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Research Article **Zoology and Biotechnology**

GROWTH PERFORMANCE AND HATCHLING RATE OF *Eudrilus eugeniae* AND *Eisenia fetida* IN DIFFERENT CONCENTRATIONS OF TEA WASTE, COW DUNG AND KITCHEN WASTE MIXTURE

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ABSTRACT

In the present investigation an attempt was made to convert industrial tea waste into organic manures through vermitechnology by using two different earthworm species such as *Eudrilus eugenia* and *Eisenia fetida*. From this investigation, the growth and hatchling production of earthworm *Eudrilus eugeniae* and *Eisenia fetida* cultured in different concentration of tea waste + cowdung + kitchen waste (T1 – T4) for a period of 90days. The different concentrations of TW + CD + KW feed mixtures differentially influenced the growth of *E.eugeniae* and *E. fetida*. The observation of present study the body weight of *E. eugeniae* increased continuously upto 90days, in all the four treatments. The total number of hatchling production after 90days in different treatment has been presented. In all four treatments the *E. eugeniae* produced more numbers of hatchlings than *E.fetida* during experimentation.

Keywords: *Eudrilus eugenia*, *Eisenia fetida*, Tea waste, Cow dung, Kitchen waste

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INTRODUCTION

Earthworms have increasingly been used for organic wastes such as animal waste, plant waste, industrial waste, municipal garbage and industrial sludge's management and production of nutrient rich organic manure-vermicompost. Recently, Bhattacharjee (2002) have been reported that India produces about 3000 million tons of organic waste annually which could be utilized for recovering important resources like fertilizer, fuel, food and fodder. The Proper utilization of organic wastes can improve the physical condition of soil and environmental quality as well as provide nutrients for plants (Bhardwaj, 1995). The employment of earthworms for waste management as an efficient alternative method is suggested by many researchers (Kale, 1994; Ramalingam, 1997; Parthasarathi and Ranganathan, 1999; Atiyeh *et al* ., 2000; Arancon *et al* ., 2003; Manivannan *et al* ., 2004; Suthar 2006).*negundo* L.

The feasibility of using earthworm for waste management is dependent on a fundamental knowledge about the basic parameters like the survival, growth and reproduction of earthworm species. Environmental conditions and population density are known to affect growth and reproduction of earthworms. The potential of earthworms as the waste processor has been well established (Kale, 1994; Neuhauser *et al* ., 1979; Elvira, *et al* ., 1998; Parthasarathi *et al* ., 1999; Karmegam and Daniel, 2000c; Ramalingam, 2004; Norman *et al* ., 2007; Herlihy, 2007). Earthworms' growth, maturation, cocoon production and reproduction potential are not only influenced by the environmental conditions alone but also strongly affected by the quality and availability of food (Reinecke and Viljoen, 1990; Garg *et al* ., 2005). A survey of literature showed reports on growth and cocoon production (Reinecke and Hallatt, 1989); growth and reproduction (Ismail, 1997; Loehr *et al* ., 1985; Reinecke *et al* ., 1992).

Elvira *et al* . (1998) studied growth and reproduction of *Eisenia andrei* using sludges from paper and textile mill. The growth and reproduction of *Eudrilus eugeniae* studied by Thilagar (1999) using sugarcane trash; Gajalakshmi *et al* . (2000) using cowdung spikled paper waste; Chaudhuri, *et al* . (2002) using kitchen wastes; Priyashankar (2005) using rubber leaf; Christy (2005) using sago industrial waste - pressmud mixture, Suthar (2008) using agriculture wastes. Many authors have studied the life cycle of the composting earthworm species *E.fetida* (Garg and Kaushik,2005; Tripathi and Bhardwarj,2004; Suthar,2009). Hence, the aim of the present investigation is to document the stepwise chemical changes during the composting of kitchen waste by an indigenous species of earthworm. Such study is necessary to determine the time of vermistabilization for harvesting of quality compost from a particular type of waste.

MATERIALS AND METHODS

Procurement and rearing of earthworms:

Eudrilus eugeniae and Eisenia fetida was obtained from the breeding stock maintained in the Department of Tea research foundation (UPASI) of coonoor, Nilgiris, India. The earthworms were stocked in cement tanks containing urine free, sun dried and powdered cowdung. The cement tanks (with *Eudrilus eugeniae and Eisenia fetida* stock) were covered by wooden framed iron mesh and maintained at room temperature (27 ± 2°C) with 60-70% moisture. Once in 15 days the surface layer of used up cowdung was removed and replaced with fresh cowdung.

Selection and collection of industrial tea wastes, cowdung and kitchen waste.

Tea Waste (TW)

Accumulation of Tea Waste near the industrial premises in landfill sites or incineration of derived Tea Waste leads to environmental pollution, loss of nutrients and has environmental and economical disadvantages. Therefore, the biological treatment methods have received much attention and are considered as low cost efficient treatments. Hence, the Tea wastes collected from the tea industry for vermiculture and utilized production of organic manure – vermicompost in an eco-friendly way. The tea waste with moisture was collected from waste pond of The Indico Tea Factory at Ooty, TamilNadu, and brought to the laboratory. In the laboratory tea waste was exposed to the sunlight for two days to kill undesirable organisms and to reduce the foul smell. After two days the tea waste was used for the present study.

Cowdung (CD)

Cowdung is deemed as highly suitable natural feed for earthworms (Graff, 1981; Hatanaka *et al* ., 1983; Lee, 1985). Hence, cow dung is selected for the present study to provide nitrogen and stimulate biodegradation of tea Waste by the action of *Eudrilus eugeniae* and *Eisenia fetida* and straw free cow dung was collected from dairy yard at the Agricultural Farm, Ooty. It was sundried powdered and stored in jute bags and it was used.

Kitchen Waste

Household kitchen waste is one of the major sources of municipal solid waste. In India, domestic waste is mostly of organic nature and contributes 70% to 80% of urban solid wastes (Kale 1993). Each household of four family members generates 0.5-0.75 kg kitchen wastes per day.Under the present condition of environmental degradation vermicomposting technology is a process of production of vermicompost through stabilization of organic waste by earthworm activity. The kitchen wastes were collected from the vegetable market at Ooty and stored in jute bags. It is used for the present study.

Growth and reproduction of *Eudrilus eugeniae* and *Eisenia fetida* in organic wastes.

Preparation of experimental media

In the present study, four preparation of industrial Tea waste, Cow dung and Kitchen waste mixture were prepared in following manner.

T1 - 100% soil
T2 - 400(g) TW + 200(g) CD + 400(g) KW

T3 - 500(g) TW + 100(g) CD + 400(g) KW

T4 - 600(g) TW + 100(g) CD + 300(g) KW

The vermicomposting experiments were performed for 90 days. Tea Waste (TW), kitchen waste (KW) and Cow dung (CD) were weighed (dry weight) in specific concentration and mixed using well water, so as to have 60-70% moisture. The feed mixtures were transferred to separate plastic troughs (35 diameter x 12 cm depths). Since initial decomposition was found to improve food acceptability by worms (Edwards and Bohlen, 1996), the feed substrates in the troughs were allowed 15 days for initial decomposition.

Inoculation of Earthworms

After 15 days of initial decomposition, 10 newly emerged hatchlings of *Eudrilus eugeniae* (Kinberg) and *Eisenia fetida* (Savingny) were collected from the stock culture and introduced after recording their initial weight into each plastic trough T1-T4 each containing one kg of feed substrate. The plastic troughs were covered by nylon net to avoid water loss, to prevent predators and also to allow free aeration. The troughs (T1-T4) were kept under laboratory conditions of 28 ± 2°C in the vermiculture lab and maintained with 60-70% moisture. For each treatment three replicates were maintained.

Growth and reproduction of compost worms

Earthworm growth is usually measured in terms of weight (biomass) gain. Once in 15 days up to 90 days weights of earthworms were recorded. Every time hatchlings and adults were collected and weighed separately and the adults were reintroduced into the respective plastic troughs, but the hatchlings were discarded. Hand gloves were used to avoid physical damage to earthworms by nails. Handling of worms every 15 days did not cause any damage to worm. Once in a month the newly prepared, the feed mixtures were added and surface layer of vermicast was removed from the experimental troughs and discarded after checking cocoons and hatchlings.

The growth rate of worms (for specific periods) was calculated using the following formula specified by Mazantseva (1982).

Worms growth rate (mg/ worm / day) = $\frac{W_2 - W_1}{T_2 - T_1}$

W_1 and W_2 = Body weight of the earthworm at the beginning

(w1) and at the end (W_2)

T_1 and T_2 = Age of worms at the beginning (T_1) and at the end

(T_2) of specific periods.

Statistical analysis

Earthworm mean biomass, standard error (SE), biomass increase or decrease percentage over control values were calculated. Further, significance of the data was also tested applying on one way analyses of variance (ANOVA) and Duncan's multiple-ranged test was used as a posthoc analysis to compare themeans.

RESULTS

The growth and reproduction (hatchling production) of compost earthworm *Eudrilus eugeniae* and *Eisenia fetida* cultured in different concentration of tea waste + cowdung + kitchen waste (T1 – T4) for a period of 90days.

The different concentrations of TW + CD + KW feed mixtures differentially influenced the growth of *E.eugeniae* and *E.fetida*. Generally the body weight of *E.eugeniae* increased continuously upto 90days, in all the four treatments. *E.eugeniae* registered 1.293 ± 0.027g; 1.483 ± 0.017g; 1.542 ± 0.023g and 1.575 ± 0.01g in T1, T2, T3 and T4 treatment respectively. Whereas, on the same day *E.fetida* recorded 1.117 ± 0.011g; 1.261 ± 0.011g; 1.321 ± 0.018g and 1.425 ± 0.010g in T1, T2, T3, T4 treatments respectively (Table –1 and 2). The efficiency of four treatments to support the growth of *E.eugeniae* and *E.fetida* could be ranked in following order: T4 – (TW 60% + CD 10% + KW 30%) > T3-(TW 50% + CD 10% + KW 40%) > T2-(TW 40% + CD 20% + KW 40%) > T1- control soil.

Among the four treatments the net individual weight gains by *E.eugeniae* were in the following order: TW+CD+KW 6:1:3 ratio (T4) > TW+CD+KW 5:1:4 ratio(T3) > TW+CD+KW 4:2:4 ratio (T2) > control soil (T1), and for *E.fetida* the net individual weight gain ranked in following order: TW+CD+KW 6:1:3 ratio (T4) > TW+CD+KW 5:1:4

ratio (T3) > TW+CD+KW 4:2:4 ratio (T2) > control soil (T1).

The calculated mean growth rate of *E.eugeniae* and *E.fetida* cultured in different concentration of TW+CD+KW feed mixture indicate the following points. Both species of worm showed maximum growth rate in T4 followed by T3, T2, T1 treatment (Table 1 &2).

Hatchling rate of *E.eugeniae* and *E.fetida*

The total number of hatchling production after 90days in different treatment has been presented in table 1 and 2. In T4 treatment maximum number of hatchlings 656 nombers in *E.eugeniae* and 605 nombers in *E.fetida* and minimum number of hatchlings at T1 treatment 575 nombers in *E.eugeniae* and 388 nombers in *E.fetida* were observed.

In all the treatment *E.eugeniae* produced more numbers of hatchlings than *E.fetida* during experimentation. The maximum number of hatchling production by *E.eugeniae* was recorded in T4 (656 nos) followed by, T3 (638 nos), T2 (526 nos) and T1 (402 nos) treatment and *E.fetida* in T4 (605 nos) followed by T3 (543 nos), T2 (480 nos) and T1 (308 nos) treatment.The average vermicompost recovery was higher in all the treatment than compost recovery of natural compost. Among the different treatment T3 and T4 recovered higher rate of vermicompost recovery than the treatment T1 (100% soil) and T2 (40% TW + 20% CD + KW 40%) (Table 1,2).

DISCUSSION

The growth rate of biomass and reproduction of earthworm in *Eudrilus eugeniae* and *Eisenia fetida* were maximum in T4 and T3. The growth rate of *Eudrilus eugeniae* cultured in different organic wastes ware reported by many investigators. *Eudrilus eugeniae* cultured on cowdung (for a period of one year) increased at the rate of 3.5 mg/worm/day (Reinecke *et al* ., 1992); *Eisenia fetida* (for total period of 90 days) cultured on sludges from paper and pulp industries increased 8.4 mg/ worm/ day (Elvira *et al* ., 1998) and *Eudrilus eugeniae* (for a total period of 105 days) cultured on kitchen wastes increased 2.5 mg/worm/days (Chaudhuri *et al* ., 2002).

Murchie (1960) proved experimentally the existence of a significant relationship between weight increase and substrate type, which may reasonably be attributed to nutritional quality of the substrate. The present investigation have been correlated in previous work, such correlation between increased growth, Cocoon production, reproduction rates etc. and quality of various organic wastes used as feed was reported in a variety of earthworms: *E. eugeniae, E. fetida*, and *P. excavatus* on cattle dung (Kale *et al* ., 1982; Reinecke *et al* ., 1992); *L. mauritii* on cattle dung (Kale *et al* ., 1992); *E. eugeniae* on sugar factory refuse (Kale *et al* ., 1994); *E. andrei* on sludge from paper and pulp industries (Elvira *et al* ., 1998); *E. eugeniae, L. mauritii* on sugar mill waste pressmud (Ramalingam, 1997, 2001); *E. eugeniae* and *E.fetida* on sugar factory refuse (Ramamoorthy, 2004); *Perionyx excavatus* on various waste such as sheep dung, biogas sludge, poultry manure (Kale *et al* ., 1982), pig solid waste, turkey wastes and horse solid waste (Edwards *et al* ., 1988), vegetable waste (Atiyeh *et al* ., 2002) gurghum industry waste (Suthar, 2006) were reported.

Different types of organic wastes originated from different sources have been used for vermiculture and vermicomposting (Edwards *et al* ., 1985; Haimi and Huhta, 1986; Kale, 1994; Ramalingam, 1997, 2001; Bhattacharjee, 2002; Loh *et al* ., 2005; Christy and Ramalingam, 2005; Suthar, 2006). But all the wastes are neither readily acceptable to worms nor equally support worms growth and reproduction. The quality and quantity of feed, various physico- chemical parameters influenced earthworm's growth and fecundity (Reinecke and Hallatt, 1989; Reinecke and Viljoen, 1990; Kale *et al* ., 1991; Kale *et al* ., 1992; Aira *et al* ., 2006; Suthar, 2006). Falling in line with these observations, in the present study (restricted to 90 days) among the different proportions of TW + CD+KW tested, in (T1-T4) *Eudrilus eugeniae* recorded maximum growth rate of 6.4 g /worm / day in T4 (TW60% +CD10%+KW30%) and 5.9 g/w/day inT3 (TW50% + CD10%+KW40%). At the same time *Eseniae fetida* recorded maximum growth rate of 6.4 g /worm / day in T4 (TW60% +CD10%+KW30%) and 5.9 g/w/day inT3 (TW50% + CD10%+KW40%).

The perusal of literature indicated higher growth rate of *Eudrilus eugeniae* during pre-reproductive period (up to 45 days) and a decline in growth rate (even though biomass continued to increase) during reproductive period (45 to 90 days). The present findings of accelerated growth rate during the pre-reproductive phase of *Eisenia fetida* is in accordance with the findings of Ramalingam (1997). The decline in worm growth rate during the reproductive phase is due to the onset of cocoon production since copulation and cocoon production need large amount of energy (Graff, 1981; Viljoen and Reinecke, 1994). Hence, the observed higher growth rate during pre-reproductive period reflects the active growth of the worms, due to availability of

more energy. On the contrary, the decline in growth rate recorded during reproductive period is an indication of onset of reproduction and utilization of energy for cocoon production besides growth. A close observation of the results revealed that among different proportions of TW + CD + KW mixture (T1-T4) treatment *Eudrilus eugeniae* gained maximum hatchling production of 604 in T4 followed by T3,T2 and T1.At the same time *Eisenia fetida* gained maximum hatchling production of 504 in T4 and minimum in T1 treatment.

The maximum weight gain by earthworm was reported by Gangadar *et al* . (1995) in 25% sulphur waste residues and cowdung mixture and Kavian *et al* . (1997) in 25% soyabean oil sludge-cowdung substrate. Tiwari (1993) reported that addition of organic matter had resulted in an increased population density and biomass of worm which coincides with the present study. Kavian *et al* . (1996) vermicomposted paper mill sludge in combination with cowdung using the earthworms *Lumbricus rubellus* and reported that 25% concentration of sludge enriched with required nutrients was an ideal substrate for the growth and reproduction of the earthworm.

In nutshell, presently under-utilized organic matter rich tea waste in balanced combination with cowdung and kitchen waste (TW+CD+KW) could be used as a culture medium to raise *Eudrilus eugeniae* and other species of earthworms and production of organic manure 'vermicompost' besides abating environment pollution. Further, the present investigation proved that tea waste and cowdung is equivalent to kitchen waste in supporting growth and reproduction of *Eudrilus eugeniae* and E *fetida*, hence cowdung and kitchen waste can also be utilized in combination with tae waste and converted into nutrient rich vermicompost.

Among the two species, *E.eugeniae* exhibits better growth and reproduction than *E.fetida* in different treatment (T1-T4). *E Eugeniae* grew significantly ($p<0.05$) and produce more hatchling in all the treatment. From the observation it is recommended that the Industrial tea waste could be better vermicomposted by *E.eugenia* and could be used for vermiculture practices.

CONCLUSSION

In the present investigation an attempt was made to convert industrial tea waste into organic manures through vermitechnology using two different species of earthworm *E. eugeniae and E. fedita.* The tea waste,cowdung and kitechen wastes mixture is easily degraded into vermicompost by the *E. eugeniae and E. fedita.* Among the two species *E. eugeniae* showed better results.

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