations and their effect on survival growth, maturation and cocoon production were also well documented (Viljoen and Reinecke, 1992). *Eisenia fetida* is an earthworm which grows rapidly (Neuhausers et al.1980), reproduces prodigiously (Hartenstein et. al 1979)and is potentially deployable for management of wastes rich in microbial biomass (Hartnstein et al. 1981). Environmental factors, like temperature, moisture, pH, nature of substrate and nutrient content in vermibed play a major role in influencing the growth and reproduction. Suthar (2010) reported that the earthworm productivity was high when the temperature and vermibed characteristics were at an optimum level. The reproduction pattern is directly related to the feed in the vermibed. Yadav and Garg (2011)also confirmed the influence of vermibed substrate on reproduction of earthworms.

Temperature also affects the incubation period of cocoons. (Bhattacharjee and Chaudhuri 2002). Suthar(2008) reported that the quality of the used substrate material and fluctuating temperature are responsible for weight gain in *Eudrilus eugeniae*.

Since no comparative study has been conducted using water hyacinth and kitchen waste as culture media for vermiculture, the present study has been undertaken to investigate the rate of growth and reproduction of composting earthworm *Eisenia fetida* and *Eudrilus eugeniae* in different media and temperature, which are commonly used for vermicomposting.

Material and Methods :

Two species of earthworms, *Eisenia fetida* and *Eudrilus eugeniae* were taken for the experiment. *Eisenia fetida* were collected from Holy Cross, “KrishiVigyan Kendra”, Hazaribagh, Jharkand and *Eudrilus eugeniae* from Agriculture Farm, Dumra, Sitamarhi. Four different feeding materials were taken as follows:

- Soil + cow dung,(S+CD) Control
- Kitchen waste + cow dung,(KW+CD)
- Water hyacinth + cow dung, (WH+CD)
- Leaf litter + cow dung, (LL+CD)

All these feeding materials were kept for microbial decomposition for 30 days. The pH ,Total Dissolve Solids (TDS) , electrical conductivity and moisture of these organic manures were recorded to check the suitability of the organic media, for culturing the earthworms. Waste materials were mixed with cow dung in 3:1 ratio (wt/wt), soil sample was taken without any kind of waste and only with cow dung in 3:1 ratio (wt/wt) (control). All these materials were dried, sieved and kept in the pot. The experiment was conducted in triplicate and in different temperature conditions in the garden, ranging from (35-42°C) and in the room (28-30°C).

Ten earthworms were weighed for recording their biomass and then were placed in each container of different organic media. After every week the feed in the container was turned out, then earthworms and cocoons were separated from the bed by hand sorting and were counted and weighed.

Then the earthworms and feed were returned to their respective containers. The growth and reproduction of earthworms in different organic media were recorded by taking their body weight, the number of cocoon production and the number of hatchlings on a weekly basis. The weights of worms were compared to the control group with the paired 't' test. The total variation present in a set of data was analysed through one-way analysis of variance (ANOVA) and $P < 0.05$ was considered as statistically significant.

Results and Discussion :

The present study showed that the four vermicultures in organic media support the growth of earthworms, and this indicates that they could be considered as good culture media for worms. The substrate combinations, namely, S+CD, KW+CD, WH+CD and LL+CD, at two different temperatures 35-42°C and 28-30°C are more suitable. The physical and chemical parameters of organic media are given in Tables 1,2,3,4.

Table 1. pH values of different organic media used in experiment (n=3)

Organic media	<i>Eisenia fetida</i>	<i>Eudrilus eugeniae</i>
Control (S+CD)	6.94±0.14	7.13±0.01
KW+CD	8.21±0.01	8.20±0.02
WH+CD	8.22±0.01	7.95±0.05
LL+CD	6.74±0.04	6.89±0.03

Table 2. Moisture (%) of different organic media used in experiment (n=3)

Organic media	<i>Eisenia fetida</i>	<i>Eudrilus eugeniae</i>
Control (S+CD)	28.34±1.51	36.31±1.52
KW+CD	40.19±1.64	45.12±1.68
WH+CD	31.45±1.57	31.32±1.76
LL+CD	28.51±1.21	27.76±1.53

Table 3. Total Dissolved Solids (mg/L) values of different organic media used in experiment (n=3)

Organic media	<i>Eisenia fetida</i>	<i>Eudrilus eugeniae</i>
Control(S+CD)	4.22±0.38	3.32±0.22
KW+CD	2.14±0.05	3.41±0.07
WH+CD	2.02±0.09	2.08±0.06
LL+CD	4.57±0.31	4.12±0.23

Table 4. Electrical conductivity (mS) of different organic media used in experiment (n=3)

Organic media	<i>Eisenia fetida</i>	<i>Eudrilus eugeniae</i>
Control(S+CD)	3.77±0.58	3.54±0.17
KW+CD	2.24±0.03	3.32±0.07
WH+CD	2.19±0.04	2.23±0.06
LL+CD	4.8±0.32	4.10±0.12

Table 5. Growth of *Eisenia fetida* in different organic media (Mean±SE, n=10)

Organic media	Weight of ten worms after 10 weeks	
	OUTSIDE (35-42°C)	INSIDE (28-30°C)
Control(S+CD)	2.13±0.03	2.15±0.03
KW+CD	2.70±0.11*	2.9±0.11*
WH+CD	2.44±0.08*	2.51±0.08*
LL+CD	2.22±0.05	2.32±0.06*

Statistically significant difference ($P < 0.05$) When compared to control(S+CD)

Table 6. Growth of *Eudrilus eugeniae* in different organic media (Mean±SE, n=10)

Organic media	Weight of ten worms after 10 weeks	
	OUTSIDE (35-42°C)	INSIDE (28-30°C)
Control(S+CD)	2.44±0.05	2.68±0.12
KW+CD	3.13±0.19*	3.56±0.31*
WH+CD	3.08±0.17*	3.27±0.19*
LL+CD	2.85±0.13	2.94±0.17

Statistically significant difference ($P < 0.05$) when compared to control

Table 7. Cocoon (mean number) of *Eisenia fetida* in different organic media (Mean±SE, n=10)

Organic media	OUTSIDE (35-42°C)	INSIDE (28-30°C)
Control(S+CD)	1.1±0.54	1.3±0.55
KW+CD	3.7±2.08	4.4±2.21
WH+CD	1.7±1.09	2.6±1.5
LL+CD	1.20±0.62	1.7±0.31

Table 8. Cocoon (mean number) of *Eudrilus eugeniae* in different organic media (Mean±SE, n=10)

Organic media	OUTSIDE (35-42°C)	INSIDE (28-30°C)
Control(S+CD)	0.6±0.33	0.7±1.84
KW+CD	3.3±1.21	4.2±1.84
WH+CD	1.6±0.66	2.2±1.08
LL+CD	1.0±0.47	1.3±0.08

Table 9. Juvenile (mean number) of *Eisenia fetida* in different organic media (Mean±SE, n=10)

Organic media	OUTSIDE (35-42°C)	INSIDE (28-30°C)
Control(S+CD)	15.81±4.58	20.98±7.09
KW+CD	33.59±12.34	35.08±15.81
WH+CD	22.38±0.06	23.21±8.43
LL+CD	20.98±7.35	21.21±7.46

Table 10. Juvenile(mean number) of *Eudrilus eugeniae* in different organic media (Mean±SE, n=10)

Organic media	OUTSIDE (35-42°C)	INSIDE (28-30°C)
Control(S+CD)	9.78±3.74	9.25±3.14
KW+CD	18.87±7.87	26.81±7.92
WH+CD	10.58±4.21	11.41±4.24
LL+CD	9.91±3.43	11.28±4.03

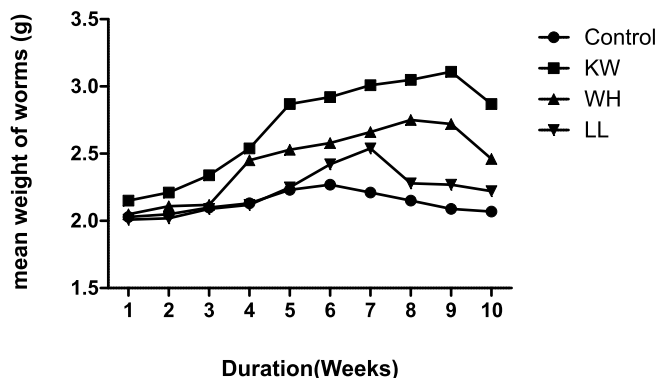


Fig 1. Weight gain of *Eisenia fetida* in four different medium (OUTSIDE) at 35-42°C

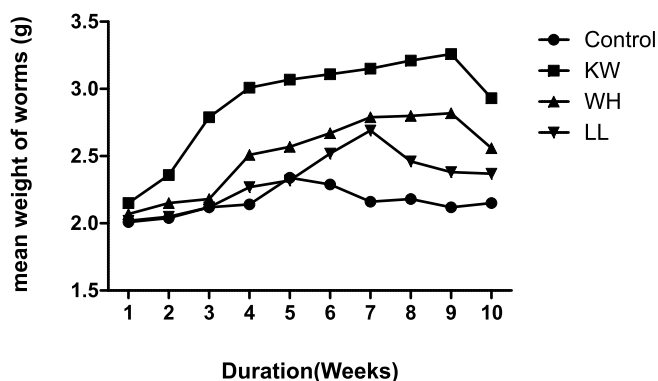


Fig 2. Weight gain of *Eisenia fetida* in four different medium (INSIDE) at 28-30°C

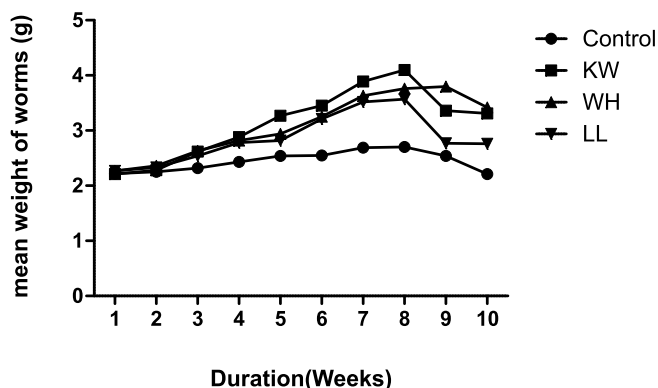


Fig 3. Weight gain of *Eudrilus eugeniae* in four different medium (OUTSIDE) at 35-42°C

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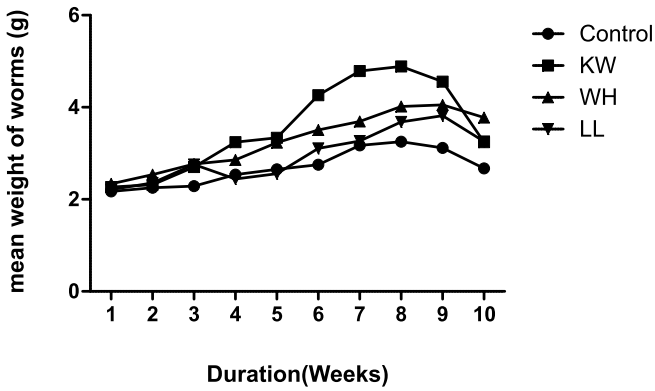


Fig 4. Weight gain of *Eudrilus eugeniae* in four different medium (INSIDE) at 28-30°

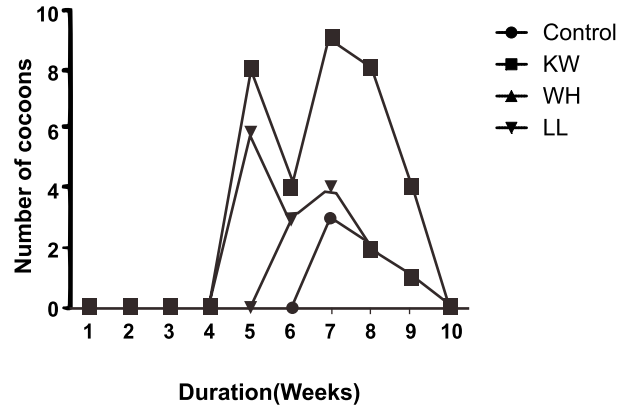


Fig 7. Effect of different organic media on cocoons production of *Eudrilus eugeniae* (OUTSIDE) at 35-42°C

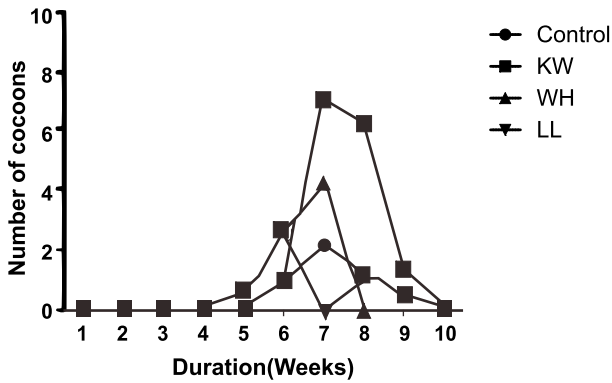


Fig 5. Effect of different organic media on cocoons production of *Eisenia fetida* (OUTSIDE) at 35-42°C

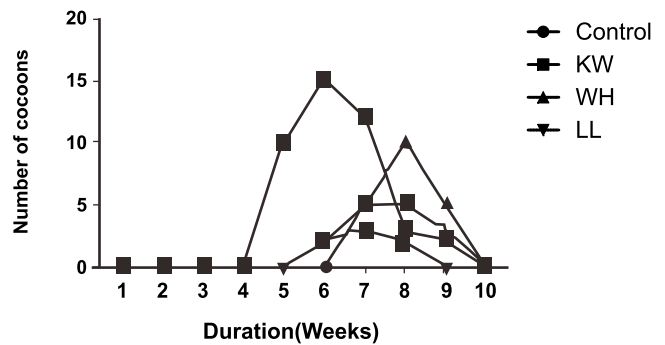


Fig 8. Effect of different organic media on cocoons production of *Eudrilus eugeniae* (INSIDE) at 28-30°C

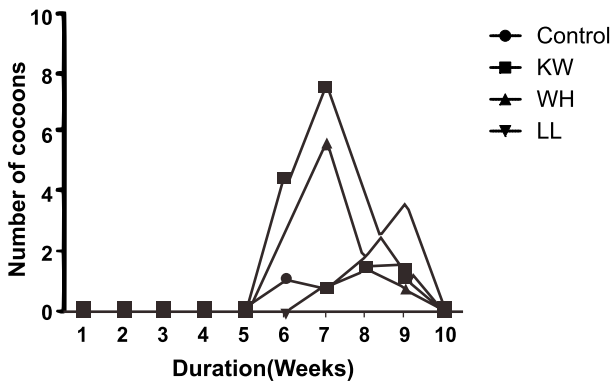


Fig 6. Effect of different organic media on cocoons production of *Eisenia fetida* (INSIDE) at 28-30°C

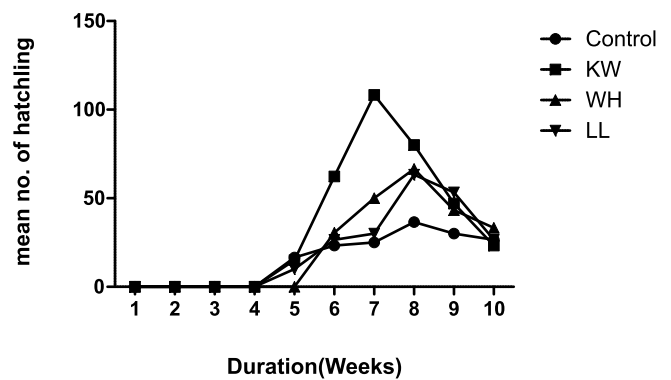


Fig 9. Effect of different organic media on cocoons production of *Eisenia fetida* (OUTSIDE) at 35-42°C

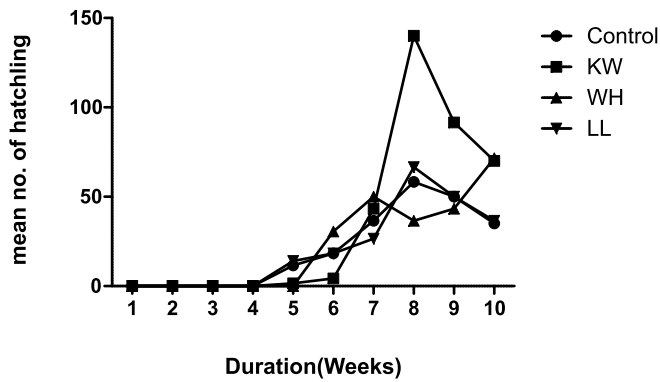


Fig 10. Effect of different organic media on cocoons production of *Eisenia fetida* (INSIDE) at 28-30°C

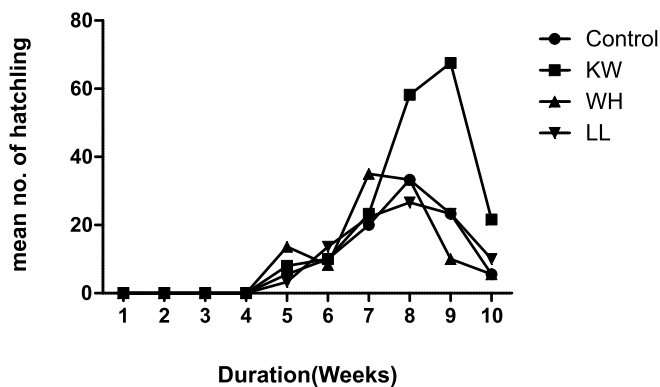


Fig 11. Effect of different organic media on hatchling production of *Eudrilus eugeniae* (OUTSIDE) at 35-42°C

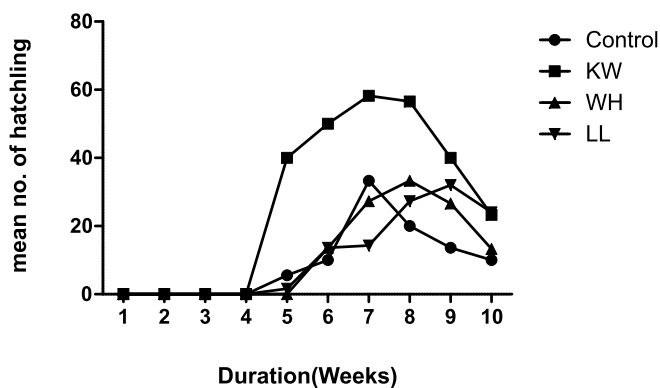


Fig 12. Effect of different organic media on hatchling production of *Eudrilus eugeniae* (INSIDE) at 28-30°C

It was observed that there was no significant increase in the body weight of earthworms *Eisenia fetida* when cultured at 35-42°C in S+CD. But it was found that the body weight of earthworms, increased significantly by 21.1% ($P < 0.05$) when cultured in KW+CD, and increased by 12.7% ($P < 0.05$) when cultured with WH+CD, in comparison to control (S+CD).

When the temperature of the experiment set-up ranged from 28-30°C, the body weight of earthworms *Eisenia fetida*, increased 34.8% ($P < 0.05$) in KW+CD media, and by 16.7% ($P < 0.05$) in WH+CD media. But the body weight increased by 7.9% at ($P < 0.05$), when cultured in LL+CD and in S+CD.

The earthworms showed maximum growth in kitchen waste, as compared to control and other organic media, a similar result being observed by Suthar (2007). The increase of body weight in the earthworms was seen 20%, highest in KW followed by WH.

The growth increased upto 5th to 6th weeks in all the four organic media but it was observed that there was slow decrease in the body weight. This fluctuation was because of the energy utilized for the reproduction and for cocoon formation. There was weight loss during the egg laying time.

The cocoon production patterns of all the organic media have been illustrated in Tables 7 and 8, and Figs 5 and 6. Earthworms, in most of the cultured worm beds started to produce cocoons after 5th to 6th week. In *Eisenia fetida*, maximum cocoon number was, observed in KW+CD media followed by WH+CD, LL+CD, S+CD. So similar increase in the number of cocoons was seen in *Eudrilus eugeniae* at temperature 28-30°C

In the present study, there was significant increase in cocoon production and hatchlings in KW+CD and WH+CD at the temperature 28-32°C.

The largest number of hatchlings was recorded in *Eisenia fetida* in KW+CD followed by WH+CD, LL+CD, S+CD, which is shown in Table 9, Fig 9 and 10 and in *Eudrilus eugeniae* shown in Table 10, Fig 11 and 12. The differences in reproductive characteristics of *Eisenia fetida* and *Eudrilus eugeniae* at different temperature confirm that the worms need a suitable temperature in the substrate to discharge their reproductive activities. This shows that the quality of the food source might influence cocoon production and hatchlings.

Conclusion :

Thus we conclude from the present study that the growth of the earthworms, *Eisenia fetida* and *Eudrilus eugeniae* in kitchen waste followed by water hyacinth waste at the temperature range (28-30°C) is an ideal temperature to activate metabolic activity and induce maximum reproduction.

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