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Production of Vermicompost from Temple Waste (Nirmalya): A Case Study

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Abstract

Vermicomposting is the phenomenon of compost formation by earthworms. Earthworms play an important role in the cycling of plant nutrients, turnover the organic matter and maintain the soil structure. The temple wastes consist of vegetable material (mainly flowers, leaves, fruits, sugar, jaggery etc.), milk and milk products, grains and water most of which are biodegradable and contain elements required for growth of microorganisms and the temple wastes are released in the water bodies or dumped at the available places of land which creates severe environmental pollution and health hazards ,hence it was thought to attempt use temple waste for ecofriendly treatment methods like Biomethanation and vermicomposting. The effluent of biomethanation upon mixing with biodegradable organic solids serves as good raw material for vermicomposting. In the present studies vermicomposting, the effluent from biogas digester (biomethanation) run on Ganesh temple waste (Sangli, Maharashtra) was admixed with temple waste solids and cattle dung and after partial the decomposition for 30 days at 30^{O}c, it was used to fill up 2 kg capacity plastic tubs and subjected for optimization of parameters like moisture content, particle size, p^{H} of material and temperature of vermicomposting using *Eudrilus eugeniae* earth worm species. It was found that 25^{o}C temperature, pH 8.0, 1-2mm particle size and 80% moisture content were optimum parameters of vermicomposting. It was further found that vermicompost obtained by above method was rich in percent carbon, Nitrogen, Phosphorus and Potassium content i.e. 28, 1.58, 0.33 and 0.28, respectively. The pot culture studies using five flowering plants (Gulab, Jaswand and Mogra varieties) of the test set (using prepared vermicompost as fertilizer) used in the studies showed good enhancement of growth in terms of height, flowering time as well as number of flowers produced as compared to control sets(without use of vermicompost as fertilizer). Thus, vermicomposting of temple waste is an excellent and ecofriendly method of temple waste management.

Keywords: Nirmalya, Pot culture, Temple waste, Vermicompost

1.0 Introduction:

Vermicomposting is the method which, recycles the crop residues and significantly increases the amount of N, P and K concentration in compost (Jambhekar, 1992). The important role of earthworms in ecosystem is in nutrient recycling, particularly nitrogen. Thus, they affect the physico-chemical properties of soil. By using variety of earthworms number of wastes can be converted into compost like, vegetable waste, domestic waste, paper, food refuses, agro - industrial waste, biogas digester effluent, sewage sludge and other industrial waste. Also vermicomposting can be also employed for plant based residues those containing high quantity of cellulose, hemi cellulose, lignin, starch etc. (Table-1).

In the vermicomposting the soil microflora are also playing very important role directly or indirectly like bacteria, yeasts, molds and actinomycetes. The earthworms feed on plant refuses or any organic matter and digest in their gut with the help of their own enzymes and enzymes secreted by gut micro flora which are having mutualistic relation with earthworms. One Kg earthworm can consume one Kg organic materials in a day. They secrete castings (vermicompost) which are rich in Ca, Mg, K, N, useful microorganisms, (bacteria, fungi, actinomycetes and protozoa) hormones, enzymes and vitamins and certain micronutrients needed for plant growth. (Lee, 1985; Bansal and Kapoor, 2000). The casts of earthworms promote growth of many important microorganisms like nitrogen fixers and phosphate solublisers. In general in the presence of casts and earthworms these microorganisms multiply faster (Parle, 1963; and Satchell, 1967). Earthworms secrete mucus and some fluids and in this way maintain pH of surrounding between 6.5 to 7.5 which is favorable for soil microflora. Vermicompost has sweet and earthy pleasant smell like the smell of first rain (Kadam, 2004).

Table 1: Kinds of Raw Materials and Earthworm Species Used in Vermicomposting

Sr. No.	Raw Material	Earthworm sp. Used	Reference
1.	Vegetable waste	*Eudrilus eugeniae*	Narayana (2001)
2.	Agriculture waste and sugarcane thrash	*Eudrilus eugeniae* *Perionyx excavatus*	Kale et al, (1982)
3.	Paper mill sludge	*Lumbricus rubellus*	Kavian et al, (1996)
4.	Cattle dung + biogas plant effluent + water hyacinth	*Megascolex sp.*	Balasubramanian et al, (1995)
5.	Sewage sludge + (paper, cardboard + grass clippings + pine needles + saw dust + food wastes)	*Eisenia andrei*	Doninguez et al, (2000)
6.	Sheep manure + cotton industrial waste	*Eisenia foetida*	Albanell et al, (1998)
7.	Green waste	*Eisenia andrei*	Frederickson, (1997)

(Source: Kadam, 2001)

Lignin degradation takes more time because of its structural complexity (Buswell, 1995). Lignin is a natural polymer having complex three dimensional structure, the phenolic compounds. While cellulose and starch contain glucose units. Pectins contain galacturonic acid monomers. Hemicelluloses contain mannans, xylans and galactans. Out of soil microflora many micro organisms can degrade above different plant components and can work with earth worms. The temperature, pH, organic matter, moisture available in organic matter and particle size and C : N ratio are the major environmental factors which directly affect the growth and activities of earthworm. According to season, fluctuation is seen in the number of factors like moisture content, temperature etc. In this condition in earthworm's growth, reproduction, respiration shows variation. In unfavorable condition they remain calm and show very negligible activity. Vermicomposting not only provides nutritional elements but shows ability to control certain diseases in plants. It contains plant growth stimulating hormones (Tomati et al, 1985). The temple waste based biogas digester slurry admixed with cattle dung and temple waste solids, after partial decomposition can be an excellent raw material for vermicomposting. Hence, it was used for vermicomposting in the present work using *Eudrilus eugeniae* earth worm.

2.0 Materials and Methods:

2.*1 Earthworms:* Earthworms belong to phylum-Annelida, sub class- Oligochaeta. They are invertebrate in nature. In the present studies the well known species of earthworm used was *Eudrilus eugeniae* (fig. 1)

2.2 Biogas Plant Effluent: After biomethanation of temple waste, slurry was mixed with admixture of temple waste solids (remaining leaves and flowers after extraction of their fluid part for preparation of microbiological media) and cattle dung (cattle dung: solids) in 50:50 proportion. This admixture was mixed with biogas digester effluent in equal proportion and was kept for partial decomposition in the trays for 30 days and then this material was used for vermicomposting.

2.3 Vermicomposting Container/Pots/Tubs: For vermicomposting plastic tubs of size 25 X 15 cm and of 2 kg capacity were used.

Table 2: Proportion of cattle dung, temple waste flower and leaf solids and biogas plant effluent (For 2 kg vermicomposting container)

Cattle dung	Flower and leaf waste solids	Biogas digester slurry (effluent)
500g	500g	1000g

(Moisture content of this admixture was determined by gravimetric method (APHA, 1985) and was adjusted to 80% by sprinkling water) and then this admixture was used for vermicomposting.

2.4 General Vermicomposting Process

The 2 kg material was filled in the set of six plastic tubs (in triplicate) and kept in dark for five weeks by adding two earthworms / pot. Every week the weight of earthworm biomass / pot and count of cocoons / pot was taken after thorough washing and blotting of earthworms and cocoons and then they were reinnoculated in the respective pots. This procedure was followed for every week

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Eudrilus eugeniae

2.5 Optimization of Parameters of Vermicomposting (Kadam, 2004):

2.5.1 Effect of Temperature on Vermicomposting:

The temperature range selected for experiment was 15, 20, 25, 30, 35 and 40^{O}c taking into account average minimum and maximum temperatures found in the Sangli area and in the seasonal variations in the year. For every temperature selected, the three plastic tubs / pots were used and were incubated for five weeks in BOD incubators and biomass weight of earthworm pots and cocoons count was taken as above.

2.5.2 Effect of pH of Material on the Vermicomposting:

The P^{H} of vermicomposting material was adjusted with 1 N HCL / 1 N NaOH to 2,3,4,5,6,7,8,9 and 10. The pH values adjusted materials were filled in 2kg amount in three pots (in triplicate) and inoculated with two earthworms per pot and incubated in dark at 25^{O}c for five weeks. The average biomass of worms and cocoon count / pot was taken per week as above.

2.5.3 Effect of Particle size of Material on the Vermicomposting:

(P^{H} of material was adjusted to P^{H} 7.0)

The particle size range of material selected for experiment was 0.5 - 1mm, 1 - 2 mm, 2-4 mm, 5-10 mm, 10-20 mm and material of each particle size was filled in three pots in 2 kg amounts (in triplicate) and inoculated with two earthworms / pot and incubated at 25^{O}C for five weeks in dark. The average biomass of worms and cocoon count / pot was taken per week as above.

2.5.4 Effect of Moisture Content of Material on the Vermicomposting:

(pH of material was adjusted to 7.0 and 1 -2 mm size). The moisture contents of vermicomposting material was adjusted to 50,60,70,80 and 90 % with water and filled in 2 kg amounts in three pots (in triplicate) and inoculated with two earthworms / pot and incubated at 25^{O}c in dark for five weeks. The average biomass of worms and cocoon count / pot was taken per week as above.

2.6 Optimized Parameters of Vermicomposting:

Using Optimized parameter of vermicomposting i.e. temperature of incubation (25^{O}c) , P^{H} (7.0), particle size (1 - 2mm) and moisture content (80%) of organic material vermicomposting was done in 2 kg pots (in triplicate) and after five weeks of incubation the vermicomposting was separated by straining out off juveniles (earthworms) and their cocoons and then it was analyzed for the percentage of N, P and K and used for pot culture studies.

2.7 Pot Culture Studies with Vermicompost Prepared from Temple Waste:

Plastic pots with 5 kg of garden soil were used for pot culture trial studies. Different common flowering plants were selected (Table-3) and used to study the effect of vermicompost on enhancement of plant growth. The experiment was performed for period of three months. In the studies two sets of flowering plants in the pots were prepared - a control set with only soil and test set with 10% vermicompost added with soil in the pots. Daily 0.5 L of tap water was added in each pot. The extent of plant growth (height of plant in cm and no. of flowers), flowering time and number of flowers were studied every week for three months. Extent of enhancement in plant growth and flowering by using vermicompost was studied.

Table 3: Flowering plants used for pot culture studies using temple waste vermicompost (Pots - Control set and test set, saplings / pot = 2)

Sr. No.	Common name	Botanical name
1.	Gulab	*Rose damascene*
2.	Gulab	*Rose damascene*
3.	Jaswand	*Hibiscus rosasinensis*
4.	Jaswand	*Hibiscus rosasinensis*
5.	Jaswand	*Hibiscus rosasinensis*

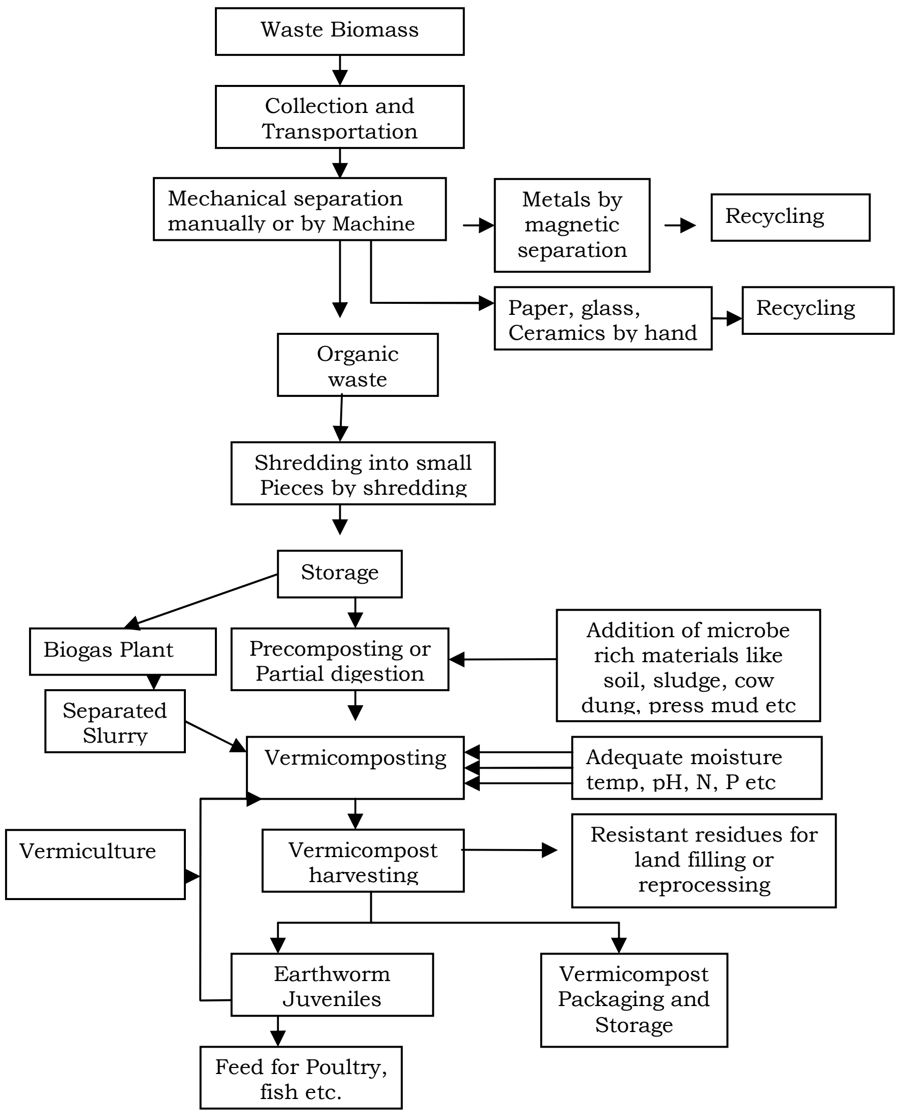


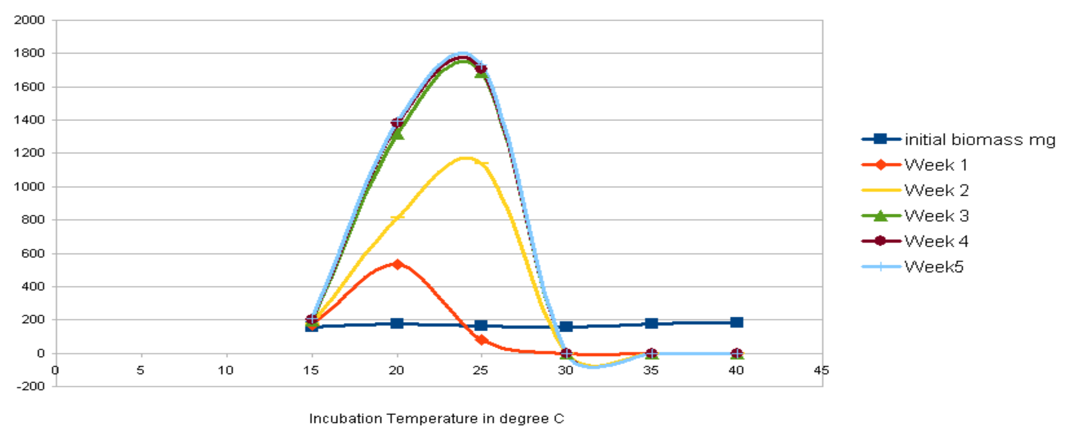
Fig 1: Flow sheet of general vermicomposting process (Kadam, 2004)

3.0 Results and Discussion:

Table 4: Growth of *Eudrilus eugeniae* at different incubation temperatures in vermicomposting (pH-7, particle size 1-2mm)

Sr. No.	Incubation temperature (°C)	Initial average biomass (mg) cocoon count/pot	Average results in different weeks / pot									
			Week 1		Week 2		Week 3		Week 4		Week 5	
			Biomass (BM) (mg) & cocoon count (CC)	% gain	BM (mg) and CC	% gain	BM (mg) CC	% gain	BM (mg) and CC	% gain	BM (mg) and CC	% gain
1)	15	155 (-)	167 (-)	107	179 (3)	115	193 (5)	125 (167)	201 (5)	130 (167)	208 (5)	134 (167)
2)	20	174 (-)	533 (2)	306	817 (4)	470 (200)	1320 (9)	759 (450)	1383 (10)	795 (500)	1395 (11)	802 (550)
3)	25	166 (-)	880 (4)	530	1140 (7)	687 (175)	1688 (12)	1017 (300)	1705 (14)	1027 (350)	1730 (14)	1042 (350)
4)	30	158 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
5)	35	179 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
6)	40	183 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Fig.2 Growth of Eudrilus eugeniae at different incubation temperature in vermicomposting



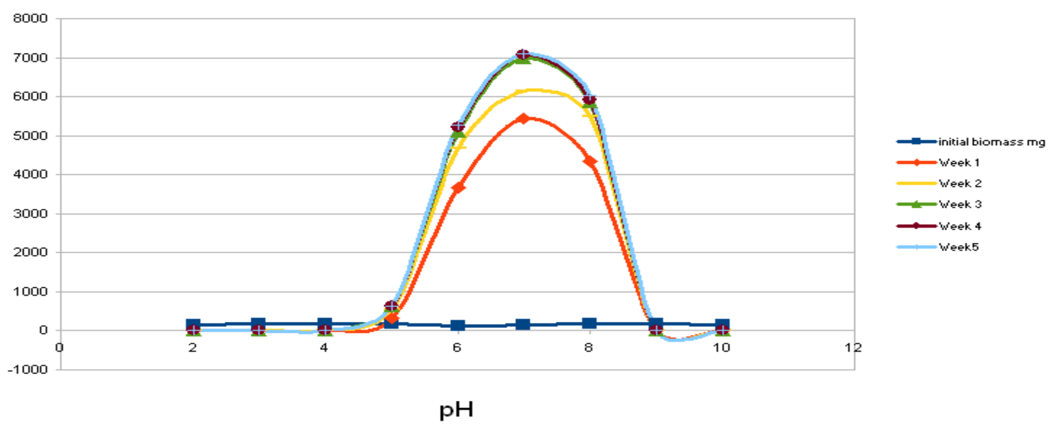
3.1 Incubation Temperature Optimization Studies:

The table 4 and figure 2 shows that out of 15,20,25,30, 35 and 40°c temperatures used for incubation there was gradual increased in biomass of earthworms and cocoon production from 15 - 25°C temperatures at all the five weeks incubation and maximum average biomass of 1730 mg and average of 14 cocoons were produced at 25°C. At the incubation temperatures beyond 25°C i.e. 30, 35, 40°C the earthworms could not survive indicating 25°C being optimal when the 7.0 p^H and 1-2 mm particle size of material used. It was reported by Kadam, 2004, Viljoen and Reinecke, 1992 and by Loehr et al 1985 that above 30°c high mortality of *Eudrilus eugeniae* was observed. The better biomass and cocoon production was reported by them at 25-30°c temperatures. It was observed that the results of present studies regarding vermicomposting temperature using *Eudrilus eugeniae* are constant.

Table 5: Growth of *Eudrilus eugeniae* at different P^H values of organic material in vermicomposting (Temperature 25^{O}c, particle size 2mm)

Sr. No.	pH	Initial average biomass (mg) cocoon count (CC) / pot	Average results in different weeks / pot									
			Week 1		Week 2		Week 3		Week 4		Week 5	
			Biomass (BM)(mg) and cocoon count (CC)	% gain	BM & CC	% gain	BM & CC	% gain	BM & CC	% gain	BM & CC	% gain
1)	2	144 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2)	3	168 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
3)	4	177 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
4)	5	181 (-)	310 (2)	171	555 (6)	307 (300)	620 (8)	343 (400)	635 (9)	351 (450)	645 (9)	356 (450)
5)	6	139 (-)	3670 (5)	2440	4690 (11)	3374 (220)	5115 (14)	3680 (280)	5225 (15)	3759 (300)	5265 (15)	3788 (300)
6)	7	159 (-)	5430 (7)	3415	6155 (14)	3871 (200)	6980 (18)	4390 (257)	7060 (19)	4440 (271)	7090 (18)	4459 (257)
7)	8	180 (-)	4355 (4)	2419	5510 (11)	3061 (275)	5870 (14)	3261 (350)	5915 (16)	3286 (400)	6020 (16)	3344 (400)
8)	9	172 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9)	10	149 (-)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Fig.3 Growth of Eudrilus eugeniae at different pH values of organic material in vermicomposting



3.2 pH Optimization Studies:

The pH range of 2,3,4,5,6,7,8,9 and 10 was used for the studies. It is evident from table-5 and figure-3 that at p^H values 2,3 and 4 and at p^H 9 and 10 earthworms did not survive indicating totally unfavorable pH. While there was gradual increased in the average biomass earthworms and average cocoon production from p^H 5 to 8. The maximum average biomass obtained at the end of 5th week was 6020 mg and maximum average cocoon production of 16 at p^H 8, indicating p^H 8 being optimal for vermicomposting with *E. eugeniae* at 25˘c temperature and 1 -2 mm particle size. It was reported by Kadam, 2004 that minimum biomass and cocoon production was obtained at p^H 5 and 9 while earthworms were killed at p^H below 5 and above 9 and maximum biomass and cocoon production of *E. eugeniae* was obtained at p^H 7.0 which is consistent with present findings. The results of present investigations of are comparable with those reported by Madign, 2005 for *E. eugeniae* were p^H range of 5.6 - 9.2 was optimal for biomass production. Gestel et al, 1992 reported reduce cocoon production at p^H 9.0.

3.3 Particle Size Optimization Studies:

The particle size ranged selected was 0.5 - 1.0, 1- 2, 2 -4, 5-10 and 10-20 mm. It is evident from table -6 and figure4 that the average biomass increase and cocoon production was gradual from 0.5 - 1 to 1 -2 mm size i.e. 2 - 4, 5 - 10 and 10 - 20 mm the average biomass and cocoon production was decreased. The maximum average biomass of 1835 mg and maximum average cocoon production of 8 was obtained at the end of 5th week at 1- 2 mm particle size indicating 1-2 mm particle size of material is optimal for vermicomposting using *E. eugeniae* at pH 7.0, 25°c temperatures and 80% moisture level. It was reported by Kadam, 2003 that maximum biomass of *E. eugeniae* was attained at 1 mm particle size using Tendu leaves *(Diospyros melanoxylon Roxb)* as raw material and findings in present investigations showed 1- 2 mm particle size as optimal. These findings are also supported by the reports of Lowe and Butt, 2003, who reported increased biomass and cocoon production by small sized particles using *Allolobophora chlorotica* and *Lumbricus terristris* earthworm species. These findings supported present results indicating large size particles are not amenable to earthworms.

Table 6: Growth of *Eudrilus eugeniae* at different Particle Sizes of Vermicomposting Material (pH 7, Temperature of Incubation -25°C)

Sr. No.	Particle sizes (mm)	Initial average biomass (mg) cocoon count / pot	Average results in different weeks / pot									
			Week 1		Week 2		Week 3		Week 4		Week 5	
			Biomass (BM) (mg) and cocoon count (CC)	% gain	BM(mg) and CC	% gain	BM(mg) and CC	% gain	BM(mg) and CC	% gain	BM(mg) CC	% gain
1)	0.5 - 1	183 (-)	315 (1)	172	765 (2)	418 (200)	920 (4)	503 (400)	1060 (6)	579 (600)	1095 (6)	598 (600)
2)	1-2	159 (-)	870 (2)	547	1240 (3)	780 (150)	1765 (5)	1110 (250)	1820 (7)	1145 (350)	1835 (8)	1154 (400)
3)	2 - 4	176 (-)	515 (4)	290	940 (6)	534 (150)	1315 (8)	735 (200)	1440 (9)	804 (225)	1475 (9)	824 (225)
4)	5 -10	164 (-)	290 (6)	177	370 (5)	226 (150)	635 (11)	387 (183)	680 (12)	415 (200)	715 (12)	436 (200)
5)	10 - 20	151 (-)	190 (5)	126	275 (7)	182 (140)	405 (9)	268 (180)	460 (10)	305 (200)	525 (10)	348 (200)

Fig.4 Growth of Eudrilus eugeniae at different particle size

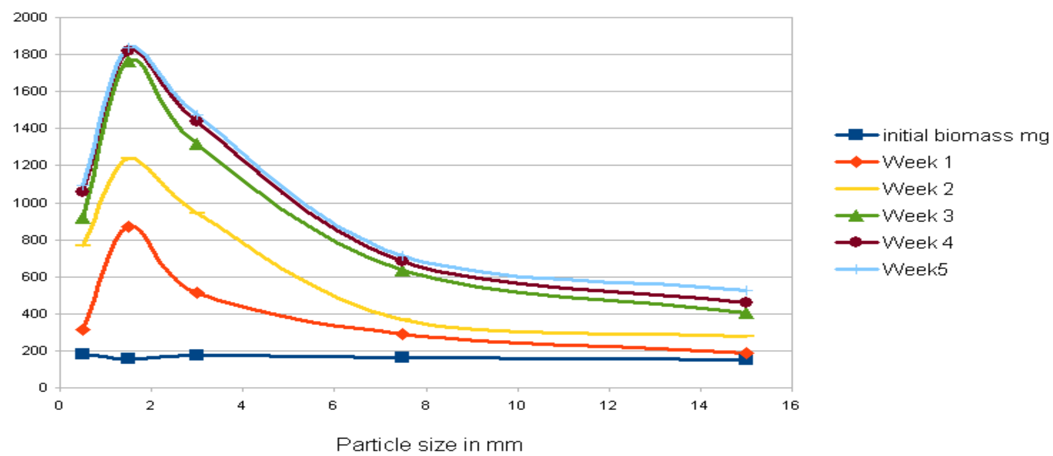
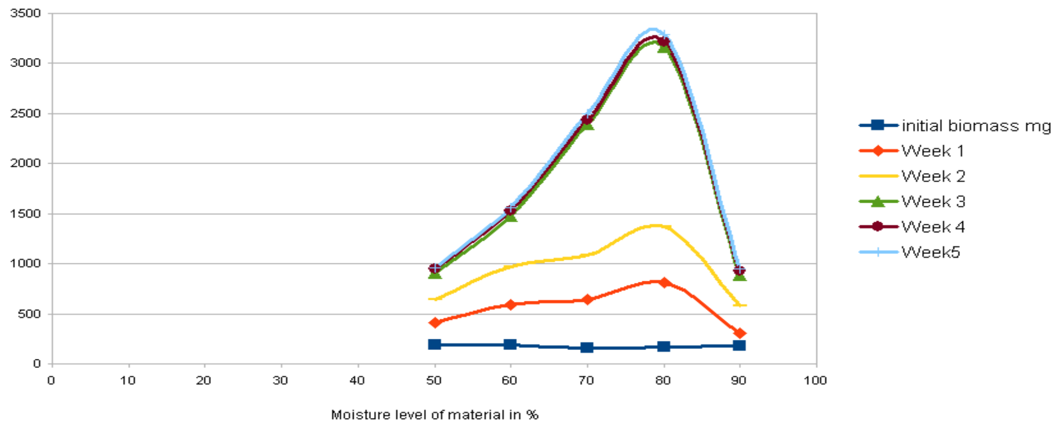


Table 7: Growth of *Eudrilus eugeniae* at different Moisture Level of Vermicomposting Material (pH 7, Temperature of Incubation -25^{O}C, Particle Size of Material 1-2 mm)

Sr. No.	Moisture level of material (%)	Initial average biomass (mg) cocoon count / pot	Average results in different weeks / pot: Week 1 Biomass (BM)(mg) and cocoon count (CC)	% gain	Week 2 BM(mg) and CC	% gain	Week 3 BM(mg) and CC	% gain	Week 4 BM(mg) and CC	% gain	Week 5 BM(mg) CC	% gain
1)	50	194 (-)	410 (2)	211	640 (4)	330 (200)	910 (7)	469 (350)	945 (8)	487 (400)	955 (8)	492 (400)
2)	60	187 (-)	590 (2)	316	975 (5)	521 (250)	1480 (8)	791 (400)	1530 (9)	818 (450)	1565 (9)	837 (450)
3)	70	154 (-)	640 (3)	416	1085 (5)	704 (167)	2390 (9)	1552 (300)	2440 (10)	1584 (333)	2495 (10)	1620 (333)
4)	80	171 (-)	815 (4)	477	1370 (7)	801 (175)	3165 (9)	1851 (225)	3215 (11)	1880 (275)	3285 (11)	1921 (275)
5)	90	179 (-)	305 (3)	170	580 (5)	324 (167)	890 (7)	497 (233)	925 (8)	516 (267)	945 (8)	528 (267)

Fig.5 Growth of Eudrilus eugeniae at different moisture level of vermicomposting material



3.4 Optimization studies on moisture content:

It is evident from table 7 and figure 5 that when vermicomposting was carried out at p^{H} 7.0 and 25^{O}c temperature and 1 - 2 mm particle size of material and with selected moisture levels of 50,60,70 and 80 there was gradual increase in the biomass of earthworms at all selected moisture levels every week till end of 5th week but maximum biogas increase and cocoon production was obtained 80% moisture content viz. initial average biomass of 171 mg to 3285 mg average biomass and average 11 cocoons at the end of 5th week where as at 50,60,70 and 90 % moisture level comparatively less biomass and cocoon production was obtained. It indicated that 80% moisture level was the optimum level for vermicomposting of temple waste using *E. eugeniae.* Dresser and McKee, 1980 reported 50 - 80% moisture level as suitable for vermicomposting while Kaplan,1980, Kadam, 2004 reported maximum biogas and cocoon production at 70 - 80% moisture level. Edwards et al, 1985 reported suitable moisture level of 50-90 % for *Eisenia foetida* and 80 - 90% being optimal, while Dominguez and Edwards, 1997 reported 85 % as optimal moisture level for *Eisenia andrei* when grown on pig manure. Viljoen and Reinceke, 1990 reported 79-80.5% as optimal moisture level for *E. eugeniae* grown on cattle manure. These reports thus support findings of present investigations.

Table 8: Extent of Enhancement of Plant Growth and Flowering Using Temple Waste Vermicompost

Sr. No.	Week no.	Type	Height (cm) and average number of flowers / plant							Remark
			1	2	3	4	5	6	7	
1)	0	C	10	11.5	12.0	11.3	14.0	13.3	12.6	No flowering
		T	10	11.5	12.0	11.3	14.1	13.2	12.5	
2)	1	C	03.3	14.2	13.3	13.5	15.3	15.6	14.1	No flowering
		T	14.5	14.8	15.5	12.9	16.3	15.9	14.9	
3)	2	C	15.8	15.9	15.8	15.4	17.6	17.9	16.4	No flowering
		T	17.6	16.8	18.3	15.5	19.5	19.5	17.8	
4)	3	C	17.9	17.1	16.9	18.6	19.4	20.2	18.6	No flowering
		T	20.5	19.5	21.6	18.6	23.6	22.8	20.3	
5)	4	C	19.5	19.5(1)	18.1 (-)	20.4 (-)	23.6(-)	22.8 (-)	21.2 (-)	No flowering
		T	23.3	22.8(2)	24.5 (3)	21.8 (2)	28.5(3)	24.6 (3)	23.5 (5)	Flowering
6)	5	C	22.5 (-)	21.3(-)	20.8 (-)	23.6 (-)	25.4 (-)	24.9 (-)	23.5 (-)	No flowering
		T	25.8 (1)	24.5(5)	27.3 (4)	25.5 (5)	32.1 (3)	26.5 (3)	27.6 (7)	Flowering
7)	6	C	24.1 (1)	22.8(-)	21.9 (2)	25.9 (-)	27.8 (1)	26.5 (-)	25.4 (-)	No flowering
		T	29.3 (3)	27.3(7)	29.8 (4)	28.3 (5)	36.5 (5)	28.3 (3)	30.5 (8)	Flowering
8)	7	C	25.6 (2)	24.3(1)	23.2 (2)	27.3 (3)	29.5 (1)	27.5 (2)	27.7 (2)	Flowering
		T	31.3 (6)	29.5(8)	31.5 (6)	31.5 (6)	38.7 (6)	31.5 (6)	32.5 (9)	
9)	8	C	26.5 (3)	26.1(3)	25.3(3)	29.5 (3)	31.6 (3)	28.8 (2)	29.3 (4)	Flowering
		T	33.5 (10)	31.8(11)	33.5(7)	34.5 (6)	40.2 (4)	33.7 (6)	34.9 (10)	
10)	9	C	27.8 (4)	27.3(5)	27.2(3)	31.3 (4)	32.9 (3)	29.5 (2)	30.6 (4)	Reduced Flowering
		T	35.5 (12)	34.4(11)	35.1(7)	36.5 (7)	42.3 (4)	35.2 (5)	36.1 (7)	Flowering
11)	10	C	28.2 (4)	27.9 (5)	29.0(3)	32.6 (4)	33.5 (2)	34.4 (3)	31.8 (3)	Reduced Flowering
		T	36.8 (13)	35.9 (12)	36.8(7)	38.1 (6)	43.2 (3)	36.8 (5)	37.3 (6)	Flowering
12)	11	C	29.0 (3)	28.2 (4)	29.7(1)	33.1 (2)	33.9 (1)	30.7 (1)	32.3 (2)	No flowering
		T	37.5 (6)	36.3 (5)	37.5(2)	39.3 (3)	44.6 (3)	37.6 (3)	37.6 (3)	Reduced flowering
13)	12	C	29.2 (-)	28.3 (1)	30.0(-)	33.4 (-)	34.3 (-)	30.8 (-)	32.5 (-)	No flowering
		T	38.1 (4)	37.1 (3)	37.8(2)	40.1 (1)	45.1 (2)	37.9 (2)	37.9 (3)	Reduced flowering
Total flowers		C	17	19	14	16	10	10	15	
		T	56	64	40	41	33	36	58	
Plant length (total) after 12 weeks		C	289.4	256.5	283.2	315.9	318.9	318.9	318.2	
		T	353.7	342.2	361.2	353.9	424.7	363.5	363.4	

It is evident from table 9 that vermicompost is rich in percent carbon, Nitrogen, Phosphorus and Potassium content i.e. 28, 1.58, 0.33 and 0.28 respectively. It was reported by Kadam, 2004 that vermicompost prepared from Tendu leaves using *E. eugeniae* earthworm contained percent carbon, nitrogen, phosphorus of 29, 1.43, 0.29 and 0.23 respectively. Thus vermicompost prepared from temple waste is composition consistent with that reported by other workers previously.

It is evident from the table-8 that all the five flowering plants of the test set used in the studies showed good enhancement of growth in terms of height, flowering time as well as number of flowers produced as compared to control sets. In case of test set flowering appeared from fourth week, while in the control set it appeared from sixth week of experiment. The total number of flowers in the test set produced in twelve weeks of experiment for seven flowering plants ranged from 33 - 64, while in the control set it ranged from 10 - 19 flowers i.e.

almost more than three times yield of flowers was observed with use of vermicompost. The flowering persisted in the test set right from fourth to twelveth weeks of experiment where in the 11th and 12th week reduction in the flowering was also observed probably due to exhaustion of nutrients. While in the control set the flowering was observed from 6th week and reduction or lowering started from 9th week of experiment and in the 11th and 12th weeks no flowering was observed. This indicated that vermicompost prepared from temple waste had enhanced the plant growth. The average total growth (lengths) of all test plants and control plants i.e. 2913.5 inches and 2415.2 inches indicated that more than 20% more plant growth was observed in the test set. Using vermicompost while taking into account total plant growth (lengths) at end of 12th week % increase in plant length in control set was 258% while in case of test set it was 323.9 % i.e. more than 25% growth enhancement was observed in test set as compared to control set.

Table 9: Physicochemical Analysis of Temple Waste Based Vermicompost, Soil and Tap Water Used For Pot Trial Studies

Parameter	Vermi compost	Soil	Tap water
pH	7.2	7.7	7.5
% carbon	28	1.4	Nil
% Nitrogen	1.58	0.03	ND
% Phosphorus	0.33	0.12	ND
% Potassium	0.28	0.22	Nil
% Calcium	2.5	0.75	0.010
% Magnesium	2.1	0.26	0.002
% Silica	38	58.5	ND
ppm Iron	860	740	ND
ppm Manganese	95	295	ND
ppm Copper	30	37	ND
ppm Zinc	12.5	88	ND
ppm Chlorides	2.2	88	125
Alkalinity ppm	ND	24.3	130
ppm Sodium	0.55	16	35
ppm Hardness	ND	ND	165
COD ppm	ND	22	Nil - 8
Electrical conductivity µS/cm	ND	70	200 - 230

Plate 3 Pot Culture Studies Using Temple Waste Based Vermicompost

3.5 Conclusion

The temple waste based biogas digester slurry admixed with cattle dung and temple waste solids, after partial decomposition works as an excellent raw material for vermicomposting using *Eudrilus eugeniae* earth worm which can produce vermicompost with good fertilizer value and which can be used for plantation in the temple premises. This ecofriendly method of temple waste management should be extended for all the temple and alike wastes.

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