

Study of Changes in Physical Parameters of compost and Vermicompost of Eucalyptus Leaf Litters

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ABSTRACT

Vermicompost and compost of leaf litter of Eucalyptus was studied in plastic bins in duplicate sets with two different proportions (100 % and 50 %). For vermicompost experiments, epigeic earthworm species *Eisenia foetida* and *Eudrilus eugeniae* were employed at 10-10 numbers each per vermicompost bins. Cattle dung was taken as control. During the entire process physical factors viz. temperature, pH, moisture content and biomass were measured and compared. The results were reveal that initial temperature was $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ in both vermicompost and compost leaf litter and after several weeks, it was set at minimum level. In 50 % leaf litter temperature was 2-3 $^{\circ}\text{C}$ higher than 100 % leaf litter. pH of both vermicompost and compost mixtures were acidic in beginning phase while set at alkaline at final stage. Vermicompost had lower pH than compost. Moisture content of leaf litter also decreased in initial phase due to generation of metabolic heat but at later phase it was increased due to decreasing of metabolic heat. More changed was seen in 100 % leaf litter followed by 50 % and then cattle dung. Biomass of leaf litter was more decreased in 100 % waste then 50 % and cattle dung.

Keywords : Eucalyptus leaf litter, vermicompost, compost, pH, temperature, moisture, biomass

1 Introduction

Using of fertilizer in agriculture is an imperative practice for accelerations of crops production. Bio-compost is one of the types of fertilizer using in agriculture. Bio-compost is prepared from cattle dung since long time by traditional manner. Although this technique is useful but prepare products limited with certain nutrients which do not fulfil the demand of agriculture resulting chemical fertilizer added as supplement. Presently it has been established that using of chemical fertilizer not only affect the natural quality of the soil but also cause bad effect on environment. Vermicomposting is an alternative way to prepare biofertilizer from similar waste using in compost preparation. Currently, vermicompost is preparing with the help of earthworm. Conventionally vermicompost generates from cattle dung as the substrate and has been recognized as a good soil conditioner and fertilizer [1]. In recent years along with cattle dung, other

substrates are also vermicomposted and prepare products have been found to be as good as the cattle dung based vermicompost [2-6]. These results create idea to turn different types of organic waste such as municipal solid waste, crop wastes, weeds, leaf litter etc., into gainful vermicompost.

Eucalyptus is well known genus of flowering tree which is ubiquitous in nature. Although it is native to Australia, but some species also found in India. [7]. *Eucalyptus globulus* is common species, found in most of the part of India. There rapid growth, low nutritional requirement, higher tolerance nature to adverse condition and beastliness make it more attractive for plantation. Eucalyptus yields substantial quantities of leaf litter which is either broomed into the existing heaps of municipal solid waste (MSW), thereby adding to the MSW burden, or is made into piles and set on fire, thereby causing air pollution. Composting or vermicomposting of leaf litters with cattle dung is better option to turn waste into best. It will not only decrease the pollution but also increase the availability of plant nutrients.

During composting and vermicomposting of Eucalyptus leaf litters, physical factors like pH, temperature, moisture content, biomass reduction, odour etc. are also significantly changed. Similar work was also done by several scientists by using different types of organic waste. Shouche et al. [8] worked on floral waste vermicomposting and revealed that different physical parameters varied periodically and became stable at the end of the process. They were also found 60-70% moisture percent and 25-30°C temperature for proper activity of microorganisms and earthworms. Larney and Blackshaw [9] was stated that in Initial phase of composting or vermicomposting moisture content was decreased due to high evaporating rates at high thermophilic phase. Liang et al [10] also observed that at the end of process, moisture percentage increase due to the production of high absorption capacity of vermicompost. Peigne and Girardin [11] also revealed that during composting process, temperature increase initially but when process drive to last stage then temperature turn decrease. During composting and vermicomposting, pH also changed significantly. Singh et al [12] found that during vermicomposting of rose flowers pH has changed from 4.3 to 8.2. Vogt *et. al.* [13] was reported about reduction in biomass during decomposition process due to loss of water by heat. It has also reported that about 40% volume of waste materials reduced from their parent mass in composting process. [14]. Ndegwa and Thompson [15] also suggested that during the process of composting and vermicomposting, bio solid waste reduced approximately 45% by their original weight. The present study was done to change and compair the vicissitudes in physical factors during composting and vermicomposting of Eucalyptus leaf litter. For vermicomposting, two species of earthworm i.e. *Eisenia foetida* and *Eudrilus eugenia* were taken which are known to be voracious feeders and have other attributes suitable for vermicomposting.

2 Material and Methods

2.1 Collection of Plant Leaves and Cattle Dung

In present experiment cattle dung was collected according to the method of Shouche *et.al.* [8] and was brought to vermicomposting unit, Govt. Madhav Science College Ujjain. *Eudrilus eugeniae* and *Eisenia foetida* equally used in this study were obtained from vermiculture centre of Govt. Madhav Science College, Ujjain (M.P.) [16, 17]. The leaf litter of Eucalyptus (*Eucalyptus globulus*) used as a substrate was collected at random from the College campus of Govt. Madhav Science P.G. College, Ujjain (M.P).

2.2 Preparation for Vermicomposting

Collected leaf wastes was chopped into small pieces and mixed with cattle dung in equal volume. 100 % cattle dung and leaf litter were taken as a control for study.

2.3 Process of Vermicomposting and Composting

Both composting and vermicomposting process carried out in plastic containers in duplicate manner. During the process all containers kept openly in room which was aerated passively *i.e.* no any effort was done for supply of air. Waste materials were turned after regular interval of time for dissipate heat as well as enhances passive aeration [18]. In order to fulfil moisture loss, mixtures were sprinkled with water after

turning it upside down. In case of vermicomposting sets, leaf litter-cattle dung mixtures were pre-decomposed for fifteen days prior adding of earthworms while other sets for composting, were run continuously without earthworm. Twenty earthworms (*E. eugeniae* and *E. foetida*) were added in vermicomposting bins [12].

2.4 Measurement of Physical Parameters

During vermicomposting and composting of Eucalyptus leaf litters, physical variables viz. pH, temperature biomass and moisture were measured change according to the methods carried out by different researchers [8, 19, 20, 21]. pH was measured by digital pH meter (Systonic) in which electrode was immersed in beaker containing vermicompost or compost suspension (figure 1). A moisture change was recorded by drying of composting materials (5.0 gm) in hot air oven at 105°C for 24 hrs. and taken dry weight by electronic balance (Citizon) (figure 2). Biomass reduction was measured with the help of scale at all four side marked areas and their mean value was taken (figure 3). In case of temperature measurement, mercury thermometer was inserted into composting bins at three different places in different depth and their mean value was record (figure 4).



Figure 1: Measurement of pH using digital pH meter.



Figure 2: Measurement of moisture of vermicomposting and composting mixtures



Figure 3: Measurement of depth of vermicomposting and composting mixture.



Figure 4: Measurement of temperature of vermicomposting and composting mixture.

3 Results and Discussion

Decomposition of organic wastes is a biological process in which physical factor of waste get change during the course of process time duration and set at constant point at the end of phase. In present work, leaf litters of Eucalyptus were subjected to vermicompost and compost with and without cattle dung and evaluate different physical parameters comparatively. Parameters viz. moisture content, depth, pH and temperature were measured for both 100 % leaf litter and 50: 50 of leaf litter-cattle dung mixture of

vermicompost and compost sets. The table 1 is given to all physical parameters related to the treatment of earthworm (vermicompost) with a mixture of leaf and cattle dung while all parameters related to mixture of leaf litters and cattle dung without treatment of earthworm (compost) are given in table 2. The control parameters of both vermicompost and compost of cattle dung are depicted in table 3. During measurement of moisture, it was notice that initial moisture level of 100% leaf litter was 68 ± 1 % while in 50 % Eucalyptus-cattle dung mixture, it was 65 ± 1 % in compared to cattle dung (60 %) using as a control. At the end of process (after 13 weeks) it was recorded 81 ± 1 % in 100 % leaf litter while 75 ± 1 % in 50 % Eucalyptus-cattle dung mixture of both vermicomposting and composting sets while in control it was 66 ± 1 %. Result revealed that moisture level was changed 13 ± 1 % in 100 % leaf litter while 10 ± 1 % in 50% mixtures in both composting and vermicomposting sets as compared to 6 ± 1 % in cattle dung.

Table 1: Variation in different physical parameters of leaf litters and cattle dung mixture treated by earthworms.

No. of Week	Earthworm (Vermicomposting)							
	Moisture percentage		Depth of biomass (cm)		pH		Temperature (°C)	
	100 %	50 %	100%	50 %	100%	50 %	100%	50 %
1 st	67.62	64.33	28.90	26.42	5.5	5.6	33.7	36.3
2 nd	69.36	64.45	25.39	23.45	6.2	6.4	32.6	34.4
3 rd	70.28	65.45	23.86	21.23	6.5	6.7	30.6	32.5
4 th	72.53	66.69	20.42	19.84	6.7	6.9	28.7	29.8
5 th	74.29	67.79	18.77	17.38	6.9	7.2	27.5	28.8
6 th	75.58	68.83	16.57	15.83	7.2	7.3	26.7	26.9
7 th	75.43	70.52	14.42	14.89	7.3	7.4	24.9	25.7
8 th	77.75	71.19	13.83	13.95	7.5	7.5	21.9	24.56
9 th	78.92	72.78	11.59	12.25	7.6	7.7	21.6	22.9
10 th	79.35	73.32	10.90	10.52	7.7	7.8	20.8	21.7
11 th	80.65	74.35	9.37	9.58	7.8	7.9	20.3	21.6
12 th	80.89	75.49	9.22	9.12	7.9	8.00	19.6	20.6
13 th	81.35	75.39	8.65	8.10	8.00	8.1	18.8	19.7

Table 2: Variation in different physical parameters of leaf litters and cattle dung mixture without earthworm treatment.

No. of Week	Without Earthworm (composting)							
	Moisture percentage		Depth of biomass (cm)		pH		Temperature (°C)	
	100 %	50 %	100%	50 %	100%	50 %	100%	50 %
1 st	69.28	66.29	29.59	27.16	5.6	5.7	33.5	35.5
2 nd	70.74	67.32	26.42	24.27	6.2	6.3	32.8	34.7
3 rd	71.95	68.66	24.15	22.29	6.4	6.6	30.5	33.6
4 th	72.24	69.54	21.17	19.38	7.2	7.4	27.4	31.2
5 th	73.21	70.25	19.45	17.29	7.4	7.6	26.4	28.9
6 th	75.46	71.23	18.33	16.65	7.5	7.7	24.5	27.5
7 th	77.44	72.45	16.69	15.58	7.6	7.8	23.3	26.5
8 th	78.29	73.37	13.58	13.24	7.7	7.9	22.6	24.4
9 th	79.39	74.24	12.63	12.64	7.9	8.00	21.2	23.4
10 th	79.83	74.89	11.17	10.56	7.9	8.1	20.5	21.5
11 th	80.11	75.03	9.52	9.94	8.00	8.2	19.8	21.2
12 th	80.37	75.83	8.99	9.58	8.1	8.2	19.5	20.4
13 th	81.32	76.64	8.80	8.39	8.1	8.3	18.7	19.6

Table 3: Variation in different physical parameters of cattle dung with and without treatment of earthworms.

No. of Week	Cattle dung							
	Moisture percentage		Depth of biomass (cm)		pH		Temperature (°C)	
1 st	V	C	V	C	V	C	V	C
2 nd	60.35	60.35	14.84	14.84	8.5	8.5	38.5	38.5
3 rd	61.37	61.37	12.78	12.78	8.4	8.4	35.4	35.4
4 th	62.95	62.95	11.11	11.11	8.3	8.3	33.8	33.8
5 th	63.83	63.83	10.68	10.68	8.2	8.2	32.5	32.5
6 th	64.69	64.69	10.34	10.34	8.2	8.2	29.9	29.9
7 th	64.89	64.89	9.72	9.72	8.1	8.1	27.5	27.5
8 th	65.65	65.65	8.74	8.74	8.1	8.1	25.5	25.5
9 th	66.28	66.28	7.95	7.95	8.00	8.00	24.7	24.7
10 th	66.35	66.35	6.17	6.17	8.00	8.00	22.9	22.9

Note: V= vermicompost (earthworm treated), C= compost (without earthworm), cm= centimetre

During the entire experiment water was added in all composting bins after regular interval of time so that lost water fulfils by addition of supply water. Moisture loss may be due to metabolic heat, generated by microbial community found in composting bins as well as inter-cellular digestion in the gut of earthworm. It has been also found that existence of abundant quantity of organic waste labile for great metabolic activity, result generating of much heat and this rate is directly proportional to the moisture loss. As the degradation rate of waste increases, then its availability decrease, resulting heat generation rate gradually decrease [22, 23, 24]. In our experiment, ample vapour loss was seen in initial phase of composting process but at the end of composting phase, moisture loss decreased due to low heat generation because of consumption of almost organic matters. In case of cattle dung, organic waste were almost digested in ruminant stomach therefore due to less availability of organic compound, less heat generates thus the water loss also minimum as compared to 100% and 50 % leaf litters. Our result was concordance with result of solid waste and food waste composting done by Suler-Finstein and Sundberg [25, 26].

During the work, depth of composting and vermicomposting mixtures was also measured. It was found that initial height of leaf litter biomass was 27 ± 1 cm in both 100 % and 50 % and 14 ± 1 cm was in cattle dung in both vermicompost and compost bins when the experiment started. The height gradually decreased during the decomposition and finally it was set at the height of 8.0 ± 1 cm. in leaf litter while 6.0 ± 1 cm in cattle dung in both vermicompost and compost sets. Based on the result obtain it was found that during decomposition process, about 70 % height in leaf litter waste and 57 % height cattle dung were reduced. Similar result obtained by Chaudhuri *et.al.* when he did the vermicomposting of kitchen waste [27]. Biomass of organic waste consists of water as well as biopolymers *viz.* carbohydrate, protein etc. along with water which make them bulky. During the composting, microorganisms and earthworm (in case of vermicompost) digest complex material into simplest form, resulting generation of heat and gas. Such heat transforms water into vapour. Therefore, digestion of organic waste and its water loss in the form of vapour are main causes for diminish the height of biomass [28, 29]. It was also found that depth reduction rate in vermicompost set was higher than compost set in both 100 % and 50 % leaf litters as well as in control (cattle dung) was also supported by result of Singh *et.al* [30] who worked on decomposition kitchen waste. pH was also measured and compared during decomposition process. It was found that initial pH of leaf litter waste was 5.6 ± 0.2 in both vermicompost and compost sets while the pH of control (cattle dung) was 8.5 ± 0.2 . As decomposition of leaf litters waste progress, pH was increased gradually and finally set near alkaline. Shouche *et.al* also found same result while working on floral waste vermicomposting. When Sannigraha worked on leaf litter degradation then he also found neutral to alkaline pH of vermicompost while more alkaline pH in prepared compost [8, 31]. The pH of any organic compound depends upon their chemical constituents. When the process of composting begins, the present microorganism takes carbohydrate preferentially and form CO₂ and water after metabolism. When generate CO₂ dissolved in

water then pH of medium turn into acidic. In our experiment, initial pH of leaf waste in both vermicompost and compost was also found acidic. When there is constant use of carbohydrate, then its quantity gradually decreases then microorganism begin to metabolized another compound for getting energy i.e. protein. Because protein is a nitrogenous compound which gives rise to ammonia at the end of metabolism causes alkaline condition in medium [27, 32]. Our result also found alkaline pH at the end of composting and vermicomposting process.

Temperature was also measured during the decomposition process. It was higher at beginning phase but gradually decreased and set at lower point alike to room temperature. In the beginning of the process, *i.e.*, up to 21 days, the temperature was high (32 to 33°C) in both vermicompost and compost bins in comparison to room temperature (26 to 30°C). Later, there was a gradual fall in temperature that reached at minimum level was 18°C (close to room temperature). However, higher temperature was recorded in vermicompost than compost bins during the entire period of decomposition process. It was also found that temperature was higher in 50 % of leaf litter-cattle dung mixture than 100 % leaf litter waste. It was also explore that there were 14-18°C difference between initial and final temperature of vermicompost and compost leaf litter waste while in case of control it was about 16°C ± 1°C .It has been found that initial temperature raised as a result of biochemical processes and decomposition of organic components of waste. As soon as organic waste depleted the temperature also turn down and set at lower constant value [23].

4 Conclusion

Vermicomposting and composting are more or less similar but distinct technique to exploit bio organic waste as a fertilizer for betterment and increase soil fertility. Both techniques undergo several physical, chemical and biological changes to established finished product. Present study revelled about fluctuations in different physical parameters viz. moisture concentration, as well their comparative account regarding the vermicomposting and composting of Eucalyptus leaf litter-cattle dung mixture. Moisture loss is more frequently in those sets (50 %) which contain more cattle dung as well as presence of earthworms (vermicompost). It has also clear that these sets having also comparatively high temperature due to more biochemical activities. Result also explores that in such sets biomass also reduced more prominently. It has also found that pH of all sets either vermicompost or compost, turn to alkaline. Present finding can apply for the study of effect of different substrate on the growth of earthworm and also finest state at which earthworm can abide physical conditions for growth. Although this study done with cattle dung which considered as a good food source for earthworm but using of different animal dung may change the survival rate of earthworm which may be key factors for preparing vermicompost. With consideration the result of present study, earthworm should be applied when favorable condition sets in composting bins.

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