Journal of Scientific and Technical Research
14 (2) 2024, 41-46
http://www.publishingindia.com/jstr

Sustainable Campus Approach: A Case Study of Sharda University Composting Plant

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Abstract: Actual meaning of education is not just only narration but its ground application. Any organization with fooding and lodging facility produces some amount of food and vegetable waste on a daily basis. In general a malpractice of disposing food and vegetable waste with municipal solid waste & further opting incineration and landfilling method is both uneconomical and non-environment friendly hence in-house composting system can be the most suitable alternative to this malpractice. This study was conducted to showcase and investigate the working of composting plant present at prestigious Sharda University campus. The study was conducted in a one cubic meter composting pit in which the food and vegetable waste collected from campus itself almost weighing 38.6 kg were used in the composting process for a time period of 21 days. Apart from temperature which was noted regularly, all the essential parameters of the composting process were analyzed after fixed interval of 7 days. It was found that the temperature reached the thermophilic phase after 5 days of composting period. pH reached the basic range of 8.5. Similarly, all other parameters like EC, moisture content, Carbon content, nitrogen content etc. were all analyzed and their contribution to efficiency of the composting process as well as remedial approach towards betterment of composting plant was illustrated.

Keywords: Leachate, Mesophilic, Methanogenesis, Segregation, Shredding, Thermophilic.

I. Introduction

With the increase in population, the environment is being polluted simultaneously by food and vegetable wastes which is turning out to be a very common and serious problem as both food and environmental security are at risk, global cities now generate more than 1.3 billion metric tons of solid waste each year, nearly twice as much as they did ten years ago (Bhada-Tata *et al.,* 2012) [1]. To reduce this risk, the composting method can be brought into use to turn this organic and biodegradable waste into organic fertilizer which again can be used for growing fruits and vegetables. If this technique is not adopted the current disposal technique observed in general is the incineration and landfilling which are environmental hazards.

According to Johri *et al.* (1999) [2], composting is a thermogenic, solid-state fermentation process that is carried out by a series of microbial communities, starting with mesophilic bacteria, actinomycetes, and fungus, then thermophiles, and finally returning to mesophiles. The composting process has three primary phases: mesophilic phase, thermophilic phase, and maturation phase. In the mesophilic phase the temperature lies between 20 °C – 40 °C, in the thermophilic phase the temperature lies between 45 °C to 70 °C while in the maturation phase, the temperature generally decreases back to the ambient temperature. Proper aeration plays an essential role in the composting process to support microbial activity, heat regulation, odor control, homogeneous decomposition, etc. (Tiquia *et al.,* 2002) [3]. In addition to these optimum moisture content is also a crucial parameter in the composting process.

Our kitchens produce a greater amount of organic waste, such as vegetable peels, fruit cores, eggshells, and coffee grounds. If randomly dumped, food scraps decompose through a process known as methanogenesis, releasing methane, a greenhouse gas 25 times more potent than carbon dioxide at trapping heat in the atmosphere. Therefore, proper composting technique is required for its efficient management at the in-situ level to provide economical and environmental benefits.

While there is extensive literature on composting organic waste with bulking materials, there are few studies on composting using crushed dry leaves and shredded food and vegetable wastes. This study focuses on food waste composting and the role of bulking agents under the domain of a University Campus with a hostel mess and staff residential quarter facility. The study primarily assesses physicochemical changes during the composting process to scrutiny the effectiveness of compost.

II. Materials and Methods

Study Site

The study was conducted at a composting plant, multi-level car parking block basement, Sharda University located in Knowledge Park III, Greater Noida, India (lat. 28.471956°, log 77.483761°) in an open environment given the regular atmospheric temperature.

Experimental Setup and Monitoring Process

The Composting experiment utilized a customized composting pit at the Sharda University composting plant. The prime material used was food and vegetable waste collected from the university mess and residential staff quarters. As noticed every day around 1500 kg of vegetable and food waste is delivered to the university composting plant via cart in plastic crates of volume 55 liters each, after shredding with shredder available at plant, the same waste decreases to weight around 1000 kg. The composting pit had a dimension of 1 x 1 meters and in that pit food and vegetable waste was transferred to a height of 1 meter.

Dry leaves were collected from within and around the university campus. Then it was shredded using leaf shredder available at the composting plant itself. In shredded form, they were used as a bulking agent as they are carbon-rich and help to improve aeration, maintain the C/N ratio, and balance moisture in the composting process.

Lime powder, also called agricultural lime, was brought ready-made from the market and used in the pit to neutralize the acidic compost and improve the conditions for decomposition.

Cow manure was arranged locally from around the university campus and was added as a valuable nitrogen source to fuel the decomposition process. Fresh manure was avoided because of the availability of a lot of moisture.

The composting pit of dimensions (1 x 1 x 1) meter was filled to the top with shredded food and vegetable waste which weighed around 38.6 kg and was mixed with dry leaves and lime powder in alternate layers weighing randomly then the top of the pit was covered with a metallic sheet provided with an opening for aeration purpose.

This entire setup was kept undisturbed for 21 days while in this period all the physio-chemical parameters of the compost were analyzed at fixed intervals of time. A typical sample of approximately 500 grams of weight was taken from the top, middle, and bottom of the pit. After that sample was put in an oven at the environmental engineering lab for 24 hours at around 80 °C, then this sample was grinded in the mixer at the lab itself, further, the sample was sieved through a 0.2 mm mesh filter. Now the sample obtained was utilized for the essential parameter analysis through respective instruments present in the university. Digital thermometers were used to keep track of the temperature during the composting process. In compost pits, temperature was gauged at three points every day to keep track, and the mean temperature was recorded. The entire composting process followed at the composting plant is illustrated in Fig. 1.

Fig. 1: Experimental Flowchart

III. Result and Discussion

Temperature is an important parameter in any composting process. It is divided into three phases namely mesophilic, thermophilic, and maturation phases. The thermophilic phase is most suitable for microbial action in the composting process. This phase was observed to be attained after 5th day of the composting period. The temperature of the pile may be a direct indicator of the microbial activity and composting process (Chen *et al.,* 2020) [4].

pH is one of the key elements that greatly influences the composting process. It changes significantly over the composting process (Sharma *et al.,* 2024) [5]. Degradation of short-chain fatty acids can also cause the pH to rise as reflected in this experiment the pH increased gradually from day 1 to day 21. On day 1 the pH read the value of 5.61 and on the last day of the composting period pH value turned out to be in the basic range of 8.15.

Electrical conductivity (EC) is the measure of the amount of soluble salts being released from decomposing organic material in a solution (Wichuk and McCartney*,* 2010) [6]. The electrical conductivity in this experiment showed a gradual increase in its value from 2.04 to 2.57 mS/cm. This increase in EC value indicates decomposition in organic matter and nutrient accumulation.

Table I: Temperature Variation Table

Date	*Days*	*Ambient Temp*	*Point A*	*Point B*	*Point C*	*Average Temp*
20/4/24	1	30.5	26.7	26.3	26.1	26.3
21/4/24	2	27.9	30.5	29.1	27.9	29.1
22/4/24	3	28.0	33.1	33.3	33.4	33.2
23/4/24	4	30.1	38.3	34.5	35.2	35.2
24/4/24	5	28.9	36.4	36.5	36.2	36.8
25/4/24	6	31.2	43.4	43.8	44.1	44.3
26/4/24	7	29.8	44.6	43.1	43.8	44.9
27/4/24	8	30.5	44.1	43.7	44	45.3
28/4/24	9	31.6	43.8	44.9	44.3	45.2
29/4/24	10	31.4	42.9	43.2	43.1	43.7
30/4/24	11	37.2	47.5	47.1	47.9	48.2
01/5/24	12	31.6	40.6	34.5	35.5	35.2
02/5/24	13	31.2	35.2	33	38.3	36.9
03/5/24	14	29.7	36.8	34.6	35.3	36.2
04/5/24	15	30.5	41.2	38.9	38.4	38.7
05/5/24	16	31.6	40.6	36.6	36.9	39.2
06/5/24	17	31.4	40.2	36.8	35.7	36.2
07/5/24	18	29.2	31.1	33.1	32.6	32.9
08/5/24	19	33.9	32.7	31.9	33.1	33.1
09/5/24	20	31.8	33.2	32	32.5	32.1
10/5/24	21	34.2	34.1	34	34.1	34.1

Fig. 2: Regular Temperature Detection via Probe Digital Thermometer

Moisture level is crucial for effective composting, as it influences substrate degradation and microbial metabolism (Zhang *et al.,* 2023) [7]. The moisture content in this experiment was not maintained externally. Therefore as per observation on 1st day the moisture content read out to be 51.8% then with the de-watering of the vegetable and food waste the moisture content turned out to be 76.4% then again the moisture content showed a decline in its value to 46% on the final day of composting as no additional moisture was added during the composting period.

Carbon content is an important measure for stabilization and decomposition in the composting process. It helps to decompose organics into carbon dioxide and water (Nema *et al.,* 2021) [8]. Initially, the composting pit in this case had a good quantity of food and vegetable waste so the carbon content was a bit low 36% on the first day of observation, and then later on the 21st day of observation, it reflected the value of 41.1% indicating good amount of organic matter degradation.

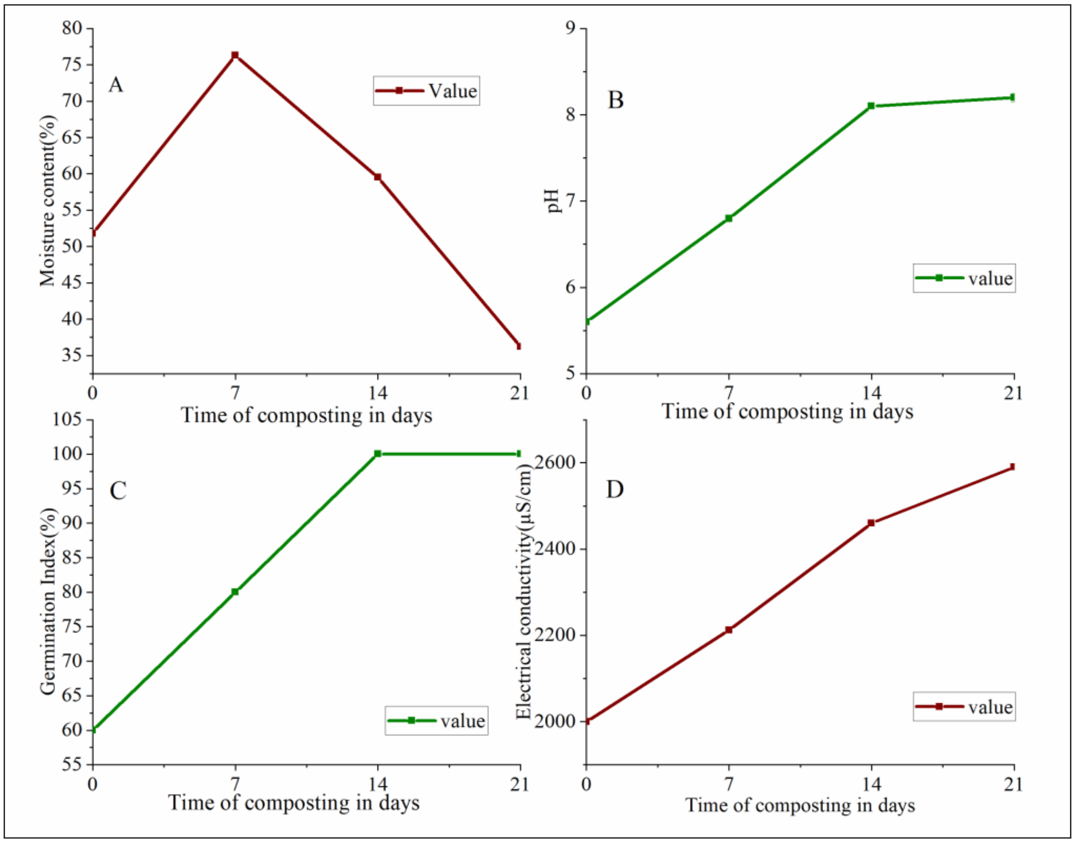

Fig. 3: Variation of (A) Moisture Content (B) pH (C) Germination Index (D) Electrical Conductivity

Nitrogen is an important factor in the reproduction and growth of microorganisms that decompose organic matter. The nitrogen content percentage decreases from 2.5 as shown on the first day of composting to the value of 0.58% on the last day of composting. It reflects that in the initial days, vegetable waste was the source of nitrogen content but as time passed due to the decomposition of organic material the nitrogen content also depreciated. Nitrogen content is a very essential parameter in maintaining the desirable C/N ratio of 25:1 in the composting process (Bernal *et al.,* 2009) [9].

The Germination Index is the indication of the phytotoxicity and maturity of compost. Feedstock with relatively high organic matter attains a 100% germination index percentage soon as reflected in this case right after the one week of composting period.

Fig. 4: Germination Index Analysis

IV. Conclusion

The case study of the Sharda University composting plant located within the campus was done to investigate and verify the processing and efficiency of the composting done there. It was found that the Collection of food and vegetable waste from all around the campus and its transportation to the university composting plant was up to the mark. Its segregation and shredding which was to be done is also a very efficient step in reducing its weight and volume. The composting process adopted in the composting pits is rapid and satisfactory as it took only 21 days but it needs to be remedified in some areas for more efficient performancethat are as follows. Firstly as it is a scientific fact that composting produces leachates (Dastyar *et al.,* 2015) [10], hence, in order to separate it from final compost a proper permanent drainage system should be provided to the composting pits. Secondly, the composting pits are properly ventilated but still aeration to the depth of the pit is not occurring so in order to remedify this aeration should be provided with either a pump or a manual rotating shaft provided through the pit. Thirdly, as observed by samples taken the initial moisture content was good due to the presence of food and vegetable waste but later as observed after two weeks in the composting period the moisture content percentage drastically reduced so in order to maintain it to an ideal moisture content 65 percent we need to add additional moisture in form of water or inoculum in the composting pit. Overall this insitu composting plant is a very sustainable approach towards food and vegetable waste management by Sharda University, many other educational, public, and private organizations should follow and appreciate its effort for better environmental conditions.

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