# A Comparative Study of Rotary Drum, Barrel and Pit Composting using Municipal Solid Waste of Guwahati City

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**Abstract:** *Guwahati, the gateway of North East India is facing scarcity of landfill for municipal solid waste (MSW) disposal due to increase in waste generation. Currently, the generated waste is being dumped into the landfill without treatment. This may lead to further shortage of dumping ground and may cause severe damage to the ecosystem. It may also contaminate the water body and the ground water of the surrounding area. Hence, an experiment was carried out at Assam Engineering College, premises in order to find a fruitful solution to mitigate the problem. In this work, three composting methods viz. rotary drum, pit and barrel composting were adopted. All the composters were filled with segregated household waste collected from the vicinity of the campus. From the series of experiments it was found that the rotary drum took least time to decompose whereas barrel composting took maximum days to alter the waste into compost.*

***Keywords***: **barrel composting, household waste, MSW, pit composting, rotary drum**

## I. INTRODUCTION

Guwahati is the biggest city in the NE India and is one of the fastest growing cities among the first 100 cities in the world. According to the 2011 census, the city has a population of 1.8 million with 3.2 lakhs households (Census of India 2011). Few years back it has been nominated as a potential smart city among the first 100 smart cities of India [1].

Solid waste management in urban area is believed to be one of the most severe ecological problems faced by the metropolitan areas in developing countries [2], [3], [4] and the city of Guwahati is one of them. Improper collection and hysterical dumping of solid waste result in a harsh health threat to the dwellers and the environment as well [5]. From the solid waste disposal point of view the city is confronting serious paucity of land but at the same time, there is an opportunity to alter the organic fraction of the waste into useful manure. Recovery of the waste such as recycling and composting is a clear option of volume reduction of the

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waste amount to be dumped. Moreover, with the help of composting, the important nutrients and organic matter can be used for soil amendment.

There are plenty of composting methods available to translate organic portion of waste into useful soil fertilizer. Some of the processes take very little time for the waste to decompose and many of them take a little longer time. In this study, three numbers of the methods were experimented in order to find an appropriate one for the MSW of Guwahati city. For all the techniques same type of waste was dumped into the composters. The waste was collected door to door from the nearby locality of the college campus. The waste was accumulated from nearly 120 households and deposited into the composters daily and the temperatures were recorded.

## II. METHODOLOGY

### Current Scenario

Currently, the un-separated waste is being gathered from the city households and accumulated into the secondary point and from there it is transferred to the dump yard. There, whole the municipal solid waste is being segregated with some mechanical devices and then send for composting. But quality of the output is not so good that it can be utilized in the agricultural land as fertilizer. The output manure is full of construction debris, glass residue and other metal contaminations. Non separation of the waste at the source might be prime cause for such impure output. However, the capacity of the composter is not sufficient enough to turn the whole some of waste into compost. Furthermore, this might be the reason for which the landfill is overflowing rapidly. If this trend of waste dumping continues in this rate, the landfill will unable to consume the whole amount waste generated by the city.

### Our Approach

In order to find a solution to shortage of landfill, three experiments *viz*. rotary drum, barrel and pit composting method have been worked out at the Assam Engineering college campus, Jalukbari. The waste was gathered from the nearby households of the campus. Each household were given two HDPE bags and requested to keep the dry and wet fraction of waste separately prior to collection. The segregated waste from approximately 120 households is collected and then brought to the campus for composting. This process of waste collection continued until all the three composters were filled.

**Barrel Composting**

To construct the barrel composter a 200 liter capacity plastic drum is taken and made ½ inch diameter holes throughout the periphery and at the bottom in a gap of 6 inch. The holes are meant to make the biodegradation process aerobic and also to leak the liquid that ooze out during the process. The drum is placed in an iron frame and a plate is put under the drum to collect the liquid. The complete arrangement is shown in fig. 1.

Inner view of the barrel Outer view

Figure. 1: Barrel composting arrangement

First of all the waste was weighed before putting into the barrel so that record of waste deposited can be maintained. Since it was household waste, it consists of both cooked and uncooked portion. A layer of waste was dumped first and then a layer of wood chip is added in a ratio of 4:1 (by weight) to maintain the optimum C/N ratio for faster decomposition. The process was repeated until the composter was full. Table 1 shows the daily waste deposited record.

Table 1: Daily waste dumping record of barrel composter

| Day | Waste Dumped (kg) |
|---|---|
| **Day 1** | 24 |
| **Day 2** | 16 |
| **Day 3** | 21 |
| **Day 4** | 18 |
| **Day 5** | 19 |
| **Total** | **98** |

The barrel got filled after dumping for 5 days and then it was allowed to decompose. During the biodegradation process the temperature was scrutinized and documented daily. Fig. 2 depicts the temperature variation curve of the waste in the composter.

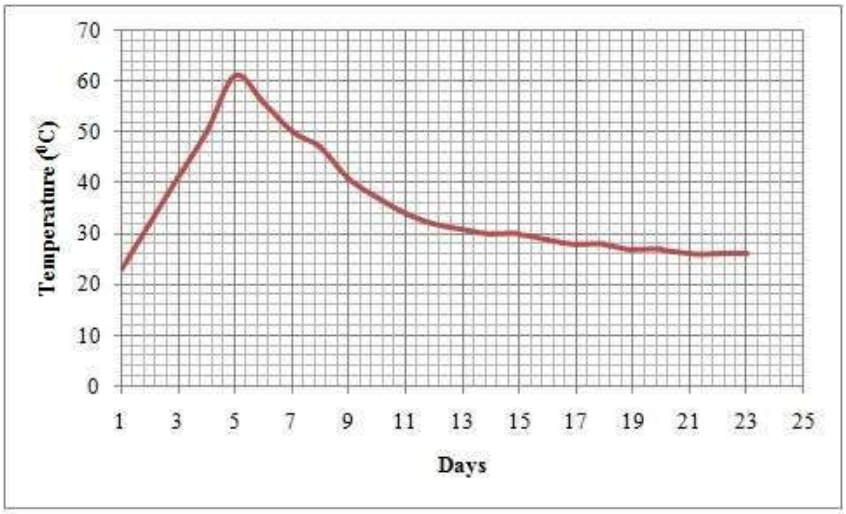


Figure. 2: Temperature variation curve of the waste in barrel composter

The temperature of the garbage normalized to room temperature after 25 days. By the time the compost of the barrel turns its color into misty brown. So, it was then withdrawn out from the composter and broadened over the floor for maturing.

**Rotary Drum Composting**

Unlike barrel composter, here also a 200 L plastic drum was taken and made ½ inch hole on the entire periphery of the container. Then two numbers holes (2 inch dia.) were made at the

middle of the top and bottom edge of the drum. The punctures on the periphery were made in order for supply of oxygen to the compost. A cylindrical shaft was put in through the drill hole on the top and bottom edge of the drum. The drum was then placed horizontal on a wooden structure as shown in fig. 3. The shaft was inserted through the middle of the composter so that it could act as an axel upon which the drum can be rotated. A metal tray was placed below the composter to collect the leachate.

Figure. 3: The rotary drum composter

The waste collected from the households was put into the composter through a small door meant for it. In this experiment also wood chips and dry leaves were mixed in the same ratio (4:1) as in the earlier method and then door was closed securely. The composter is then swiveled manually to mix the dry and wet portion of the waste. The same procedure was taken up in the following days until the composter was filled. The daily waste dumping record has been tabulated in table – 3. The composter was filled within 5 days of dumping. The composter was then allowed there to settle and let the waste to decompose further. In the mean time the temperature was observed regularly and recorded. The variation of temperature is depicted on figure.4.

Table 3: Garbage deposited record of rotary drum composter

| Day | Waste Dumped (kg) |
|---|---|
| **Day 1** | 16 |
| **Day 2** | 27 |
| **Day 3** | 12 |
| **Day 4** | 18 |
| **Day 5** | 16 |
| **Total** | **89** |

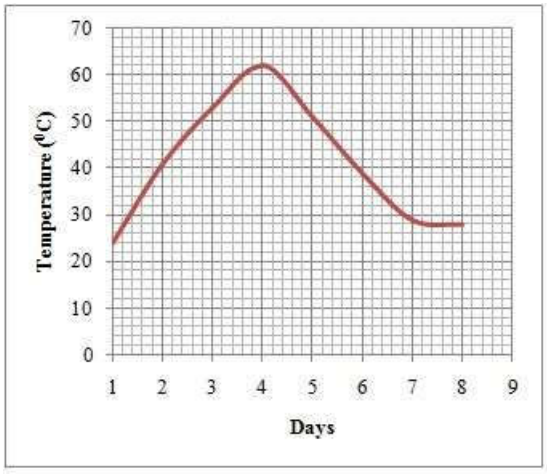


Figure. 4: Temperature variation of the garbage in rotary drum

After 8 days when the temperature stabilized the manure was taken out of the composter. By then the color of the waste turned to brownish. The manure was then spread over the floor for further curing.

**Pit composting**

In this experimental setup wooden pit was used and the reason behind making a pit with wood is the cost of preparation. The cost of making concrete pit would have been much higher than the wooden pit. Besides, wooden pit can very easily be dismantled. The pit is shown in fig. 5. The dimension of the pit is 1m x 0.5m x 0.5m (LxWxH). The pit is designed in that dimension so that the desired temperature can be achieved in thermophilic phase. A pipe with many holes drilled was inserted through the bottom of the pit in order to supply

enough oxygen naturally and the process becomes an aerobic one. The pipe was wrapped with a net so that waste particle won't enter into and choke the pipe.

Figure. 5: The wooden pit

The collected household waste was dumped into the pit daily after mixing with wood chips and saw dust as bulking agent. The ratio in which dry fraction is added is as same as the earlier two experiments. The waste dumping record has been tabulated in table 4. Before putting fresh waste into the pit, everyday, the existing waste on the pit was turned manually for better aeration. The composter took 7 days to get filled and total waste dumped was 148 kg. Unlike the earlier two experiments, temperature was recorded regularly to check the different phases of the composting processes. The temperature curve is shown in fig. 6

Table 4: Waste dumped record of wooden pit

| Day | Waste Dumped (kg) |
|---|---|
| **Day 1** | 31 |
| **Day 2** | 22 |
| **Day 3** | 24 |
| **Day 4** | 19 |
| **Day 5** | 21 |
| **Day 6** | 18 |
| **Day 7** | 13 |
| **Total** | **148** |

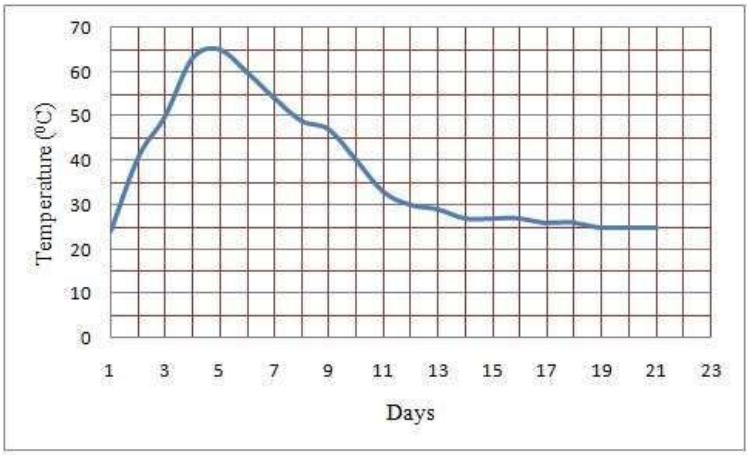


Fig. 6: Temperature variation of the garbage in wooden pit

## III. RESULT AND DISCUSSION

The temperature curves show that the mesophilic and thermophilic stage of all the three composting methods took 7 days to 21 days depending upon the composter. The rotary drum composter took least time of 7 days whereas barrel composter took the maximum time of 23 days. The biodegradation of waste in rotary drum was much faster compared to the other two composting techniques. These might be due to the mixing of the garbage in rotary drum enhanced the supply of oxygen and thus accelerated the degradation process. The rise in temperatures in all the cases were more than $60^0$ C, which indicates killing of harmful pathogenic micro-organism and can be used as manure [6]. The curing stage for all the three processes were undergone for another 7/8 days and by then the color of the manure turned to dark brown and smelled like soil.

Table 5: Different characteristic parameter of the compost samples

| Parameters | Rotating Drum Composter | Barrel Composter | Pit composter |
|---|---|---|---|
| Moisture content (%) | 38 | 34 | 36 |
| pH | 7.6 ± 0.1 | 7.12 ± 0.03 | 8.07 ± 0.03 |
| EC (dS/m) | 3.43 ± 0.17 | 3.51 ± 0.09 | 6.93 ± 0.21 |
| Volatile solids (%) | 29.99 | 24.67 | 46.35 |
| Total Organic Carbon (TOC) (%) | 16.66 | 13.71 | 25.14 |
| Total Kjedahl Nitrogen (%) | 1.64 | 1.45 | 1.22 |
| Total Phosphorous (%) | 2.88 | 2.24 | 2.50 |
| Na (g/kg) | 12.05 | 5.31 | 6.85 |
| K (g/kg) | 20.8 | 25.45 | 12.43 |
| Ca (g/kg) | 22.3 | 33.25 | 17.35 |

The test results for all the three processes are shown table 5. The different compost parameters of the samples show nearly equal values. Moreover, the nutrient contents in rotary drum composter are better than the other two methods. Apart from Potassium (%) content, which is slightly less in compost produced from rotary drum composter, the total Kjedahl Nitrogen (%) and Phosphorous (%) content are more. These three parameters (N, P & K) are some of the most essential plant nutrients to be present in the organic manure.

## IV. CONCLUSION

These experiments suggest that all the composting procedures yielded nearly same quality of manure and can be used in agricultural field for soil improvement. But the times taken by them are different. The biodegradation of the garbage in barrel composter took 23 days, wooden pit took 21 days while rotary drum composter took 8 days only to complete. If the municipal authority of Guwahati treats the organic part of the waste through rotary drum composting, a bulk volume can be processed in a short period of time.

This work further suggest that if the waste can be handled in decentralized location of the city and implements rotary drum composting technique instead of treating in a central location, transportation cost the garbage will be reduced to a great extent. Additionally, the municipal authority may even make some revenue by selling the manure.

## V. ACKNOWLEDGEMENT

We extend our heartiest gratitude to the college authority for providing us the space for conducting the experiments and allowing us to do so in the campus. We also thank our students those who helped us in collecting the waste from door to door. Finally, our sincere thanks are extended to the families of the nearby area for cooperating with us and given us the segregated waste.

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