Rotary Drum Composting of Flower Waste

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Abstract - *In India about 300 MT/day flower waste produced which are either mixed with municipal solid waste or thrown in river. Flower waste is good source of organic matter and nutrients which are beneficial for plants growth. Aim of the present study was composting of flower waste by using rotary drum technique. For composting, flower waste was mixed with cow dung, saw dust, and wheat bran. Cow dung acts as inoculum whereas saw dust and wheat bran as bulking agents. Physico-chemical changes were evaluated for forty-five days. Physico-chemical parameters such moisture content, Electrical Conductivity, Potassium, Phosphorus, pH, and temperature, C:N ratio and Total Organic Carbon were evaluated. Two different trials were performed and from the series of trials 1-2 the different proportions of cow dung were 5:3 (kg) and 6:2 (kg) respectively. Finally the compost produced by both trials were found to have pH 6.5 to 7.5 , Electrical Conductivity 1.5 to 3 (mS/cm), reduction in the total percentage of carbon 22 – 33%, percentage of the increase in Nitrogen 1-2 %, C:N ratio 15-22, Moisture content and phosphorus was decreased and potassium was increased.*

Key Words: **Rotary Drum, Flower Waste, Composting, Vessel Composting, Leachate**

1. INTRODUCTION

1.1 General

The disposal of solid waste is a big challenge both in the rural and the urban areas. The waste generation in India is 400–600 gram/capita/day. Due to the huge production of waste, the availability of land for land filling is increasing. Land filling requires a large area of land which is very costly and that land can be used for other purposes. The municipal waste generated contains 70% of organic waste which are the vegetable waste, flower waste, fruit waste, etc. Most of the municipal waste used for land filling produces leachate and pollute the groundwater of the surrounding area. Land filling causes air pollution and is a threat to the environment.

The setting for present study happened to be Surat, one of the fastest growing cities of India in the state Gujarat which is located on the banks of river Tapti. The city is situated at 72.83° east longitude and 21.17° north latitude. Surat alone generates solid waste of 1700 ton/day. Among the wastes, the generation of flower waste is 1500 kg/day. The flower waste contains organic materials which are easily degradable and are a good source of macro and micronutrients. Composting is the best option for degradation of the flower waste. The conversion of organic waste available into compost is anoption for disposal. The compost obtained from flower waste is an alternate for the replacement of chemical fertilizers. Chemical fertilizers decrease the fertility of soils whereas compost will increase the organic content of the soil. The compost also increases the water holding capacity of the soil and reduces soil erosion.

1.2 Need of Study

Composting is a potential recycling process in which the resources are conserved in a more available form so that they can be most efficiently used. Unlike other chemical and physical disposal process such as burning and landfill, this biological means of disposing can add much advantage to the ecosystem by conserving the plant nutrients. Installation of batch drum composters at community level and source separation of organic waste will reduce much burden of collection and transportation costs. Composting of organic waste will result in nutrient rich and stabilized end product. It also reduces the greenhouse gases and leachate production in landfill and open (illegal) dumping, if they are source segregated and composted using rotary drum composter. Agriculture is receiving huge attention worldwide, as government and non- government authorities recognize that there is a need to increase productivity in a more accelerated way in order to ensure food security and improved nutrition to a growing population.

1.3 Aim of Study

The aim of the present study was to determine the changes in physicho-chemical and biological changes during the composting of flower waste by using rotary drum method.

1.4 Objectives

- To monitor changes in physicho-chemical parameter during composting.
- To study and analysis of leachate of compost.
- To minimize the solid waste (flower waste).

2. COMPOSTING

Composting is an aerobic process under the thermophilic condition for transforming organic matter into nutrient-enriched compost. Aeration and moisture content play an important role in maintaining the thermophilic condition. Aeration is also important to maintain the process of aerobic condition. Flower waste contains 75–83% moisture which produces leachate and gives out an unpleasant smell if not managed properly. The moisture content is very important for the composting process to provide proper aeration, increasing the rate of microbial activity and the free air space. The moisture content and proper aeration can be controlled by the addition of the bulking agent. Numerous researchers had used various types of bulking agents such as leaves, biochar, and sawdust to maintain proper moisture content, free airspace, and aeration.

2.1 Composting Methods

Different composting methods are available and the most commonly used are presented here below together with the requirements of each.

2.1.1 Windrow Method

Aerated or turned windrow composting is suited for large volumes such as that generated by entire communities and collected by local governments, and high volume food-processing businesses (e.g., restaurants, cafeterias, packing plants). It will yield significant amounts of compost, which might require assistance to market the end-product.

2.1.2 Aerated Static Pile Method

This method regulates heat and oxygen supply with an aim of producing safe compost within a shorter time period. Apart from waste materials and other conditions stated under windrow system, aerated static Pile method also require two hollow perforated wooden or pkamrylastic rods for aerating the pile

2.1.3 Box Composting Method

Although it has a lot of similarity to windrow method, box composting is done in a container. All the ingredients, size of the pile, layering and turning frequency are handled similarly

2.1.4 Vessel Composting Method

In-vessel composting can process large amounts of waste without taking up as much space as the windrow method and it can accommodate virtually any type of organic waste (e.g., meat, animal manure, biosolids, food scraps). This method involves feeding organic materials into a drum, silo, concrete-lined trench, or similar equipment. This allows good control of the environmental conditions such as temperature, moisture, and airflow. The material is mechanically turned or mixed to make sure the material is aerated. The size of the vessel can vary in size and capacity.

2.1.5 Vermi Composting Method

This is the combination of biological processes, designs and techniques used systematically and intensively to culture large quantities of certain species of earthworms and at the same time to speed up stabilization of organic wastes materials. The waste are eaten, ground and digested by the earthworms with the help of aerobic and some anaerobic micro flora. They are thereby naturally converted into finer, humified microbially active faecal material (castings), where important plant nutrients are held in a form much more soluble and available to plants than those in the parent compound.

2.1.6 Pit Composting Method

As demonstrated by the law of nature, in a forest environment for example, dead organisms keep piling one on top of the other, and over a period of time those underneath decompose and turn into humus. In this method, organic wastes are piled into a pit daily and as time goes on those underneath decompose into compost. The method is suitable for use in institutions like hospitals, boarding schools, children's homes, etc, where daily production of organic waste is high.

3. MATERIALS AND METHODS

3.1 Materials

Flower waste was used as main feedstock. Flower waste contains a variety of flowers such as rose, marigold, lotus, and siroi lily. Among these flowers, it was observed that the quantity of marigold flowers was the maximum. Flowers waste was collected from nearby temples and transported to the composting laboratory of B.M.C.E.T, Surat, India. Segregation of waste was done manually to remove the unwanted materials (plastic, threads, incense sticks, coconut, etc.) before using it for the experiments. Cow dung was used as microbial inoculum to enhance the microbial biomass and biological activities during the composting process. A dairy farm in village Katargam, Surat provided the cow dung for the study. Sawdust and wheat bran were used as bulking agents. Likewise, sawdust was collected from a sawmill in Katargam, Surat and wheat bran was collected from a nearby flour mill in Surat. Bulking agents (sawdust and wheat bran) was used to control the excess moisture and reduce the air space between the material particles.

3.2 Rotary Drum Method

Rotary drum composting is usually done in and enclosed vessel, such as a large diameter drum. The material is typically agitated, turned, and/or force-aerated on a daily basis or perhaps multiple time each day, depending on the size of the unit and how it is operated. Because of this daily turning and aeration, the composting process starts quicker and progresses faster in rotary drum than with static-bin, windrow composting and the highly degradable, oxygen demanding materials are decomposed more quickly than with other composting alternatives.

Fig 1 shows the rotary drum composter of capacity 0.05 cube meter was made to perform the composting process. The dimensions of the drum were length 1' 10 " and diameter 1' 2" and the thickness of drum 1mm.For the rotation of the drum , one turning lever is provided at one end of the drum and for proper mixing of waste two angles were bolted inside the drum along longitude. To drain off the leachate during the composting process, four small holes were made on the surface of drum. A plastic bucket was used to fill the waste mixer inside the drum as required for the trials. After daily manual turning, opening of the door (dimension 11" by 7") for maintaining the aerobic condition inside the drum. A sample of about 10g was collected from the opening provided in the drum and the sample was collected at intervals of 1 day. The sample was kept for further physico-chemical parameter analysis.

Fig 1 Rotary Drum Composter

4. RESULT AND DISCUSSION

Table 1 shows the different instruments that were used during the investigation and experimental analysis.

TABLE 1 : DIFFERENT INSTRUMENT USED FOR EXPERIMENTATION

Sr.No.	Parameter Analysis	Instrument Method
1	Moisture Content	Hot air oven
2	Ph	pH meter
3	Electrical Conductivity	Muffle furnace
4	Volatile Matter	Muffle furnace
5	Ash	Muffle furnace
6	Fixed carbon	Muffle furnace
7	Potassium	BY ICP-OES
8	Phosphorous	BY ICP-OES
9	Total Organic Carbon	Fertilizer Testing Protocol
10	Nitrogen	IS 6092 (part 6): 1985
11	C:N ratio	Fertilizer Testing Protocol

TABLE 2: INITIAL CHARACTERISTICS OF SOLID WASTE

Sr. No.	Parameter	Flower waste	Cow dung	Saw dust	Wheat Bran
1.	Moisture Content (%)	70.55	72.44	11.02	7.55
2.	pH	6.72	6.46	6.86	5.48
3.	Electrical Conductivity (uS/cm)	0.46	0.47	1.06	2.14
4.	Organic Carbon (%)	46.87	47.97	53.44	53.87
5.	Volatile Matter (%)	32.87	16.11	8.67	5.86
6.	Ash (%)	2.07	10.60	1.90	2.10
7.	Fixed Carbon (%)	25.51	0.81	8.81	9.20
8.	Total Nitrogen (%)	2.32	1.42	0.55	1.30
9.	C:N Ratio	22.40	23.02	85.75	22.45
10.	Potassium (g/kg)	17.12	10.03	1.21	4.86
11.	Phosphorus (g/kg)	3.25	2.95	1.70	4.30
12.	Trial 1 (kg)	5	3	0.6	0.6
13.	Trial 2 (kg)	6	2	0.6	0.6

A sample of about 5-10g was collected from composter. The sample was collected at intervals of 1 day. After collecting sample the various physio-chemical parameters were analysed in both trials .

TABLE 3 : SOME TYPICAL CHARCTERISTIC OF COMPOST (FINAL)

Sr. No.	Parameter	Compost (Trial 1)	Compost (Trial 2)
1.	Moisture Content (%)	50.13	48.56
2.	pH	6.67	6.05
3.	Electrical Conductivity (uS/cm)	1.86	1.94
4.	Organic Carbon (%)	19.83	20.25
5.	Total Nitrogen (%)	0.96	1.56
6.	C:N Ratio	20.66	19.90
7.	Potassium (%)	6.93	6.50
8.	Phosphorus (%)	5.48	4.85

Variation in Physcio-chemical parameters during composting

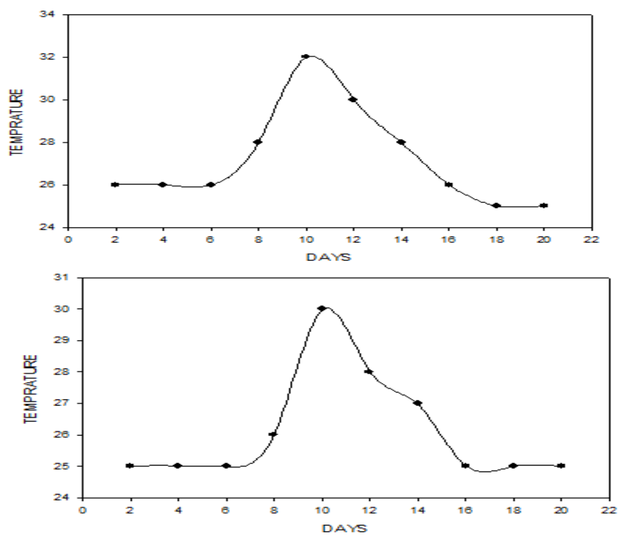

Fig 2 Temprature profile during both trials

Fig. 2 shows the temperature profile of both trials during rotary drum composting. In both trials, a fast increase in temperature was recorded indicating a higher microbial activity. The rise in temperature recorded in the early stages of both the trial, the temperature pattern was similar in both trials. A maximum of 32°C was observed in trial 1 and 31°C in trial 2.

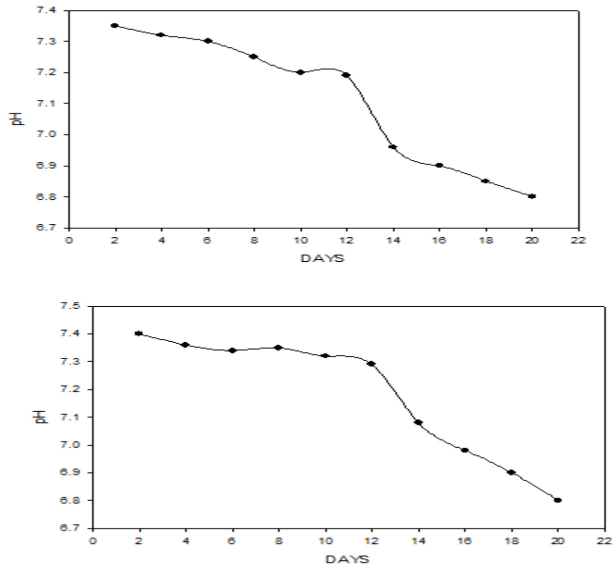

Fig 3 pH profile during both trials

The changes in pH was observed to carry out the same pattern in both the trials, ranging from slight alkaline to slight acidic conditions. Initially the pH was in the range of 7.35, 7.40, and finally it decreased towards acidic conditions and was in the range of 6.80, 6.75 in trial 1, 2 respectively.

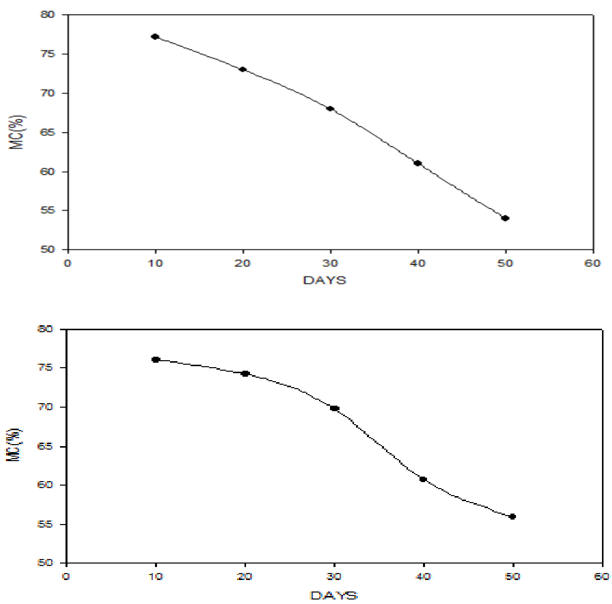

Fig 4 Moisture Content profile during composting

As the temprature rises, the loss in Moisture Content was observed. Fig. 4 depicts the loss of moisture content during composting period . Hence loss of moisture during the composting process can be viewed as index of Decomposition rate, as the heat generated due to the microbial metabolism accompanies decomposition as well as vaporization or moisture loss.

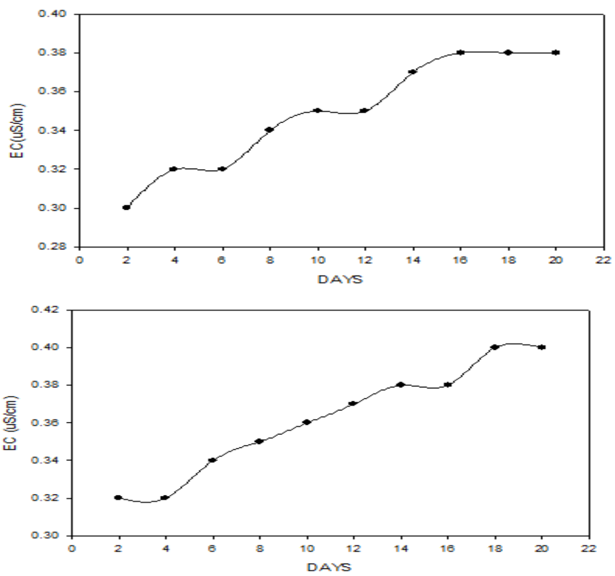

Fig 5 Electrical Conductivity profile during both trials

Electrical Conductivity is the indicator of the degree of salinity. It indicates the phytotoxicity effect on the growth of plants. Initial electrical conductivity in both the trials were low, but it increased after composting. The Fig. 5 shows the initial electrical conductivity of trial (1-2) were 0.30 and 0.32 uS/cm respectively which after 45 days increased.

4. CONCLUSIONS

- Rotary drum composting of flower waste was successful with the combinations of cow dung, saw dust and wheat bran.
- The 45 days of operation was found highly efficient for producing stabilized compost within shorter time. Appropriate addition of waste materials played a major role in the degradation process.
- The successful operation of flower waste composting is followed out by adding appropriate quantity of bulking agents such as saw dust and wheat bran to maintain the thermophilic phase and increase the efficiency of process. Since, lower addition of bulking agents during the process might lead to the production of leachate thereby deteriorating the quality of compost (loss of micro and macro nutrients). However, higher addition of bulking agents might take longer time for further degradation.

- Microbial population growth was influenced by the temperature and also the effective organic matter degradation.
- However, combinations of waste materials played a major role in favoring microbial succession. The final end product was completely stabilized with lower oxygen uptake rate and CO_2 evolution rate at the end of composting period.
- Leachate is generated during initial stage of composting. Leachate production was only upto 30 days and maximum generation wasn70ml.
- The variation of pH was 6.67, electrical conductivity was 1.86 uS/cm, Total Organic Carbon was 19.83 %, C:N ratio was 20.66, Potassium was 6.93 %, and Phosphorus was 5.48 % in trail 1 at end of the 45 days.
- The variation of pH was 6.50, electrical conductivity was 1.94 uS/cm, Total Organic Carbon was 20.25 %, C:N ratio was 19.90, Potassium was 6.50 %, and Phosphorus was 4.85 % in trail 2 at end of the 45 days.

REFERENCES

[1] Ajay S. Kalamdhada, Yatish K. Singhb, Muntjeer Alib, Meena Khwairakpamb, & A.A. Kazmib Rotary drum composting of vegetable waste and tree leaves, Bioresource Technology, 2009.

[2] Dayanand Sharma & Kunwar D. Yadav, Application of rotary in-vessel composting and analytical hierarchy process for the selection of a suitable combination of flower waste, Geology, Ecology, and Landscapes, 2:2, 137-147, 2018.

[3] V. SudharsanVarma & A. S. Kalamdhad Evolution of chemical and biological characterization during thermophilic composting of vegetable waste using rotary drum composter, Int. J. Environ. Sci. Technol. (2015) 12:2015–2024

[4] V. SudharsanVarma & Ajay S. Kalamdhad Effects of Leachate during Vegetable Waste Composting using Rotary Drum Composter, Environ. Eng. Res. 2014 March, 19(1) : 67-73.