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Culture of Epigeic Earthworm, *Eudrilus eugeniae* Using Green Gram Waste

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Abstract

The rate of cocoon production and weight gain/loss of the epigeic earthworm, *Eudrilus eugeniae* kept in 0, 10, 25, 50, 75 and 100% substrate ratios (PSR) prepared from partly decomposed green gram waste (DGW) with soil for 35 days were determined. The worms kept in 10, 25, 50, 75 and 100 PSR showed a gradual increase in their body weight and their respective per cent body gain values observed were 13, 95, 101, 115 and 114. Though the worms kept in soil alone showed 100% survival value with 35% weight loss after 35 days, only 24 cocoons were laid during the course of study due to less organic matter present in the soil. The worms kept in all DGW media produced relatively more cocoons than the control, but the rate of cocoon production and hatchlings production, and hatching success observed in 100 PSR was relatively more when compared to other PSR studied. The hatchlings obtained and grown in different DGW media showed a gradual increase in their total length and weight throughout the study period. The hatchlings kept in 100, 75 and 50 PSR attained sexual maturity at the end of 50 days of exposure respectively with an average total length of 14.5, 15.1 and 15.2 cm and an average total weight of 1.53, 2.30 and 1.95 g. But the hatchlings kept in 25 and 10 PSR attained sexual maturity only after 60 days of exposure after reaching the length of > 14 cm. The hatchlings obtained and kept in control medium were in the state of no movement from 40 days onwards but get itself coiled all the times though showed a slight improvement in their length and weight up to 40 days. The results proved that the culture medium containing DGW was the best one as far as cocoon production and growth of earthworm are concerned.

Key words : Green gram waste, Cocoon production, Hatching success, *Eudrilus eugeniae.*

A bulk amount of green gram waste was dumped along the road sides of cauvery delta region during summer season after paddy cultivation. Without knowing the utility value of the above waste, farmers burnt the entire lot as a whole or it may be used as fuel material for their daily use. Due to its bulk production and its utility value in mind, the current study was undertaken to utilize the same for the vermiculture and vermicomposting practices to achieve the goal of replacing chemical fertilizers used in agriculture to ensure pollution free crop production and sustainable development. The most effective use of earthworms in organic waste management requires a detailed understanding about the biology of all potentially useful species (Edwards and Burrows 1988). The studies on the life cycle and reproductive strategies of earthworms inhabiting in temperate (Lavelle 1979, Jimenez et al. 1999) and tropical (Dash and Senapati 1980, Chaudhuri and Bhattacharjee 2002) regions provide the required information for effective vermiculture and vermicomposting practices. Making use of fast growing, effective decomposing and widely used epigeic earthworm, *Eudrilus eugeniae,* the current study was made to assess the reproductive potential and biomass production of the same cultured in the medium containing green gram waste under laboratory condition.

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Methods

Procurement and Maintenance of Eudrilus eugeniae

Specimens of adult *Eudrilus eugeniae* were purchased from a vermiculture farmer at Chidambaram. The worms were kept in large trays with substrate medium, containing 50% partly decomposed cowdung and 50% soil and maintained under the laboratory condition (temperature range, 31—36 C) for 30 days. The worms with the size 16.5—22.3 cm in length and 1.500–2.300 g in weight were used.

Table 1. Values showing the body weight (g) and cocoon production by the earthworm, *Eudrilus eugeniae* fed with different PSR of partly decomposed green gram waste (DGW) for 5 weeks. Upper row values indicate the total number of cocoons produced by 60 earthworms. Lower row values indicate the total weight of 60 earthworms. Values in parentheses indicate the production of cocoon/worm per day.

Period	PSR 0	10	25	50	75	100
Initial	0	0	0	0	0	0
	85.9	85.5	86	85.9	85.6	85.3
I Week	0	0	5	8	9	13
	86.5	92.0	97.7	100.4	116.6	110.7
II Week	4	15	18	26	29	41
	82.5	99.8	105.4	112.4	148.1	136.5
III Week	6	49	92	109	111	127
	69.8	106.4	119.2	137.7	171.6	168.7
IV Week	10	57	104	135	175	219
	62.0	100.3	134.3	155.7	178.2	173.8
V Week	4	52	80	142	202	262
	55.5	96.4	167.3	172.8	183.9	182.6
Total cocoons produced	24 (0.011)	173 (0.082)	299 (0.142)	420 (0.20)	526 (0.25)	662 (0.315)
Per cent weight change over initial	-35	+ 13	+ 95	+ 101	+ 115	+ 114

Collection of Soil and Green Gram Waste

Dry soil taken from the Cauvery riverbank at Government Arts College (Autonomous), Kumbakonam was manually powdered using stone mortar.

The waste materials of green gram *(Vigna radiata)* were collected from the road sides of Ayyavadi village, Kumbakonam Taluk, Thanjavur district.

Partial Decomposition of Green Gram Waste

A rectangular brick work cement tank with size, 180 × 75 × 90 cm free from earthworm invasion was constructed and used for the decomposition of green gram waste. The tank was filled with dry green gram waste and poured with sufficient water. The tank was closed with polythene sheets to avoid water evaporation and a possible release of foul smell during decomposition. Water was poured regularly in the tank after removing the polythene sheets and the tank was closed again with the same polythene sheets for proper decomposition. Once in three days, the decomposing materials were thoroughly mixed by using a wooden rod to ensure uniform decomposition. Ideal semi-decomposed green gram waste (DGW) in the form of loose cake can be obtained only after 50 days of decomposition. This wet semi-decomposed matter was sun dried, powdered and sieved with a sieve having a hole of 1 mm^2 to obtain a medium with a particle size less than 1 mm as suggested by Reinecke and Venter (1985). Reduced particle size of the culture medium was found to be favorable for raising growing worms and also provides more surface area per volume of culture medium which facilitates microbial activities and moisture availability (Reinecke and Venter 1985). About 50 kg of dry DGW powder can be obtained at the end of each process.

Preparation of Substrates for Cocoon Production

Six sets of five media with per cent substrate ratios (PSR) of 100, 75, 50, 25, and 10 were prepared using powdered DGW and dry soil with volume by volume basis and mixed well. Four liters of each PSR was taken in an earthen pot and sufficient volume of water was added into it to ensure optimum moisture condition as suggested by Martin (1982). To assess the rate of cocoon production in the above media, 10 adult earthworms were introduced into each pot. Six sets of control (soil alone as substrate) experiment

Table 2. Values showing the incubation time and hatching success of cocoons collected from the earthworm, *Eudrilus eugeniae* fed with different PSR of DGW under laboratory condition.

PSR	Total cocoons produced by 60 earthworms	Incubation time (days)	Total hatchlings obtained	Hatchling/ cocoon	Hatching success (%)
0	24	10—13	17	0.7	70.8
10	173	13—16	138	0.8	79.7
25	299	13—16	246	0.8	82.2
50	420	14—17	353	0.8	84.0
75	526	14—17	450	0.9	85.5
100	662	14—17	597	0.9	90.2

with 10 adult earthworms in each were also maintained simultaneously along with these media. Regular watering is a must for this culture study to provide optimum moisture condition to the earthworms. Cocoons produced by earthworms were collected and recorded once in seven days for a period of 35 days. Survival of earthworms was also observed in the above media during the course of study. Rate of cocoon production was calculated at daily basis.

Hatchlings Growth

All the media used in the cocoon production study after 35 days were renewed with fresh partly DGW for the study to assess the incubation time, hatching success and hatchlings growth rate. Cocoons collected from the study during the course of 35 days at 7-day intervals were placed separately in plastic cups containing the same PSR medium and observed their incubation time and hatching ability daily until all the cocoons were hatched out into hatchlings. The hatchlings collected from the cups were placed in the earthen pots containing the respective medium and measured their length and weight at 10 days interval until all the worms get developed into clitellum. Incubation time and hatching ability of all cocoons were also assessed.

Results and Discussion

Cocoon Production

The rate of cocoon production and weight gain/ loss of the epigeic earthworm, *Eudrilus eugeniae* kept in 10, 25, 50, 75 and 100 PSR media prepared from partly DGW with soil for 5 weeks are given in Table 1. The worms kept in these DGW media showed a gradual increase in their body weight until the termination of the study except 10 PSR, where a gradual decline was noticed after third week. However, the worms kept in the same DGW media (10, 25, 50, 75 and 100 PSR) showed an increased value in their body weight over their respective initial weight and the respective body gain values were 13, 95, 101, 115 and 114%. On the contrary, all the worms kept in control medium (soil alone) showed a gradual decline in their body weight from second week onwards and the per cent weight loss value after fifth week was 35 (Table 1).

The worms kept in soil alone for 35 days though showed 100% survival value, only 24 cocoons were laid during the course of study due to less organic matters present in the medium. Though the worms kept in other PSR media for 35 days produced relatively more cocoons than the control, but the worms in 100 PSR produced relatively more cocoons (0.315 cocoon/day per worm) than the worms kept in10, 25, 50 and 75 PSR media (0.082 to 0.25 cocoon/day per worm) (Table 1).

The values of incubation time and hatching success of cocoons collected from the earthworm, *Eudrilus eugeniae* exposed to five PSR media of partly DGW are given in Table 2. Among the five PSR media studied, the worms kept in 100 PSR produced a maximum of 662 cocoons and were hatched out into a maximum of 597 youngones with the hatching rate of 0.9 hatchling/cocoon and hatching success of 90.2% after a period of 14 to 17 days of incubation time.

The production of hatchlings (0.7 to 0.9 hatchling/cocoon) observed (all PSR media) did not

Table 3. Values showing the body length (cm) and weight (g) of hatchlings obtained from cocoons of *Eudrilus eugeniae* cultured under different PSR media of DGW. Upper row values indicate mean ± SD of body length of 12 worms. Lower row values indicate the average body weight of 12 worms. *Indicates the termination of growth study after the formation of clitellum.

Period	PSR 0	10	25	50	75	100
0 day	1.10 ± 0.17 0.0005	1.20 ± 0.25 0.0004	1.20 ± 0.75 0.0005	1.20 ± 0.67 0.0006	1.20 ± 0.69 0.0006	1.40 ± 0.67 0.0005
10 days	2.90 ± 0.30 0.0064	2.70 ± 0.42 0.0086	3.00 ± 0.44 0.016	2.05 ± 0.81 0.0175	2.90 ± 0.36 0.018	2.60 ± 0.55 0.021
20 days	4.20 ± 0.55 0.045	5.10 ± 0.71 0.029	4.70 ± 0.66 0.03	5.30 ± 0.40 0.12	4.60 ± 0.98 0.133	5.00 ± 0.69 0.145
30 days	4.90 ± 0.33 0.075	6.30 ± 0.42 0.591	6.80 ± 0.69 0.983	7.00 ± 0.68 1.166	7.00 ± 0.9 1.29	7.80 ± 0.72 0.7
40 days	5.00 ± 0.70 0.275	7.20 ± 0.44 0.791	12.30 ± 1.16 1.23	12.70 ± 1.10 1.4	12.40 ± 0.83 1.54	12.80 ± 0.79 1.05
50 days	4.70 ± 0.44 0.3	13.40 ± 2.37 1.04	14.00 ± 0.96 1.8	15.20 ± 1.90 1.95*	15.10 ± 1.69 2.3*	14.50 ± 1.28 1.53*
60 days	4.70 ± 0.48 0.3	14.60 ± 2.13 1.33*	14.70 ± 1.65 2.06*			
70 days	4.70 ± 0.48 0.3					

follow the findings of Dash and Senapati (1980) and Bakthavathsalam and Ramakrishnan (2004), where they observed usually one or very rarely two juveniles from each cocoon on hatching. The number of hatchlings obtained in the current study was found to be less when compared to studies made in *Perionyx excavatus* and *Pheritima hawayana* respectively with 1.1 and 1.2 (Loehr et al. 1985), *Eisenia fetida* with 2.7 (Venter and Reinecke 1988) and *Eudrilus eugeniae* with 2.63 hatchlings/cocoon (Ramalingam 1997). However, the present study follows the findings of Bakthavathsalam and Geetha (2004), where they found 0.9—1.0 and 0.7—1.0 hatchling/cocoon on hatching using the earthworm, *Lampito mauritii* exposed to decomposed paddy chaff and weed plants material respectively. But a contradictory observation was recorded in the incubation period of cocoon collected from the earthworm cultured in different green gram waste media as observed by Reinecke et al. (1992) and Bakthavathsalam and Geetha (2004), where they found ± 23 and 26—54 days respectively for the *Eisenia fetida* and *Lampito mauritii*. In spite of good health condition and 100% survival value observed in the adult earthworms kept under different media, the rate of cocoon production from lower PSR to higher PSR showed an increasing trend, but it was relatively less when compared to the studies made by Ramalingam (1997) in the earthworm, *Lampito mauritii* cultured under press mud medium where he found ± 0.4 cocoon/worm per day.The earthworm culture made by Subramaniyan (2008) using paddy straw waste showed relatively very low cocoon production value (0.126 cocoon/worm per day) over the current value observed in DGW. The reduction observed in the body weight of earthworm kept in soil may be due to low level of nitrogen and carbon (presence of poor organic content) as reported by Jana et al. (2002) since the earthworms need nitrogen for the synthesis of cellular protein and production of cocoon. The observed results (Tables 1 and 2) proved beyond that the culture medium containing DGW was the best for cocoon production and growth of earthworm.

Hatchlings Growth

Measurements of length and weight of *Eudrilus eugeniae* hatchlings obtained from 100, 75, 50, 25, 10 and 0 PSR media of green gram waste and cultured in the respective media at laboratory condition for 70 days are given in Table 3. The hatchlings grown in different DGW media showed a gradual increase in their total length and weight throughout the study period. All the hatchlings kept in 100, 75 and 50 PSR media for 50 days attained sexual maturity once they reach a mean total length of 14.5, 15.1 and 15.2 cm and

a mean total weight of 1.53, 2.30 and 1.95 g respectively. On the contrary, the hatchlings kept under 25 and 10 PSR media attained sexual maturity only after 60 days of exposure having a mean total length of 14.7 and 14.6 cm and a mean total weight of 2.06 and 1.33 g respectively. The hatchings kept in the control medium (soil alone) showed no sign of any movements from 40 days onwards but get itself coiled all the times though the worms showed slight improvement in their length and weight upto 40 days. Over all the time of sexual maturity (as shown by thick clitellum) and the total length values in the hatchlings growth study were followed strictly in accordance with the PSR values, where there is a high PSR value the length value is also high and vice versa. An important observation noted here was that irrespective of total weight or the age of worms they may have, the worm after attaining a length of > 14 cm showed a positive sign of developing a thick clitellum at its anterior region. Similar observation of attainment of sexual maturity at different periods was also noticed by Subramaniyan (2008) using the same earthworm cultured in paddy straw wastes under laboratory condition. The observed results though showed relatively higher rate of cocoon production and hatching success over the same species cultured under 100% paddy straw waste (Jena et al. 2002) and different species, namely *Lampito mauritii* cultured under different PSR of vegetable market waste Bakthavathsalam and Uthayakumar 2007), the gain in length and weight values observed (Table 3) were also relatively high when compared to the results reported by Bakthavathsalam and Ramakrishnan (2004) and Bakthavathsalam and Geetha (2004) in *Lampito mauritii* with different ratios of cow dung, decomposed paddy chaff and weed plants materials as substrates. We can conclude that the green gram waste is a good substrate media for the culture of *Eudrilus eugeniae* at least for the production of biomass to meet the protein requirements of food industry pertaining to fish, poultry and pigs.

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