Performance Evaluation of Vermicomposting Pit by using Different Types of Solid Waste

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Abstract— Management of solid waste is one of the biggest problems we are facing today. The rapid increasing human population, urbanization and change in standard of living style has increased the waste load and there by pollution loads on the urban environment to unmanageable and alarming proportions. The existing waste dumping sites are insufficient and conditions leading to pollution of water sources and spreading infectious diseases, foul smell and odors, release of toxic metabolites, unhealthy environment etc. Vermicomposting is the better option to overcome this problem. Vermicomposting is environment friendly and cost effective method for solid waste management. It serves two main purposes for the happiness of humans as it helps in the degradation of solid waste and the cast produced during this process is used as a natural fertilizer. This technique is much better than chemical fertilizer because it is not associated with any kind of risk. Earthworms are potentially important that are capable of transforming garbage into gold. Eisenia fetida is the most commonly used species of earthworms for vermicomposting. It becomes an important tool of waste recycling the world over.

Key words: Eisenia Fetida, Earthworm, Organic Waste, Vermicomposting

I. INTRODUCTION

Earthworms are important vermiresources having simple, cylindrical, hollow and segmented body characterized by presence of stiff hair[4]. Earthworms are terrestrial worms well adapted for burrowing life. They depend on soil for all of their activities hence they are called geobionts. In order to protect themselves from enemies and sear most of the species prefer to live in burrows and come out during night in search of food (night crawlers). Earthworms are also known as rain worms, as they are seen in large numbers during rains, manure worms, as some varieties flourish well in manures and compost heaps, angel worms as they suddenly appear like angels after some days of rains, or fish worms as they are largely used as fish bait and fish food.

Earthworms play an important Eco functional role in soil environment by affecting physical, chemical and biological properties of the soil. Earthworms have dynamic potentials and can do wonderful jobs for man and biosphere. The capacity of earthworms has been proved in decomposition of waste materials. Many organic bi-products of agricultural production and processing industries are currently seen as .waste' and thus become potential environmental hazards. A part of this waste is currently reused, recycled or reprocessed: however a majority of it is disposed of in landfills (anaerobic composting), which is a matter of worry due to many factors including cost and environmental issue. Due to ill effects of modern technologies and un-sustainable developments, the importance of ecofriendly technologies is now stressed upon. Vermicomposting is a promising technique.

A. Why Compost With Worms?

Worm composting is a method for recycling waste into an affluent, dark soil conditioner. The great advantage of worm composting is that this can be done inside and outside, thus making all year round composting. It also provides apartment residences with a means of composting. In a nutshell, worm compost is made in the container filled with moistened bedding and red worms. Then waste is added for a period of time, and the worms and micro-organisms will eventually convert the entire contents into rich compost.

B. Humus – The Soil's Gum:

Humus is an important bi-product of compost. Humus is created from decomposition of all the organic matter you place in your compost. Humus acts like gum that holds all the soil particles together, and it helps prevent soil erosion and increases a soil's moisture holding ability.

II. MATERIALS AND METHODS

A. Materials Required for Vermicomposting:

Organic wastes, Cow Dung, Earthworms species, Coconut shells, liner, soil, etc.

B. Pre composting:

The organic wastes is sprayed in layer and exposed to sunlight for 5 to 10 days to remove microorganisms and gases. The pre- composting process takes 5 to 10 days for their completion but cotton waste which require 20 to 25 days for their decomposition.

C. Collection of material:

The material required for vermicomposting such as agricultural waste is collected from campus. Also paper wastes are collected from department. While remaining material such as soil, cow dung, and coconut shell, is collected from nearby areas.

D. Collection of earthworm species:

Earthworms were collected from vermicomposting center, located in Zilla Parishad Office, Pune.

E. Collection of Samples:

Vermicomposting was done for 4 weeks and samples were collected after 7 days, 14 days & 21 days from all the beds and analyzed for their nutrient composition.

III. EXPERIMENTAL SETUP

Two sets of experiments were conducted in the current study.

B1	Soil + agricultural waste + cow dung (1:1)
B2	Soil + paper waste +cow dung (1:1)

IV. LAYERS USED FOR VERMICOMPOSTING

Followings are the layers used for vermicomposting process:

LAYER	INGERIDENTS
7 th Layer	Soil (2cm)
6 th Layer	Cow dung (2 cm)
5 th Layer	Earthworm species (1 cm)
4 th Layer	Agricultural waste, paper waste, etc.(3 cm)
3 th Layer	Soil (3 cm)
2 th Layer	Coconut shell (3 cm)
1 th Layer	Liner (1 cm)

V. EXPERIMENTAL-DESIGN OR VERMICOMPOSTING

The vermicomposting was done in Plastic Pots under shed condition. In this 2 set of experiment were conducted for vermicomposting. In each set of experiment two different type of waste was used. In this experiment, two pots B1& B2 were arranged. The important factors i.e. moisture and temperature were controlled by means of spraying water on the bed thereby, the temperature was maintain about 35°C by placing wet gunny bags over bed and moisture was maintained between 50-60%. 20 adult Eisenia Fetida were introduced in each tray. The appearance of black powder on top of vermin beds indicates harvest stage of compost. Watering was stopped for 5 days at this stage and vermicompost was collected from the top without disturbing the lower layer.. Liner is being provided at the bottom of the boxes to prevent leachate percolation through ground so as to prevent ground water pollution and finally filling of material is done in the pots.

VI. PREPARATION OF BOXES

Vermicomposting can be prepared in concrete tanks, wooden boxes, and plastic boxes or mud pots. Depending on the material available and land it may vary.. We are taking the plastic boxes for our project work.

Fig. 1: Preparation of vermin bed

VII. CHEMICAL ANALYSIS

In the process study, the pit was filled up with different solid waste contents with use of Eisenia Fetida earthworm species. To maintain the moisture content in the pit, the water was sprinkled on the pit. The initial characteristics and periodic characteristics of the solid waste were analyzed during the period of two months. The parameter studied were pH, N, P, K, C/N Ratio, OC, EC, etc. The analysis was carried out in four sets 0, 7, 14, 21 days span. The 7 days analysis was done during the month of January, 2017 and 21 days during at the end of the month of February, 2017. The results are shown in the table (with respective parameter) 1 and 2.

Sr. no	Parameters	Initial	B1	B2
1.	pH	7.35	7.14	6.67
2.	EC	3.70	3.64	3.12
3.	OC	21	19.7	18.8
4.	TN	0.90	0.98	1.02
5.	TP	0.20	0.23	0.24
6.	TK	0.17	0.24	0.34
7.	C:N	23.45	20.01	18.43

Table 1: 7 days analysis of sample

Sr. no	Parameters	B1	B2
1.	pH	6.88	6.75
2.	EC	3.49	2.88
3.	OC	17.9	16.3
4.	TN	1.15	1.18
5.	TP	0.26	0.28
6.	TK	0.37	0.53
7.	C:N	12.3	10.5

Table 2: 21 days analysis of sample

VIII. RESULT AND DISCUSSION

A. pH:

The pH of solid waste was checked after 7 days and 14 days. For, the initial 7 days the pH decreased. The lowering of pH due to productions CO2 which is an acidic gas and when it comes in contact with water it forms carbonic acid, due to which pH get decreased.

The initial pH value of all pits is 7.35. The values after 7 days of B1, B2 were 7.14, 6.67 respectively. The values after 14 days value of B1, B2 were 6.97, 6.89. The values of pH after 21 days were 6.88 and 6.75 resp. The variation in pH with respect time (days) is as shown in graph number 1.

B. Electrical conductivity:

The electrical conductivity of all the bed was considerably decreasing during the process. The reduction of EC in all beds shows the reduction of salinity considerably. The lower level of salinity is the essential character of good bio compost which is better for crop growth. The low value of EC shows the greater the decomposition rate. A decrease in the values of EC in vermicompost may be due to the presence of exchangeable Ca, Mg, and K.

The initial EC value of all pits is 3.70. The values after 7 days of B1, B2 were 3.64, 3.12 respectively. The values of B1, B2 after 14 days were 3.51, 2.97. The values of EC after 21 days were 3.49 and 2.88 resp. The variation in EC with respect time (days) is as shown in graph number 2.

C. Organic Carbon:

Organic Carbon loss has been observed during the vermicomposting process. Earthworm modifies layer conditions, which consequently affects carbon losses from the layers through microbial respiration in the form of CO_2. A large fraction of organic matter was lost in the initial layer because CO_2 by the end of the vermicomposting period.

The initial OC value of all pits is 21. The values after 7 days of B1, B2 is 19.7, 18.8, respectively. The values of B1, B2 after 14 days were 18.2, 16.6. The values of OC after 21 days are 17.9 and 16.3resp. The variation in OC with respect time (days) is as shown in graph number 3

D. Total Nitrogen:

The TN present in the vermicompost is depending upon the nitrogen content of waste used. The TN is increasing about 12% to 16% due to the recycling of Nitrogen in the process. The TN in the graph shows increase during every interval.

The initial TN value of all pits is 0.90. The values after 7 days of B1, B2 were 0.98, 1.02 respectively. The value of B1, B2 after 14 days were 1.12, 1.14. The values of TN after 21 days are 1.15 and 1.18 resp. The variation in TN with respect time (days) is as shown in graph number 4.

E. Total Phosphorous:

The TP in the graph shows increase during each interval. The earthworm increases phosphorous in soils. The increase in TP content reveals that the vermicomposting process is in great order.

The initial TP value of all pits is 0.20. The values after 7 days of B1, B2 were 0.23, 0.24 respectively. The value of B1, B2 after 14 days is 0.25, 0.26. The values of TP after 21 days are 0.26 and 0.28 resp. The variation in TP with respect time (days) is as shown in graph number 5.

F. Total Potassium:

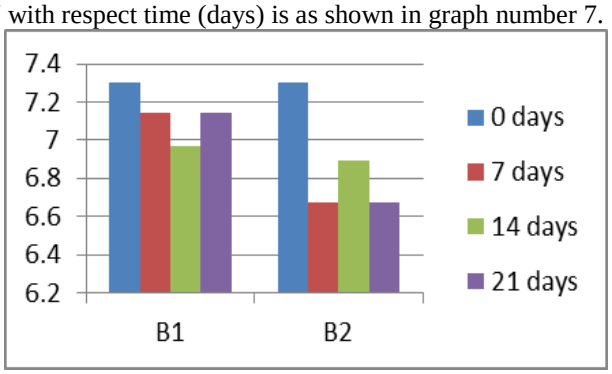
The increasing content of TP shows that the composting is taking place in well order,.

The initial TK value of all pits is 0.17. The values after 7 days of B1, B2 were 0.24, 0.34 respectively. The value of B1, B2 after 14 days is 0.31, 0.47. The values of TK after 21 days are 0.37 and 0.53 resp. The variation in TK with respect time (days) is as shown in graph number 6.

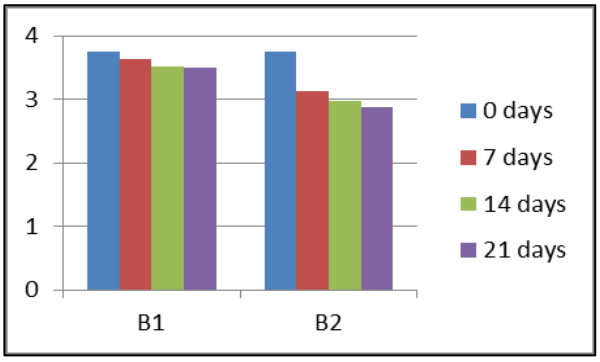
G. C: N Ratio:

The C/N ratio gradually decreases. The carbon content was utilized present in the organic waste as source of energy for earthworms. Simultaneously, the Nitrogen is being converted in the compost. During this process, earthworm enriches the nutrients such as N, P, and K and results the bio compost as an organic fertilizer. For good compost the C/N ration is about 15 to 20:1. But the C/N ratio depends upon the quality of organic waste used.

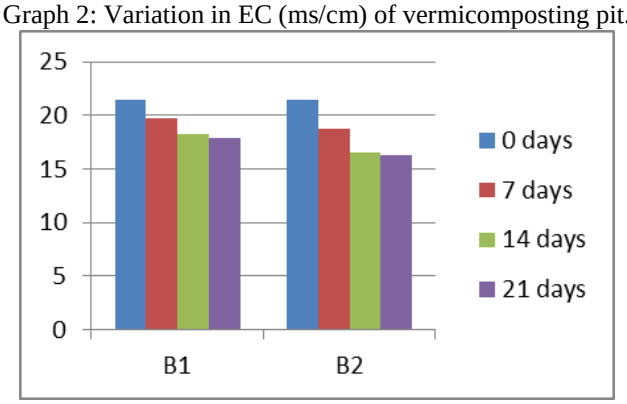
The initial C: N value of all pits is 23.45. The values after 7 days of B1, B2 were 20.1, 18.43 respectively. The values of B1, B2 after 14 days is 16.25, 14.56. The values of C: N after 21 days is 12.3 and 10.5 resp. The variation in C: N with respect time (days) is as shown in graph number 7.



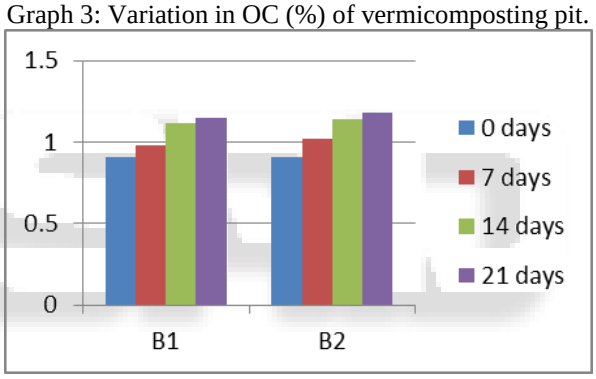
Graph 1: Variation in pH of vermicomposting pit



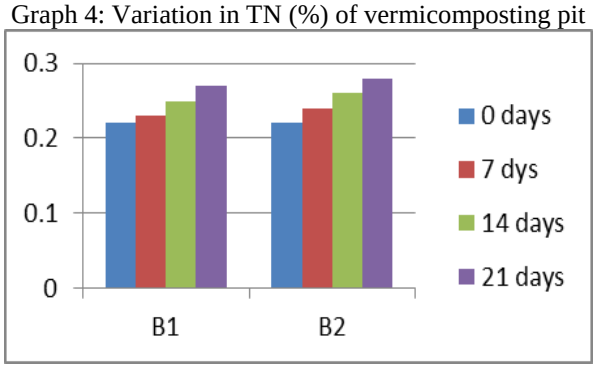
Graph 2: Variation in EC (ms/cm) of vermicomposting pit.



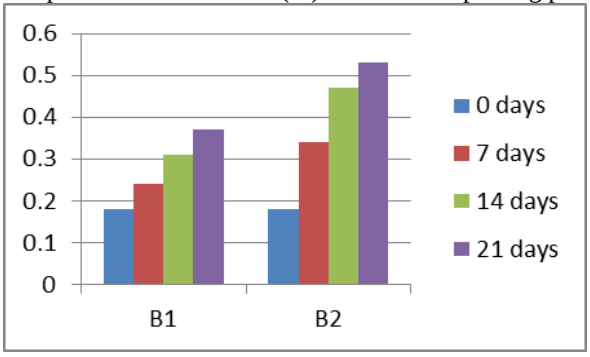
Graph 3: Variation in OC (%) of vermicomposting pit.



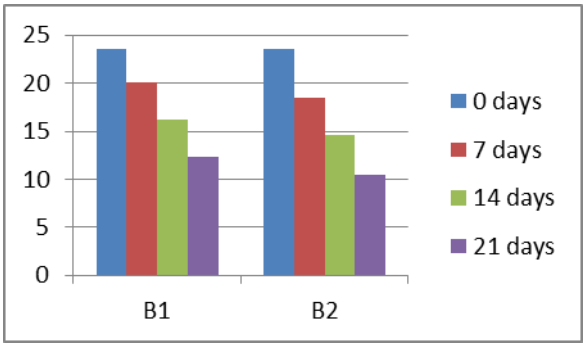
Graph 4: Variation in TN (%) of vermicomposting pit



Graph 5: Variation in TP (%) of vermicomposting pit.



Graph 6: Variation in TK (%) of vermicomposting pit



Graph 7: Variation in C:N of vermicomposting pit.

IX. Conclusion

Vermicomposting of different wastes such as paper waste, agriculture waste were done for degradation of solid wastes. Vermicompost which is nutrient rich end product was used as a effective natural fertilizer with no environmental hazards. Different vermibeds were prepared for different wastes and were treated for four weeks. Every week the vermicompost were analyzed for the presence of nutrients such as phosphate, total organic matter, chloride, carbon, calcium carbonate and sulphate are decreased considerably.

pH and moisture content were also determined every week for different vermicompost. Rate of decomposition and mineralization becomes faster with optimum moisture content. Moisture content of 60-70% was proved having maximum microbial activity and 50% was the minimum requirement for rapid increase in microbial activity.

Vermicomposting is considered superior to other type of compost because of its quality. Following are some conclusions of the present study at the end of vermicomposting process:

1) pH & moisture content decreases continuously.
2) Value of N, P, K increases & it better for crop growth.
3) C:N ratio was observed to be decreasing day by day which is helpful for agricultural purpose.

X. Advantages of Vermicomposting

- It reduces soil erosion and reduces flood hazards.
- Increase the soil layer thickness every year.
- It multiplies the microbial population.
- No chemical treatment is needed to seeds.
- It does not have any adverse effect on soil, plant, and environment.
- It increases the water holding capacity of soil.

XI. Disadvantages of Vermicomposting

- Emissions of ammonia, carbon dioxide, methane, and nitrous oxide, especially in the early stages.
- Run-off from the compost piles must be controlled to prevent movement of nutrients into ground or surface water.
- Moisture must be managed throughout the composting process.

XII. Future Scope

- Vermicomposting used for different type of crops & studied their characteristics (Growth, productivity, etc.)
- Various type of Earthworm species used for various types of solid waste can be studied in future.

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