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GROWTH AND REPRODUCTION OF THE EPIGEIC EARTHWORM, *EISENIA FETIDA* (SAVIGNY, 1826) CULTURED IN VARIOUS ORGANIC WASTES

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ABSTRACT: The study was carried out to evaluate the influence and suitability of various organic wastes on growth and reproduction of the epigeic earthworm, *E. fetida* maintained at uncontrolled laboratory environmental conditions. There was a much variation in biomass, growth rate and cocoon production by this earthworm in different organic wastes such as False Ashoka Waste-FAW (*Polyalthia longifolia*), Parthenium Waste- PW (*Parthenium hysterophorus*), Cotton Residue Waste- CRW (*Gossypium*), Lawn Grass Waste- LGW (*Agrostis*) and Control- Cattle manure-CM used in these experiments. The mean maximum (923.54 ±1122.59) and minimum (481.47±56.13) biomass of worm was observed in PW and FAW respectively. The mean growth rate of worm was 6316.10±529.36, 11836.00±1086.30, 9053.00±807.22, 6969.00±582.42, 10842.00±1011.50 observed in FAW, PW, CRW, LGW and CM (control) respectively. There is a significant variation ($P \leq 0.05$**)** in both worm biomass and growth rate of worms was observed among all the organic wastes, whereas no significant variation was noticed in between different organic wastes, except between PW & FAW, CM & FAW, LGW & PW and CM & LGW in biomass and between LGW & FAW; CM & PW and CM & CRW in growth rate respectively.

The attainment of sexual maturity and 100% maturity was observed early in Control-CM on 6th week and 8th week followed by all other organic wastes on 7th week and 9th week respectively. The maximum cocoon production/ worm/week was observed in Control-CM with 2.86±0.37 followed by CRW (2.16±0.30), PW (2.11±0.30), FAW (1.95±0.27) and it was least in LGW (1.28±0.18). The cumulative cocoon number (CCN)/worm for 17 weeks was 33.27, 35.95, 36.77, 21.77, and 48.65 in FAW, PW, CRW, LGW, and CM respectively. Significant difference ($P \leq 0.05$) was also noticed in cocoon production among and between different organic wastes, except between PW & FAW, CRW & FAW and CRW & PW. Based on the results, it can be concluded that biomass, growth rate, attainment of sexual maturity and cocoon production of the epigeic earthworm, *E. fetida* were influenced much by different organic wastes, that inturn affect on the production of quantity and quality vermicompost and worm multiplication during vermicomposting process. This work also suggests that epigeic earthworms are very much choosy in selection of particular type of organic wastes for their growth, development and cocoon production.

KEYWORDS: Epigeic earthworm-*E.fetida*, Biomass and Growth rate, Sexual maturity and Cocoon production and Organic wastes.

INTRODUCTION

It has long been known that earthworms are important creature's helps in the breakdown of organic matter and release of nutrients that it contains[12,18]. Almost all kinds of non-toxic organic wastes can be utilized in vermicomposting process by using epigeic earthworms. These earthworms are the surface litter feeders, they do not influence on soil fertility directly but they can be efficiently utilized in organic waste management. They remain active throughout the year, enhance the area of organic manure production through biodegradation, mineralization and nutrient mobilization process, when maintained in a captivity under semi-natural conditions[42,45].

Large amount of organic wastes can be easily managed and processed through the densed population of earthworms[24]. In the past, various kinds of organic wastes were tested as a feed materials for variety of earthworm species such as sewage sludge[7,13,14,16,37], paper mill industry sludge[9], pig waste[10,40], water hyacinth[22], paper waste[23], brewery yeast[9], crop residues[6], cow slurry[27], cattle manure[35], wine fruit industry sludge[4], rice stubbles, mango leaves[44], brewery waste[34,36] winery waste[21], processed crop residue waste[6] in organic waste management and recycling of nutrients through vermicomposting.

The growth, reproduction and mortality of *Eisenia fetida* cultured in solid manure, pig manure and solid supermarket waste have been studied by Gunadi and Edwards[26] for over a period of one year. Kale *et. al*.[29] have reported the potentials of *Perionyx excavatus* in vermicomposting of different kinds of wastes like sheep dung, cow dung, biogas sludge, poultry manure and sand as control. Kale and Bano[30] have also witnessed that earthworms preferring nitrogen rich diet will grow faster and produce more number of cocoons than those feeding on mineralized soils. Understanding the growth and reproductive potentials of vermicomposting worms in various substrates is highly essential for effective utilization in sustainable waste management system[3,28]. Reproductive and growth performance of various earthworm species in a range of substrates can act as useful biomarkers to measure their efficiency in vermitechnology[28,43].

The most commonly used epigeic earthworm species in vermicomposting are *Eudrilus eugeniae*, *Eisenia fetida* and *Perionyx excavatus* in Indian conditions[25]. There are number of reasons behind why these species are preferred in bioprocessing of organic wastes as because they have a wide range of temperature tolerance and can live in variety of organic wastes with a flexible range of moisture content. Besides this, they have a very short life span, voracious feeders and breeders throughout the year. Therefore, it requires a detailed knowledge and understanding about the biology of useful epigeic earthworm species, which are widely used in vermitechnology[20]. *Eisenia fetida* is also one of the epigeic earthworm widely distributed throughout the temperate regions of the world and is the species most commonly used in commercial vermiculture and waste reduction process.

Hence, the study was carried out to evaluate the suitability and influence of different organic wastes on the growth and reproduction of the epigeic earthworm, *Eisenia fetida* at uncontrolled laboratory environmental conditions.

MATERIALS AND METHODS

Collection and preparation of organic wastes

Based on the availability in large quantity, various organic wastes such as False Ashoka Waste -FAW (*Polyalthia longifolia*), Parthenium Waste- PW

(*Parthenium hysterophorus*), Cotton Residue Waste- CRW (*Gossypium*), Lawn Grass Waste- LGW (*Agrostis*) were collected. These wastes were chopped into small pieces, allow them to dry under shade, then individual organic wastes were mixed with Cattle Manure-CM in 10:1 (v/v) proportion to maintain proper C/N ratio. All these mixed organic wastes were sprinkled with tap water so as to maintain moisture content of about 70 to 80% and allowed to stabilize for microbial (primary) degradation for about one week. Cattle Manure-CM alone was served as control against all other organic wastes.

Collection and culture of epigeic earthworm, *E. fetida*

The *Eisenia fetida* earthworms were obtained from the University of Agricultural Sciences, GKVK campus, Bangalore and were stock cultured in cattle manure for their multiplication at Department of Zoology, Karnatak University, Dharwad for further experimental use.

Inoculation of earthworms

Each stabilized organic wastes were transferred to an earthen pots of size 11cm diameter X 10 cm height (in triplicates) in order to get accurate results for statistical authentication. To each experimental pot, five one week aged *Eisenia fetida* juveniles were inoculated after noting their weight. All experimental pots were maintained in uncontrolled laboratory environmental conditions with moisture content of about 70 to 80% by sprinkling of tap water whenever necessary; shortage of food for earthworms was avoided by providing sufficient quantity of each stabilized organic waste till the end of the experiment (17 weeks).

Weekly observations were made with respect to increase in juvenile or worm biomass, growth rate, attainment of sexual maturity and cocoon production in all organic wastes till the end of the experiment (17weeks). The growth rate of worms was calculated as per the following formula given by Biradar *et.al.*[8]

$$\text{Growth rate of worm /day/gm} = \frac{\text{Weight of worm on the day of observation} - \text{Initial weight}}{\text{Number of days on the day of observation}} \times 1000$$

Statistical analysis

Statistical analysis of the data was carried out by using ANOVA test through SPSS programme to see the significant difference in growth and reproduction of the earthworm, *E. fetida* cultured in various organic wastes.

RESULTS AND DISCUSSION

The results of the present study with respect to biomass, growth rate, attainment of sexual maturity and cocoon production of the epigeic earthworm, *E.fetida* were represented in the Table 1– 9 and Graph 1–4.

Biomass and growth rate

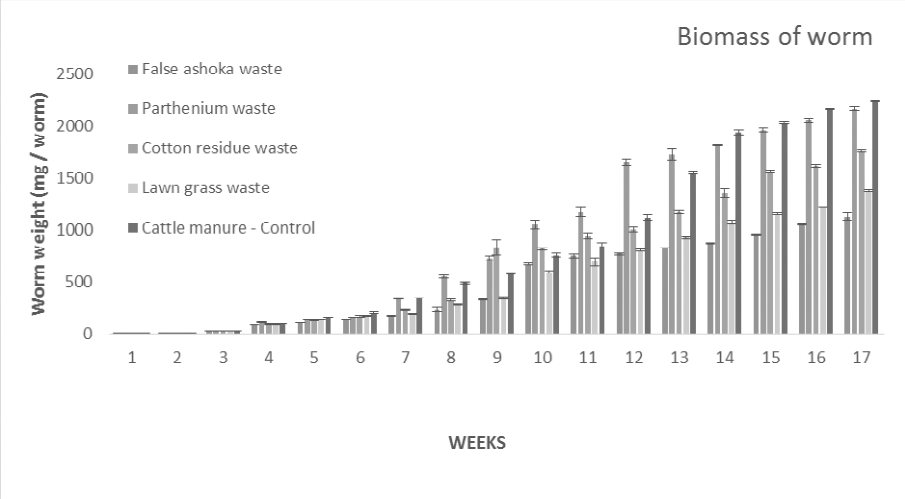
The biomass pattern of the earthworm, *E. fetida* and their variations in different organic wastes was summarized in Table-1 & 2 and Graph-1.The initial biomass of individual juveniles of all the wastes at the time of inoculation was between 9 to 10 mg. There is a gradual increase in juvenile/ worm biomass during initial weeks up to 7th weeks, then there was a sudden increase in the worm biomass from 8th week onwards, then it increased gradually and maintained up to the end of experiment up to 17th weeks (Graph - 1). The mean biomass of worm 481.47±56.13; 923.54±112.59; 710.46 ±85.99; 537.93±65.37 and 858.55±112.51 was noticed in FAW, PW, CRW, LGW and CM (control) respectively. The maximum (923.54±1122.59) and minimum (481.47±56.13) worm biomass was observed in PW and FAW respectively (Table -1). There is a significant difference ($P \leq 0.05$**)** in biomass of worms among all the organic wastes was observed (Table-1), whereas no significant variation was noticed in worm biomass between various organic wastes, except between PW & FAW, CM & FAW, LGW & PW and CM & LGW (Table – 2).

The growth rate (mg/day/gm) of *Eisenia fetida* cultured in different organic wastes for a period of 17 weeks is given in the Table – 3 & 4 and Graph - 2. Growth rate was calculated based on the increase in the worm biomass every week. The growth rate was slow during initial weeks i.e. up to 5-6 weeks, and then it steadily increased up to the attainment of sexual maturity and cocoon production, later on it maintained up to end of the experiment (17 weeks). The maximum growth rate of worm was observed during 11th, 12th, 15th, 15th and 14th week in FAW, PW, CRW, LGW organic wastes and control-CM respectively (Table -3 and Graph -2). Comparatively, maximum growth rate was noticed in PW and minimum in FAW among all organic wastes used (Table -3 and Graph -2). The mean growth rate of worm was 6316.10±529.36, 11836.00±1086.30, 9053.00±807.22, 6969.00± 582.42 and 10842.00±1011.50 observed in FAW, PW, CRW, LGW and control-CM respectively. There is a significant difference was noticed in growth rate of worms among (Table-3) and between different organic wastes, except between LGW & FAW; CM & PW and CM & CRW (Table-4).

There was a much variation in the biomass and growth rate of *E. fetida* among and between different organic wastes used in this experiment may be due to preferential feeding habit of this earthworm. The worm biomass and growth rate are dependent on the texture, particle size, chemical composition, quality of raw organic waste food materials used in the experiment[2,41]. Kale and Krishnamoorthy[31] have also reported that the type of food influences various life activities of the earthworms. Loh *et. al.*[33] have reported that biomass gain and cocoon production by the earthworm, *Eisenia fetida* was more in cattle waste than that of goat waste. The preference of litter feeding earthworm's preference was for

certain leafy matter organic waste materials rather than that of other type of organic wastes[31].

The biomass and growth rate of *E. fetida* was similar in trend to some extent throughout the experimental period, regardless of variations in the nutritional status of different organic wastes, this clearly suggests that minimum dietary requirement of the earthworm, *E. fetida* was fulfilled by all the organic wastes used in the present experiment. Similar trend of biomass and growth rate patterns was witnessed by Bano *et.al*.[5] and Biradar *et.al*.[8]. Increased biomass and growth rate of worms during pre-clitellar stage than that of post-clitellar period in all the organic wastes might be due to enhanced feeding activities before the maturity for their growth and development and even for cocoon production. William *et.al*.[46] has also reported that more vermicompost production was noticed during the pre-clitellar stage than that of the post-clitellar stage of earthworms.



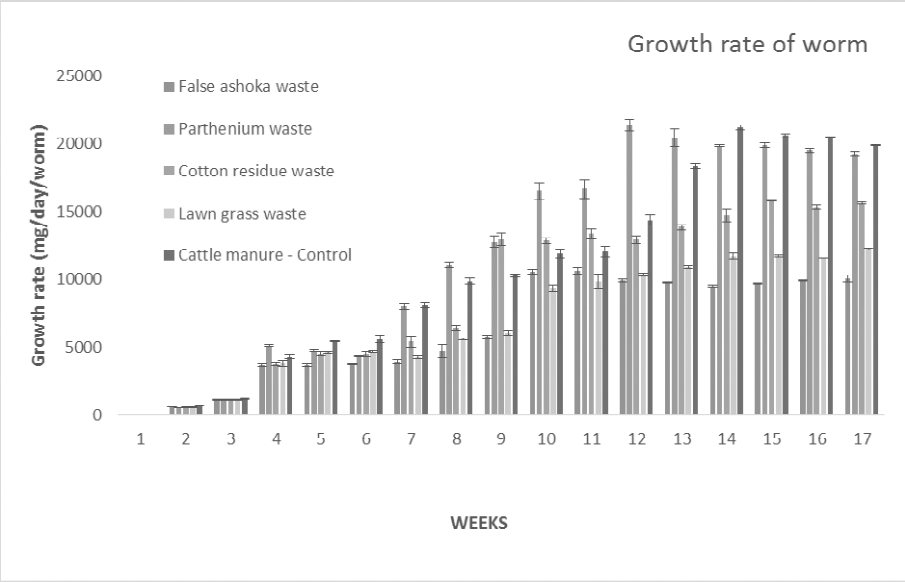
Graph 1. Biomass (mg/worm) pattern of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks. Data are in Mean ± SE.

Table 1. Biomass (mg/worm) pattern of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks and their significance F & P values. Data are in Mean ± SE.

Sl. No.	Weeks	False Ashoka Waste (FAW)	Parthenium Waste (PW)	Cotton Residue Waste (CRW)	Lawn Grass Waste (LGW)	Cattle Manure (Control)
1	1	9.80±.11	10.20±.23	10.00±.11	10.13±.35	10.20±.23
2	2	14.33±.06	14.20±.23	14.20±.23	14.33±.17	15.13±.17
3	3	26.60±.23	26.73±.17	26.33±.17	26.73±.29	27.60±.41
4	4	86.73±2.09	117.40±1.63	88.80±3.30	89.80±5.14	100.93±3.46
5	5	112.20±3.44	143.40±2.11	137.20±3.97	140.20±1.83	162.47±1.56
6	6	140.93±.75	162.40±1.40	167.80±6.36	173.53±3.03	205.87±9.80
7	7	175.00±7.62	347.27±9.67	237.53±17.79	190.07±4.29	350.47±7.90
8	8	241.40±22.21	552.07±10.07	325.00±7.03	285.87±4.50	493.27±9.58
9	9	332.60±6.50	724.80±23.36	836.07±75.62	349.47±10.59	585.87±6.70
10	10	674.67±10.62	1051.20±38.46	821.47±13.28	599.20±14.76	759.33±18.56
11	11	753.07±15.67	1175.50±45.34	944.87±23.95	697.07±37.27	852.60±26.31
12	12	773.53±8.84	1655.80±31.94	1005.90±22.72	805.73±6.67	1117.10±27.58
13	13	829.20±2.64	1725.70±52.88	1174.00±17.40	927.13±8.11	1552.10±14.50
14	14	874.33±6.03	1816.90±5.98	1352.50±41.28	1074.40±20.19	1938.30±19.22
15	15	961.33±2.64	1959.00±17.77	1561.00±8.77	1157.70±6.10	2027.70±13.03
16	16	1050.80±3.86	2054.90±18.12	1617.60±14.01	1224.90±1.12	2159.80±3.40
17	17	1128.50±35.43	2162.70±17.40	1757.70±9.02	1378.50±8.06	2236.50±3.52
18	**Mean ±SE**	**481.47±56.13**	**923.54±112.59**	**710.46±85.99**	**537.93±65.37**	**858.55±112.51**
19	F - Value	1199.0	1258.0	680.59	1593.0	3965.0
20	P- Value (P≤ 0.05)	0.000	0.000	0.000	0.000	0.000

Table 2. Significant variations (P≤0.05) in biomass (mg/worm) of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks.

Sl. No.	Organic wastes	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	**False ashoka waste**	——	**0.00**	0.08	0.66	**0.00**
2	**Parthenium waste**	**0.00**	——-	0.08	**0.00**	0.61
3	**Cotton residue waste**	0.08	0.08	——-	0.19	0.22
4	**Lawn grass waste**	0.66	**0.00**	0.19	———	**0.01**
5	**Cattle manure (Control)**	**0.00**	0.61	0.22	**0.01**	———



Graph 2. Growth rate (mg/day/gm) of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks. Data are in Mean ± SE.

Table 3. Growth rate (mg/day/gm) of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks. Data are in Mean ± SE.

Sl. No.	Weeks	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	**1**	——-	——-	———	———	———
2	**2**	647.62±25.19	571.42±32.99	600.00±28.57	599.99±43.64	704.76±9.52
3	**3**	1200.00±24.74	1180.90±28.96	1166.70±20.75	1185.70±24.74	1242.90±29.73
4	**4**	3663.50±94.65	5104.80±88.49	3752.40±161.15	3802.60±252.05	4320.60±158.06
5	**5**	3657.10±120.02	4757.10±83.70	4542.80±141.12	4645.20±76.63	5438.10±59.80
6	**6**	3746.70±23.40	4348.60±33.48	4508.60±180.00	4668.60±85.58	5590.50±274.17
7	**7**	3933.30±183.95	8025.40±235.90	5417.50±422.73	4285.70±104.43	8101.60±182.82
8	**8**	4729.20±454.57	11058±208.82	6428.60±145.01	5627.20±87.23	9858.50±196.40
9	**9**	5764.30±118.01	12761±420.86	12965±448.12	6059.50±183.09	10280±117.55
10	**10**	10553±170.33	16524±614.14	12880±212.78	9350.30±228.78	11891±291.58
11	**11**	10619±224.73	16648±651.05	13355±343.71	9806.70±531.39	12034±372.96
12	**12**	9918.60±113.67	21371±417.81	12933±296.60	10332±82.14	14376±357.25
13	**13**	9754.80±30.15	20422±627.61	13857±207.91	10917±92.70	18356±169.95
14	**14**	9500.40±66.74	19853±63.81	14752±454.42	11695±218.07	21188±210.01
15	**15**	9709.50±26.14	19886±182.38	15827±89.21	11710±59.93	20589±133.18
16	**16**	9914.30±37.44	19474±173.56	15310±134.42	11569±12.74	20472±34.44
17	**17**	10062±241.74	19219±157.41	15604±79.99	12217±69.04	19878±32.47
18	**Mean ±SE**	**6316.10±529.36**	**11836±1086.3**	**9053.0±807.22**	**6969.0±582.42**	**10842±1011.5**
19	F- Value	575.81	604.86	578.44	567.92	1453
20	P- Value (P≤0.05)	0.00	0.00	0.00	0.00	0.00

Table 4. Significant variations (P≤0.05) between growth rate (mg/day/gm) of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks.

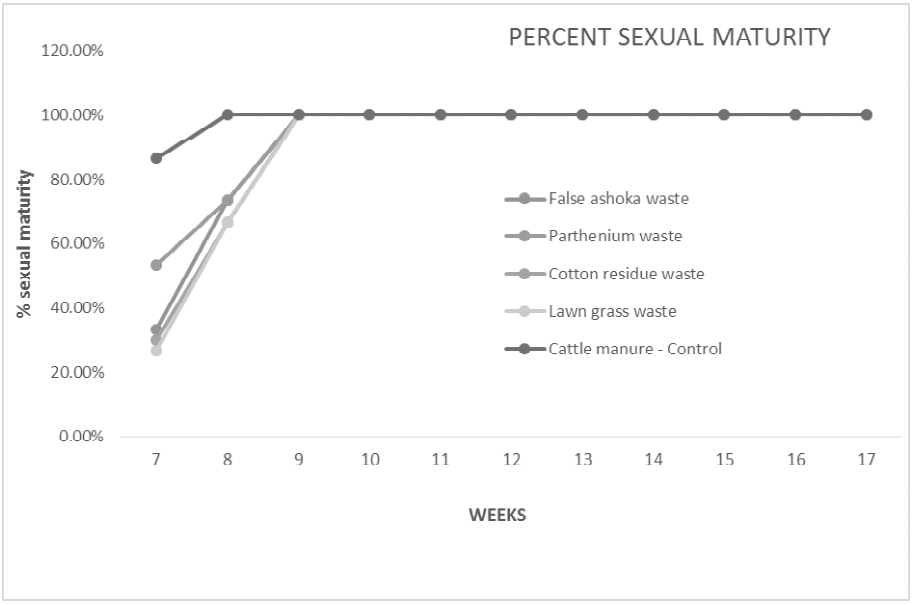
Sl. No.	Organic wastes	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	**False ashoka waste**	———	0.00	0.01	**0.54**	0.00
2	**Parthenium waste**	0.00	———-	0.01	0.00	**0.36**
3	**Cotton residue waste**	0.01	0.01	———	0.05	**0.10**
4	**Lawn grass waste**	**0.54**	0.00	0.05	———-	0.00
5	**Cattle manure (Control)**	0.00	**0.36**	**0.10**	0.00	———-

Sexual maturity and cocoon production

The attainment of sexual maturity of the earthworm, *E. fetida* cultured in different organic wastes was summarized in Table - 5 & 6 and Graph - 3. The early sexual maturity was noticed in cattle manure (Control) on 6th week with 33.33%, but, it was on 7th week in FAW, PW, CRW, and LGW with 33.33%, 53.33%, 30.00%, and 26.66% respectively. 100% sexual maturity of worms was observed early in CM (control) on 8th week, but it was on 9th week in all other organic wastes, which was maintained up to the end of experiment up to 17 weeks (Table-5 and Graph-3). No regression of clitellum was noticed in any of the worms cultured in all organic wastes throughout the experiment. There is a significant difference was noticed in sexual maturity of worms among all the organic wastes, but no significant variation was seen between any of the organic wastes (Table-6). Variations in sexual maturity of worms may be due to quality and preference of food provided to them. The time taken for sexual maturity varies in direct relationship with nutrient abundance or food quality (Dominguez *et. al.*, 2000) and their microbial composition (Suthar, 2007). The physical and biochemical composition of the feed substrate is an important factor in determining the growth of worms and the time taken to reach their sexual maturity (Edwards, 1998).

Cocoon production by the earthworm, *E. fetida* in various organic wastes was represented in Table-7 & 8 and Graph-4. The worms start producing cocoons soon after 1-2 weeks of their sexual maturity i.e. from 8th and 9th week onwards in CM and all other organic wastes respectively (Table-7 and Graph-4). The pattern of cocoon production by the worms is continuous and multimodal in nature (Graph-4). The rate of cocoon production was slowdowns towards the end of experiment i.e. from 13th week onwards up to 17 weeks in all the organic wastes. The cumulative cocoon number (CCN)/worm was 33.27, 35.95, 36.77, 21.77 and 48.65 in FAW, PW, CRW,

LGW and CM respectively for 17 weeks. The maximum cocoon production/worm/ week was noticed in control-CM with 2.86±0.37 followed by CRW (2.16±0.30), PW (2.11±0.30), FAW (1.95±0.27) and it was least in LGW with 1.28±0.18 (Table 7 & 9). There is much variation in cocoon production was observed by the earthworm, *E. fetida* cultured in all organic wastes (Table-7). Significant difference ($P \leq 0.05$) was noticed in cocoon production among and between different organic wastes (Table-7 & 8) except between PW & FAW, CRW & FAW and CRW & PW (Table-8). Loh *et.al*. (2005) have mentioned about the intrinsic nature/property of earthworms, *E. eugeniae* and *E. fetida with respect to* their cocoon production cultured in laboratory conditions. Chaudhuri and Bhattacharjee (2002) and Pulikeshi and Amoji (2003) have reported the variations in cocoon production by different earthworm species with respect to quality of food provided. The quality of feed, which provides sufficient amount of easily metabolizable organic matter and non-assimilated carbohydrates, which will favor the growth and reproduction of the earthworms (Edwards, 1998).



Graph 3. Percent sexual maturity observed by the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks.

Table 5. Percent sexual maturity observed by the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks.

Sl. No.	Weeks	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	1	——	——	——	——	——
2	2	——	——	——	——	——
3	3	——	——	——	——	——
4	4	——	——	——	——	——
5	5	——	——	——	——	——
6	6	——	——	——	——	33.33%
7	7	33.33%	53.33%	30.00%	26.66%	86.66%
8	8	73.33%	73.33%	66.66%	66.66%	100%
9	9	100%	100%	100%	100%	100%
10	10	100%	100%	100%	100%	100%
11	11	100%	100%	100%	100%	100%
12	12	100%	100%	100%	100%	100%
13	13	100%	100%	100%	100%	100%
14	14	100%	100%	100%	100%	100%
15	15	100%	100%	100%	100%	100%
16	16	100%	100%	100%	100%	100%
17	17	100%	100%	100%	100%	100%
18	F- Value	440.81	432.93	271.51	443.62	666.20
19	P- Value (P≤0.05)	0.00	0.00	0.00	0.00	0.00

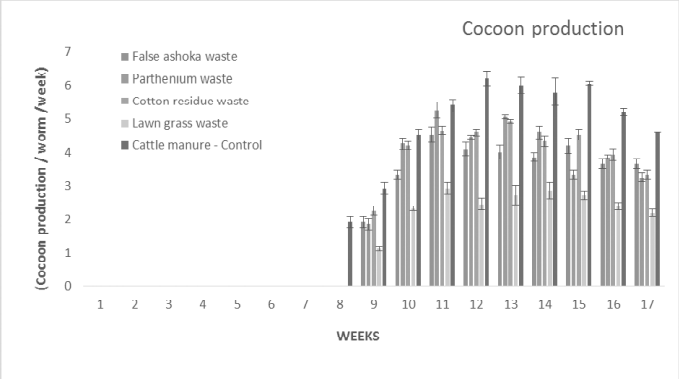
Table 6. Significant variations (P≤0.05) in per cent sexual maturity of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17weeks.

Sl. No.	Organic wastes	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	False ashoka waste	—	0.80	0.93	0.87	0.10
2	Parthenium waste	0.80	—	0.74	0.68	0.17
3	Cotton residue waste	0.93	0.74	—	0.93	0.09
4	Lawn grass waste	0.87	0.68	0.93	—	0.07
5	Cattle manure (Control)	0.10	0.17	0.09	0.07	————

In general, biomass, growth rate, sexual maturity, cocoon production and Cumulative cocoon number (CCN) of the earthworm varies with respect to different organic wastes used in this study (Table-9). It is well known fact that food resources not only influence the size of an earthworm population but it also affects worm's growth and reproduction (Dominguez, 2004). The biomass, growth rate and reproductive performance of composting earthworm species could be directly associated with the physico-chemical properties, palatability and microbial composition of their feed substrate (Suthar, 2007; Prasanthrajan and Kannan, 2011). The time taken for attainment of sexual maturity differs in direct relationship with nutrient availability or food quality (Dominguez *et. al.*, 2000) and microbial composition of food materials (Suthar, 2007). Variations in growth and reproduction of worms in different wastes even during favorable season may be due to palatability of food material, that might be because of variations in chemo-stimulants rather than the level of nutrients present in it (Chaudhuri and Bhattacharjee, 2002 ; Aira and Dominguez, 2008). Any changes in worm biomass and growth rate may alter whole life cycle of an earthworm (Lofs-Holmin, 1980). The variations in the cocoon production could be again related to the biochemical composition and quality of the feed materials, which is an important factor in determining the life cycle of earthworms (Edwards, 1988; Edwards *et.al.*, 1998).

Table 7. Rate of cocoon production/worm/week by the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks. Data are in Mean ± SE.

Sl. No.	Weeks	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	1	-	-	-	-	-
2	2	-	-	-	-	-
3	3	-	-	-	-	-
4	4	-	-	-	-	-
5	5	-	-	-	-	-
6	6	-	-	-	-	-
7	7	-	-	-	-	-
8	8	-	-	-	-	1.93±0.17
9	9	1.93±0.17	1.86±0.17	2.26±0.13	1.13±0.06	2.93±0.17
10	10	3.33±0.13	4.26±0.17	4.20±0.11	2.33±0.06	4.53±0.17
11	11	4.53±0.24	5.26±0.24	4.66±0.13	2.93±0.17	5.40±0.20
12	12	4.10±0.20	4.46±0.06	4.60±0.11	2.46±0.17	6.20±0.23
13	13	4.00±0.20	5.06±0.06	4.93±0.06	2.73±0.29	6.00±0.23
14	14	3.86±0.13	4.60±0.20	4.33±0.17	2.86±0.24	5.80±0.41
15	15	4.20±0.23	3.33±0.13	4.53±0.17	2.73±0.13	6.06±0.06
16	16	3.66±0.17	3.86±0.06	3.93±0.17	2.40±0.11	5.20±0.11
17	17	3.66±0.17	3.26±0.13	3.33±0.13	2.20±0.11	4.60±0.00
18	Mean ± SE	1.95±0.27	2.11±0.30	2.16±0.30	1.28±0.18	2.86±0.37
19	CCN/17weeks	33.27	35.95	36.77	21.77	48.65
20	F- Value	205.25	390.16	456.03	112.20	285.43
21	P- Value (P≤ 0.05)	0.00	0.00	0.00	0.00	0.00



Graph 4. Cocoon production/worm/week by the epigeic earthworm, *Eisenia fetida* in various organic wastes and cattle manure (control) for 17 weeks. Data are in Mean ± SE.

Table 8. Significant variations (P≤0.05) in cocoon production /worm/week by the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks.

Sl. No.	Organic wastes	False ashoka waste	Parthenium waste	Cotton residue waste	Lawn grass waste	Cattle manure (Control)
1	**False ashoka waste**	—	**0.21**	**0.26**	0.00	0.00
2	**Parthenium waste**	**0.21**	—	**0.89**	0.00	0.00
3	**Cotton residue waste**	**0.26**	**0.89**	—	0.00	0.00
4	**Lawn grass waste**	0.00	0.00	0.00	—	0.00
5	**Cattle manure (Control)**	0.00	0.00	0.00	0.00	—

Table 9. The overall potentiality of the epigeic earthworm, *Eisenia fetida* cultured in various organic wastes and cattle manure (control) for 17 weeks. Data are in Mean ± SE.

Sl. No.	Organic wastes	Biomass (mg / worm)	Growth rate (mg/day/gm)	100% Sexual maturity at weeks	Cocoon production/ worm/week	Cumulative cocoon no./ worm/ 17 weeks
1	**False ashoka waste**	481.47±56.13	6316.10±529.36	9th week	1.95±.27	33.27
2	**Parthenium waste**	923.54±112.59	11836.00±1086.3	9th week	2.11±.30	35.95
3	**Cotton residue waste**	710.46±85.99	9053.00±807.22	9th week	2.16±.30	36.77
4	**Lawn grass waste**	537.93±65.37	6969.00±582.42	9th week	1.28±.18	21.77
5	**Cattle manure (Control)**	858.55±112.51	10842±1011.5	8th week	2.86±.37	48.65

SUMMARY AND CONCLUSION

The data of the present study revealed that the biomass and growth rate of the epigeic earthworm, *E. fetida* varied with respect to different organic wastes including control-CM. The biomass and growth rate of worm were more in PW followed by control-CM, CRW, LGW and least in FAW (Table-9). The attainment of sexual maturity was early (on 6th week) in CM followed by all other organic wastes (on 7th week). 100% sexual maturity of worms was noticed on 8th and 9th week in CM and all other organic wastes respectively. Similarly, the cocoon production was also more in control-CM followed by CRW, PW, FAW and least in LGW. As like that of cocoon rate, the CCN/ worm for 17weeks was also more in CM followed by CRW, PW, FAW and least in LGW (Table-9).

Based on the above results, it can be concluded that the biomass, growth rate and cocoon production of the earthworm, *E. fetida* were influenced much by different organic wastes, that in turn affects on whole vermicomposting process. These results also suggests that the earthworm, *E. fetida* can be best utilized in organic waste management for the production of worm biomass as vermiprotein and vermicompost as bio-fertilizer as this earthworm is known to be voracious feeder and breeder throughout the year, this can be cultured easily in wide variety of non-toxic organic wastes and also tolerates wide fluctuation of temperature and % RH.

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