Windrow Composting of Vegetable Waste Using Naturally Available Activated Material

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Abstract: Composting is one of the most common methods of recycling organic matter back into the soil to improve the soil quality and fertility. In the present study, composting of vegetable waste is done with easily decomposable activated material (AM) such as cow dung and poultry manure along with dried straw and green leaves as bulking agents. In the first attempt, the windrow piles were set-up which consisted of different combinations of vegetable waste, along with AM and bulking agents. Secondly, a comparative study was carried out where the effects of AM on temperature, pH, moisture content, TOC, TN, C: N ratio, etc., during the composting process was studied. Among all the PILES, PILE-2 (with cow dung as AM) maintained a higher range of temperature, pH (7.83) and moisture content (76.323%) throughout the composting period. An increase in TN and reduction in TOC was also observed in PILE-2, which indicates faster rate of organic matter degradation, as a result, C/N ratio of finished compost in this case showed significant reduction. Hence PILE-2 showed the best results. Therefore, according to the present study, cow dung is one of the combinations of waste materials which may serve the purpose during composting process.

Key Words: —*Activated material (AM), Composting, Cow dung, Poultry manure.*

I. INTRODUCTION

With the increase in population and urbanization the amount of waste generated is increasing tremendously, these wastes not only have disposal constraints but also pose a serious threat to the human health and environment and toxicity to beneficial micro flora and fauna in the soil (Giuntini et al., 2006). Moreover, In India about 320 million tonnes of agricultural waste is generated annually, in which the vegetable waste contributes the major proportion. When the vegetable waste is dumped along with municipal solid waste (MSW), it contributes a major greenhouse gas emission through decomposition processes. Composting is considered the most appropriate environmentally acceptable method of waste treatment. Composting is a natural process in which microbes are allowed to feed on organic matter and in this process, they produce humus (i.e., also called as compost) along with H2O, CO2 and heat. The heat produced in this process can destroy pathogens and weed seeds.

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II. OBJECTIVES

To carry out the window composting of vegetable waste with an easily decomposable activated material such as poultry manure and cow dung.

To carry out comparative study on the effects of activated material on various physico-chemical and biological parameters such as temperature, pH, moisture content, TOC, TN, C:N ratio, OUR, CO_2 evolution rate etc., during composting process.

III. MATERIALS AND METHODS

3.1 Compost materials

Vegetable waste, cow dung, poultry manure, dried straw, and green leaves were used for the preparation of three sets of PILES. The vegetable waste for this project was collected from mess of North Eastern Regional Institute of Science and Technology (NERIST) girl's hostel and all the objectionable materials were separated at the generation place itself. The collected vegetable waste was then taken to the site for making the PILES.

3.2 Experimental setup

Composting experiment was carried out in a temporary shed of size 5mx5m, which was constructed in NERIST, where 3 sets of PILE was maintained for each AM. Composting PILES of approximately 5.0 ft. ×2.0 ft. ×1.0 ft. (length× width× height) was formed and composted for 90 days. Each PILE consisted of vegetable wastes mixed with AM (except for PILE 1), bulking agents and sprinkled with water. The mixture was in the ratio of 5: 2: 1 (i.e., 5 parts of vegetable waste + 2 parts of bulking agents + 1 part AM)

- PILE 1: It consisted of Vegetable waste, dried straw, green leaves, sprinkled with water.
- PILE 2: It consisted of Vegetable waste, dried straw, green leaves, Cow dung and sprinkled with water.
- PILE 3: It consisted of Vegetable waste, dried straw, green leaves, and poultry manure, sprinkled with water.

IV. Results And Discussion

4.1 Physico-Chemical Analysis

4.1.1 Effect of AM on temperature

Temperature is an important indicator of composting, which determines the rate of organic matter decomposition. High temperature maintained during composting serves to promote efficiency and effectiveness of compost by accelerating the process and by destroying pathogenic microorganisms, on the other hand, low temperatures retards the composting process. Low temperatures during composting process are an indication of reduced microbial activity and a lack of oxygen or inadequate moisture conditions. (*Roger et al.,1991*). In the present study, the temperature at a depth of 20 cm from the top of the pile was measured with a compost thermometer during the composting process. The change in temperature as observed in PILE-1, PILE-2 and PILE-3, is presented in fig.4.1 (a).

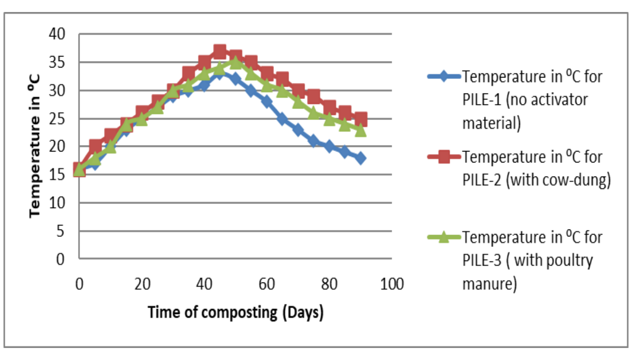

Fig.4.1 (a) Change in temperature (ºC) during different stages of composting

4.1.2 Effect of AM on pH

The pH was measured for all the three piles and the testing for pH were done by using pH meter for an interval of 5 days. For the better biodegradation of composting materials, the pH value should not be very basic and very acidic it should be between the ranges of 6-8. Fig. 4.2(b) illustrates the influence of AM on pH during composting process.

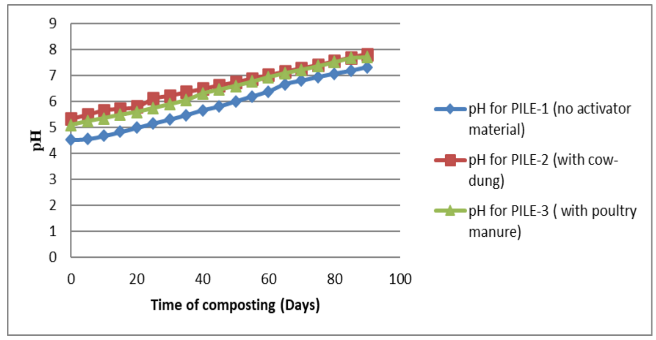

Fig 4.1(b) pH variations with time for three piles

4.1.3 Effect of AM on moisture content

The optimum moisture content in the composting environment should be in the range of 60-80% for microbial activity (*TMECC, 2002)*. The moisture content was observed to increase gradually from 0-25 days and it reached its peak value during 25'Th day (74.99%, 76.323% and 75.95% in PILE-1, PILE-2 and PILE-3 respectively) and finally it gradually reduced as the composting progressed. Moisture content of PILE-2 and PILE-3 were found to be much higher than PILE-1 as shown in the fig.4.2 (c).

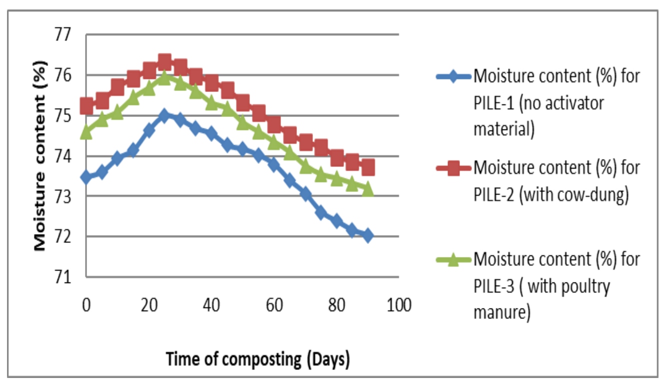

Fig 4.1(c) moisture content variations with time for three piles

4.1.4 Effect of AM on EC

The EC value of compost shows the degree of salinity in the composting and its possible phytoxicity effects on the growth of plant. Higher EC values in final composts slow down plant rooting and reduce the transportation of water and nutrients into the plants (*Chiang et al., 2007*). EC value was measured at an interval of 7 days. It was found that EC value increased from 0.77 dS/m on day 0 to 2.45 dS/m at the end of 90 days in PILE-1, 0.77 dS/m on day 0 and 2.86 dS/m at the end of 90 days in PILE-2 and 0.77 dS/m on day 0 to 2.78 at the end of 90 days on PILE-3. EC value was lowest in PILE-1(with no AM) which shows number of soluble salts is less in it. However, it was observed that EC values of all the three piles were less than 3 dS/m, which would not affect the growth of slightly salt tolerant plants.

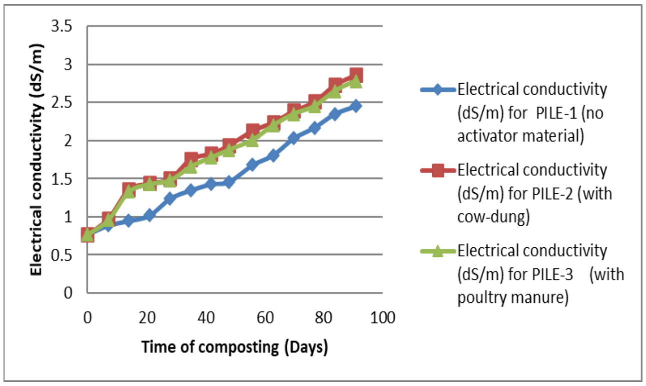

Fig.4.1(d) EC Variations with time for three piles.

4.1.5 Effect of AM on TOC, TN, and C/N ratio

The effect of AM on total organic carbon (TOC), total nitrogen (TN) and C/N ratio was studied at an interval of 10 days. During the composting process CO_2 is produced as a metabolic end product and as the decomposition proceeds there is reduction in organic carbon content. Similar reports were observed in the present study with decrease in carbon content as the composting progressed. Fig.4.1 (e) explains the significant reduction of TOC in all the 3 piles. An increase in total nitrogen content was observed in PILE-2and PILE-3 samples, which indicates faster rate of organic matter degradation. As a result, C/N ratio of finished compost in these cases showed significant reduction. In the present study it was observed that the nitrogen content increased as the degradation progressed, which can be clearly seen in fig. 4.1(f). A good proportion of carbon and nitrogen in a composting substrate provide a balanced diet for micro-organisms along with enough energy source and protein for optimal growth and reproduction. The composting process depends upon the action of microorganisms, which require a source of carbon to provide energy and a supply of nitrogen for cell proteins. On day 0 the C: N ratio was noted to be 26 in all the three piles which showed the decreasing trend and reached till 11, 13 and 12 in PILE-1, PILE-2 and PILE-3 respectively, At the end of 90 days as shown in fig.1.4(g).

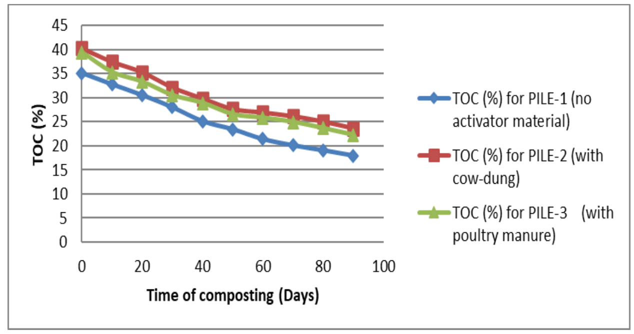

Fig.4.1(e) TOC variations with time for three piles.

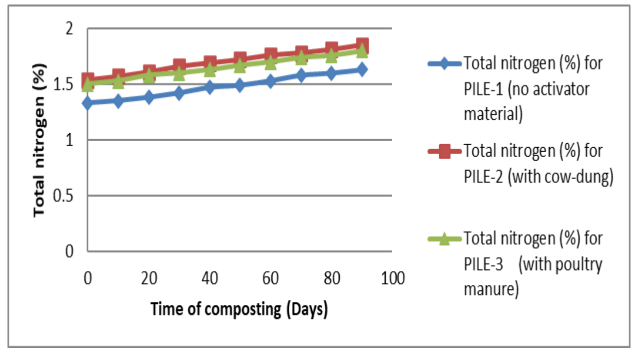

Fig.4.1 (f) TN variations with time for three piles.

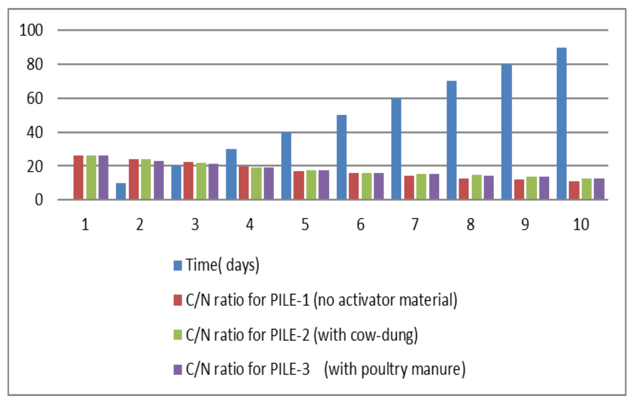

Fig. 4.1(g) C: N ratio variations with time for three piles.

4.2 Biological Characteristics

4.2.1 Effect of AM on CO_2 evolution rate and the oxygen uptake rate (OUR)

OUR and CO_2 evolution rate were measured at an interval of 10 days. OUR and CO_2 evolution rate are important parameters which can be used to measure the stability of compost. Unstable compost has high demand of oxygen and high evolution of CO2. Hence with different combinations of AM different degradation pattern was observed. Due to higher microbial action on organic content of vegetable waste mix, higher amounts of $C0_2$ were observed in the initial days. The CO_2 evolution rate decreased from 16.15, 17.32, and

17.07 mg/g VS/d to 2.55, 3.87 and 3.59 mg/g VS/d in PILE-1, PILE-2 and PILE-3 respectively at the end of 90 days. OUR is one of the most important stability parameters of the composting. It is a measure of microbial activity in the compost. More the oxygen uptake rate more is the rate of decomposition. OUR is found high in all the three piles, which is an indication of high microbial activity, such materials can be very much suitable for composting process. In the present study it was found that initial value of OUR ranged from 21.853, 21.998 and 21.894 mg/g VS/d which denoted higher microbial activity, and finally reduced to 2.195, 3.156 and 4.762.694 mg/g VS/d in PILE-1, PILE-2 and PILE-3 respectively. The lower values of OUR at the end of 90 days clearly states that the vegetable waste was completely degraded by the microorganisms and was converted to a stabilized compost.

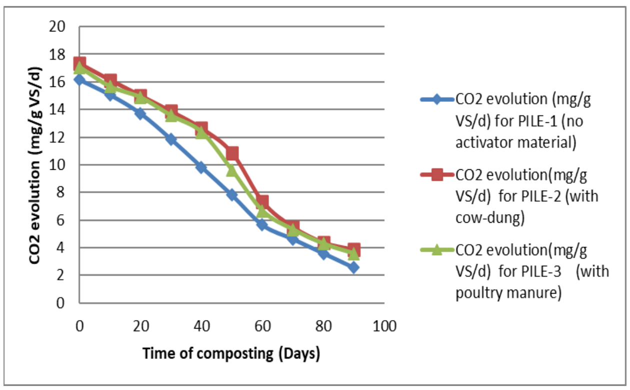

Fig.4.2 (a) CO_2 evolution with time for three piles

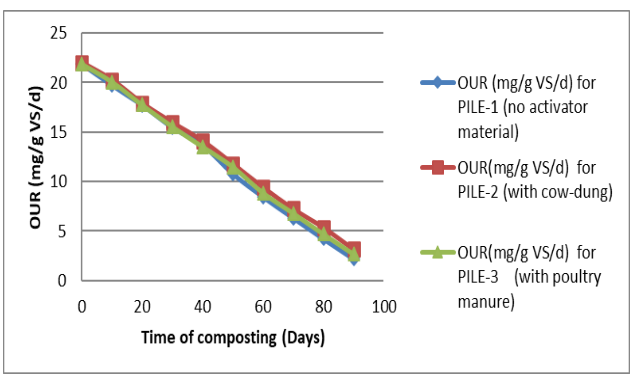

Fig. 4.2(b) OUR variations with time for three piles

V. Conclusion

In the present study it was found that among all the PILES, PILE-2 (with cow dung as AM) maintained a higher range of temperature, pH (7.83) and moisture content (76.323%) throughout the composting period. An increase in TN and reduction in TOC was also observed in PILE-2, which indicates faster rate of organic matter degradation, as a result, C/N ratio of finished compost in this case showed significant reduction. Hence PILE-2 showed the best results. Therefore, according to the present study, cow dung is one of the combinations of waste materials which may serve the purpose during composting process. The result shows that, during the composting of vegetable wastes the addition of animal manure can enhance the degradation process, Nevertheless, the compost provided must comply with the standard limit to ensure the quality of the compost.

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