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# Exploring Household Composting as an Effective Solution for Urban Waste Management

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**Abstract -** Organic wastes are generated from many sources' compiles, solid waste, food, kitchens wastes, etc. Disposal of solid waste is stinging and widespread problem in both urban and rural areas in many developed and developing countries. Collection and disposal of solid waste is one of the major problems of urban environment in most countries worldwide today. Improper Solid Waste Management causes many environmental problems. Traditional composting methods have been common practices in many rural/sub urban areas and requires more time for complete degradation. Traditional method requires large sites for disposal, which nowadays is not possible, as limited spaces are available in the cities. So, here comes the need to find new techniques such as Home Composting. The research focuses on understanding the effectiveness of household composting as a waste management technique for household garbage. Household composting is an attractive method in which small bins can be used as an alternative to composting sites to a small scale. This technique helps to decompose the organic matter in lesser time than the traditional methods. Addition of compost accelerators in the bins increases the decomposition rate. Simply by home composting, the quantity of waste can be reduced.

***Key Words*: Solid Waste Management, Composting, Compost Accelerators, Home Composting, Household Garbage**

## 1. INTRODUCTION

India is having second largest population in the world after China with more than 1.27 billion population contributing 17.6% of world's total population. Over-population, Rapid industrialization, uncontrolled urbanization and improved living standards will lead to increased rate of per capita waste generation. Currently, 1,27,486 tons per day of municipal solid waste is being generated due to various household activities and other commercial & institutional activities (CPCB, 2012). Municipal waste and certain industrial waste have comparatively significant impact on environment. A substantial amount of these wastes is extremely dangerous to the living organisms including human. It may downgrade groundwater quality by leachate percolation and cause air pollution by emission of greenhouse gases through various course of treatment. To overcome this problem, effective solid waste management must be implemented. The objectives of solid waste management are to control, collect, process, utilize and dispose of solid wastes in such an economical way which protects health of human being and natural environment and the objectives of those served by the system. In this regard, in 1989, the U.S. Environmental Protection Agency (U.S. EPA) adopted hierarchy of waste management practices. The elements of hierarchy are:

- Source reduction
- Recycling of materials
- Combustion
- Landfilling

### 1.1 Waste characteristics

Solid waste can be defined as waste not transported by water; that has been rejected for further use. It includes industrial, mining, municipal and agricultural wastes. It mainly consists of a large organic matter, ash and fine earth, paper and plastic, glass and metals. Composition of solid waste however varies depending on various factors such as weather, living standards etc.

### 1.2 Composting

Composting is a biological process of decomposition and stabilization of organic matter of solid waste by microbes either in presence or absence of oxygen. Depending on availability of oxygen, it is further classified as aerobic composting and anaerobic composting also known as bio methanation. It can also be classified as open or window, mechanical or closed etc. depending upon operating condition and design of plant. In India, large amount of waste is treated by this method for which efficiency largely depends on temperature.

In this process, solid substrates are degraded over a period of weeks, by a succession of microbial population to form dark

brown, granular, humus like end product sometimes described as "loamy". This compost can be used beneficially as a soil conditioner, improving the characteristics of both excessively clayey and sandy soils. Fig 1 shows the cycle of composting.

Fig 1. Composting Cycle

The advantages of composting do not lie simply in the production of a soil conditioner. It can be a viable method of domestic refuse disposal. The composting of domestic refuse in Europe has received significant attention since the 1920s. It is less popular in the USA because there is less demand for soil conditioner. The typical refuse soil refuse composition is not as suitable, and alternative means of disposal appear more economically attractive.

A range of materials, from municipal refuse and paper to sewage sludge and mixtures of these, can be composed. The primary objective of composting in most cases is to convert an unstable, potentially offensive material into a stable end product. In contrast to stabilize degradable, potentially offensive material composting is an aerobic process.

The composting process is an environmentally sound and beneficial means of recycling organic materials and not a means of waste disposal. It is important to view compostable materials as usable and not as waste requiring disposal. A major portion of municipal solid wastes in India contain up to 70% by weight of organic materials. In addition, certain industrial by products from food processing, agricultural and paper industries are mostly composed of organic materials.

## 1.3 History of composting

Composting was somewhat modernized beginning in the 1920s in Europe as a tool for organic farming. The first industrial station for the transformation of urban organic materials into compost was set up in Wels/Austria in the year 1921.The early personages most cited for propounding composting within farming are for the German-speaking world Rudolf Steiner, founder of a farming method called biodynamics, and Annie Francé-Harrar, who was appointed on behalf of the government in Mexico and supported the country 19501958 to set up a large humus organization in the fight against erosion and soil degradation. In the English-speaking world it was Sir Albert Howard who worked extensively in India on sustainable practices and Lady Eve Balfour who was a huge proponent of composting. Composting was imported to America by various followers of these early European movements in the form of persons such as J.I. Rodale (founder of Rodale Organic Gardening), E. E. Pfeiffer (who developed scientific practices in biodynamic farming), Paul Keene (founder of Walnut Acres in Pennsylvania) and Scott and Helen Nearing (who inspired the back-to-land movement of the 1960s). Coincidentally, some of these personages met briefly in India - all were quite influential in the U.S. from the 1960s into the 1980s.

## 1.4 Traditional Methods of Composting

Traditionally the organic material is getting converted into most stable form of it using various methods of decomposition. These methods are briefly explained in the further sections.

### 1.4.1 The Indian Bangalore Method

This method of composting was developed at Bangalore in India by Acharya (1939). The method is basically recommended when night soil and refuse are used for preparing the compost. The method overcomes many of the disadvantages of the Indore method such as problem of heap protection from adverse weather, nutrient losses due to high winds / strong sun rays, frequent turning requirements, fly nuisance etc. but the time involved in production of a finished compost is much longer. The method is suitable for areas with scanty rainfall. It includes two operations.

Preparation of the pit- Trenches or pits about one metre deep are dug: the breadth and length of the trenches can be made depending on the availability of land and the type of material to be composted.
Filling the pit- Organic residues and night soil are put in alternate layers and, after filling, the pit is covered with a 15-20 cm thick layer of refuse. The materials are allowed to remain in the pit without turning and watering for three months.

### 1.4.2 The Indian Indoor Method

An important advance in the practice of composting was made at Indore in India by Howard during the period 1924 to 1926. The traditional procedure was systematized into a method of composting now known as the 'Indore method'.

A) Pit method
Site and pit dimensions: The pit should be about 1 m deep. 1.5-2 m wide and of any suitable length.
Filling the pit- The material brought from the cattle shed is spread evenly in the pit in layers of 10-15 cm. On each layer is

spread a slurry made with 4.5 kg dung, 3.5 kg urine-earth and 4.5 kg of inoculum taken from a 15-day-old composting pit. Water is sprinkled over the material in the pit to wet it.

Turning: The material is turned three times (15days, 15days, 30days) during the whole period of composting.

B) Heap method
Site and heap dimensions: The basic Indore pile is about 2 m wide at the base, 1.5 m high and 2 m long. The sides are tapered so that the top is about 0.5 m narrower in width than the base.
Forming the heap- The heap is usually started with a 20 cm layer of carbonaceous material such as leaves, hay. straw, sawdust, wood chips and chopped corn stalks. This is then covered with 10 cm of nitrogenous material such as fresh grass, weeds or garden plant residues. fresh or dry manure or digested sewage sludge. The pattern of 20 cm carbonaceous material and 10 cm of nitrogenous material is followed until the pile is 1.5 m high and the material is normally wetted so that it may feel damp but not soggy

When enough nitrogenous material is not available, a green manure or leguminous crop like sun hemp is grown on the fermenting heap by sowing seeds after the first turning. The green matter is then turned in at the time of the second mixing. The process takes about four months to complete.

### 1.4.3 In-Vessel Composting

In-vessel composting refers to a group of methods which confine the composting materials within a building, container, or vessel. In vessel methods rely on a variety of forced aeration and mechanical tuning techniques to speed up the composting process. Many methods combine techniques from the windrow and aerated pile methods in an attempt to overcome the deficiencies and exploit the attributes of each method. There are a variety of in-vessel methods with different combinations of vessels, aeration devices, and tuning mechanisms. The few methods discussed here have either been used or proposed for farm composting. They also serve as good examples of the types of in-vessel systems available. There are various methods of In-vessel composting such as Bin Composting, Rotating Drums, Transferable Containers and Rectangular agitated bed.

### 1.4.4 Wind Row Method

In agriculture, windrow composting is the production of compost by piling organic matter or biodegradable waste, such as animal manure and crop residues, in long rows (windrows). This method is suited to producing large volumes of compost. These rows are generally turned to improve porosity and oxygen content, mix in or remove moisture, and redistribute cooler and hotter portions of the pile. Windrow composting is a commonly used farm scale composting method. Composting process control parameters include the initial ratios of carbon and nitrogen rich materials, the amount of bulking agent added to assure air porosity, the pile size, moisture content, and turning frequency.

### 1.4.5 Vermicomposting

Vermicompost is the product of composting utilizing various species of worms, usually red wigglers, white worms, and earth worms to create a heterogeneous mixture of decomposing vegetable or food waste (not to include meat, dairy, fats, or oils), bedding materials, and vermicast. Vermicast, also known as worm castings, worm humus or worm manure, is the end product of the breakdown of organic matter by species of earthworm. This type of composting is sometimes suggested as a feasible indoor composting method

The earthworm species (or composting worms) most often used are Red Wigglers (Eisenia foetida or Eisenia andrei), though European nightcrawlers (Eisenia hortensis) could also be used. Red wigglers are recommended by most vermiculture experts, as they have some of the best appetites and breed very quickly. Users refer to European nightcrawlers by a variety of other names, including dendrobaena, dandruff, and Belgian nightcrawler.

Containing water-soluble nutrients, vermicompost is a nutrient-rich organic fertilizer and soil conditioner in a form that is relatively easy for plants to absorb. Worm castings are sometimes used as an organic fertilizer. Because the earth worms grind and uniformly mix minerals in simple forms, plants need only minimal effort to obtain them. The worms digestive system also add beneficial microbes to help create a "living" soil environment for plants.

Vermicompost tea has been shown to cause a 173.5% increase in plant growth by mass over plants grown without castings. These results were seen with only 10% addition of castings to produce these results.

Fig 2. Vermicomposting

## 2. LETERATURE SURVEY

Extensive literature survey has been done towards the work done by various researchers in the field of composting.

Mona Rani et al. (2013) Studied that the solid waste generation is a worldwide phenomenon depending upon the various factors viz., season of the year, frequency of collection, characteristics of population, extent of salvage &recycling, public attitude, climatic condition, legislation etc. Improper management of solid wastes causes hazards to the environment and also the people who are residing in that particular area. It is a very big challenge all over the world and it should be overcome. In India there are over 300 universities and 45000 colleges of various types. The objectives of the study wereto evaluate the current status, identify the problems and Physical characterization of waste generated at MNIT Campus, Jaipur. The solid waste generated at MNIT Campus was not properly disposed off, only dumped un-hygienically. Methodology for this research includes: Collection of population data, existing solid waste management practices as well as physical characterization of solid waste zone wise. The major findings of the study are: Total population of MNIT fraternity was 2883. The total amount of waste generated was around to 5.4 tons/week. Amount of organic fraction generated was 78.88% of the total waste and the remaining21.12% of the total waste includes dry waste: cardboard, clothes, glass, leather, metal, paper, pebbles/sand, plastic, thermocol and wood. Jawahar et al. (2013) **a**ttempted to focus on the treatment of Municipal Solid Wastes by methods of aerobic composting with a bio consortium used for wastewater treatment and vermicomposting. The physical, chemical and biological characteristics of samples collected at different stages of decomposition of the wastes during the treatment processes were analyzed and their variations were compared to obtain an idea on the efficiency of treatment using the two methods. The fertilizer value of the compost obtained from the two methods had been compared to get an insight into the efficiency and usefulness of the new technique as vermicomposting was used and well-studied method of solid waste treatment.

A Q Dar et al. (2013) presented a comprehensive physical and chemical examination to utilize decomposable organic waste generated in the Ganderbal district to produce valuable organic manure using Vermicomposting technique. This technique accelerates organic stabilization and giving chelating and phytohormonal elements which have high content of microbial matter and stabilized humic substances. From the study it has been observed that almost all biodegradable waste is decomposed in a very short period of time compared to simple composting with very high values of nitrogen, potassium, and phosphorus within a period of 5-6 weeks. The method at household level can reduce the workload of Municipal Committee Ganderbal (MCG) by 30-35%. Neetu Dabi et al. (2014) Studied that the rapid increase in population and the adopted modern lifestyle is the reason of increase in generation of solid waste, which results into the contamination of air, water and land resources. Improper solid waste management (SWM) causes hazards to inhabitants. It is a big challenge all over the world for human beings. The present study was taken to find out the problems and prospects of solid waste in JIET Campus, Jodhpur, and Rajasthan, India. A detailed investigation was made regarding the methods of practices associated with sources, quantity generated, collection, transportation, storage, treatment and disposal of solid waste in JIET Campus. The data concerning to SWM in JIET Campus was obtained through questionnaire, individual field visit, and interacting with people. Photographic evidences were also made about generation, storage, collection, transportation, treatment and disposal of Solid Waste. This study reveals that if few steps are taken the SWM of JIET can become more efficient.

Trivedi et al. (2015) Envisaged that solid waste compost prepared by organic matter composting can serve as a valuable organic nutrient source that can maintain long-term ecological health and simultaneously target short-term productivity gains. Also, the ill effects of chemical farming can be controlled. Moreover, in recent times India has faced rise in cost of labour, agricultural inputs and biological degradation of lands. The annual crop productivity has decreased, and awareness of organic farming technology is lacking. Thus, keeping in view, the advantages of organic farming as well as its inherent limitations such as analysis and slow action, present studies had focused on domestic solid waste management by its conversion into enriched compost and to evaluate their nutritional quality. The experiments were conducted for a period of 12 months and it was concluded that during composting the E4/E6 ratio linearly in-creased till the 24th day and that suggests a reduction in density of organics. After this period starting from 25th day the ratio of E4/E6 subsequently reduced. This confirms that maturity had been attained between 24-32 days. Moreover, the chemical properties and micronutrient analysis conducted during experiments suggest that the obtained organic manure was qualitatively appropriate to be adopted as a cost-effective fertilizer. Therefore, it can be envisaged that sustainability can be attained in agriculture by means of processed manure that are organic in nature. **S.** Haripriya et al. (2018) studied the need to standardize compost tea production method using kitchen waste from CARE Group of Institutions hostel and application rates as far as possible to increase their effectiveness, avoid adverse effects and decrease human and environmental potential hazards. Most of the evidence on their effectiveness in plant growth enhancement or disease suppression was anecdotal. They had done few well-designed experimental trials or scientific reports that assess their effectiveness or focus on finding optimal production methods or application rates. There were also few reports on possible mechanisms by which they promote plant growth or suppress plant diseases. They also studied intensive use of chemical fertilizer in agriculture increases the crop production but at the

same time it causes negative impact on land, air, water and on environment health Concerns regarding soil degradation and agricultural sustainability have kindle interest in assessment of soil quality.

## 3. NEW TRENDS IN COMPOSTING

### 3.1 A Worm Composting Bin

Worm composting is a suitable composting option for apartment buildings or other homes with no yard space. The worms stay in the bin and eat household scraps, and the bin gives off little odor. Fig 3 below shows the worm composting bin.

A worm composting bin, also known as a vermicomposting bin or worm farm, is a container specifically designed to facilitate the decomposition of organic waste with the help of worms. Here are the key components and factors that affect the effectiveness of a worm composting bin.

Fig 3 Worm Composting Bin

Materials required for making Bin

- One 4-x-8-foot sheet of 1/2-inch exterior plywood
- One 12-foot length of 2 x 4 lumber one 16-foot length of 2 x 4 lumber
- 16d galvanized nails (1/2 pound)
- 6d galvanized nails (2 pounds)
- Two galvanized door hinges
- One pint of clear varnish (optional)
- Plastic sheets for placing under and over the bin (optional)
- Worms
- Bedding for worms: peat moss, brown leaves, moistened, shredded newspaper or moistened, shredded cardboard

Tools Required

- Tape measure
- Skill saw or hand saw
- Hammer
- Sawhorse
- Long straight-edge or chalk snap line
- Screwdriver
- Drill with 1/2-inch bit
- Eye and ear protection
- Work gloves
- Paint brush(optional)

Building a Worm Composting Bin

1. Measure and cut the plywood as shown, so that you have one 24-x-42-inch top, one 24-X-42-inch base, two 16-x-24-inch ends, and two 16-X-42-inch sides.
2. Cut the 12-foot length of 2 x 4 lumbers into five pieces: two 39-inch pieces, two 23-inch pieces, and one 20-inch piece.
3. Lay the five pieces on edge on a flat surface to form a rectangle, with the long pieces on the inside and the 20-inch length centred parallel to the ends, Nail the pieces together with two 16d nails at each joint.
4. Nail the 23-x-42-inch piece of plywood onto the frame with 6d nails every 3 inches.
5. Cut four 1-foot lengths from the 16-foot length of 2 x 4 lumbers. (Save the remaining 12-foot piece.) Take the two 16-X-42-inch pieces of plywood and place a l-foot length flat against each short end and flush with the top and side edges. Nail the 2 x 4s in place using 6d nails.
6. Set the plywood sides up against the base frame so that the bottom edges of the 2 x 4s rest on top of the base frame and the bottom edges of the plywood sides overlap the base frame. Nail the plywood sides to the base frame using 6d nails.
7. To complete the bin, nail the 16-x-24-inch pieces of plywood onto the base and sides at each end.
8. To reinforce the bin, stagger nails at least every 3 inches wherever plywood and 2 x 4s meet.
9. Drill twelve 1/2-inch holes through the plywood bottom of the bin for drainage.
10. To build lid frame, cut the 12-foot piece (from the 16-foot length) of 2 x 4 lumber into two 45-inch pieces and two 20-inch pieces. Lay the pieces flat, forming a rectangle with the short pieces inside.
11. Lay the 24-X-42-inch piece of plywood on top of the lid frame so that the plywood is 1 1/2 inches inside all the edges of the frame. Nail the plywood onto the frame with 6d nails.
12. Attach the hinges to the inside of the back of the bin at each end (on the 2 x 4), and the corresponding undersides of the back edge, of the lid frame, so that the lid stands upright when opened.
13. The unfinished bin should last for at least five years; finishing the bin with varnish or polyurethane will protect the wood and prolong the life of the bin. Two

coats of varnish with a light sanding between coats should be sufficient. If pressure-treated lumber is used, the bin will last years longer.

14. Find a good location for the bin. It can be placed anywhere, as long as the temperature is more than 50°F (10°C). The most productive temperature is between 5s° and 77°F (139-25°C). Garages, basements, and kitchens are all possibilities, as well as the outdoors in warm weather (not in direct sunlight). Make sure to place the bin where it is convenient for you to use. It is wise to place a plastic sheet under the bin.

By managing these factors effectively, a worm composting bin can efficiently convert organic waste into nutrient-rich compost while minimizing odor and pest problems.

### 3.2 Factors affecting Composting process

Several factors can influence the composting process, affecting its efficiency and the quality of the end product. Some of these factors include:

1. **Carbon to Nitrogen (C/N) Ratio**: The ideal ratio of carbon-rich materials (such as dry leaves, straw) to nitrogen-rich materials (such as food scraps, green plant material) is crucial for microbial activity and decomposition.
2. **Moisture Content**: Adequate moisture is necessary for microbial activity and decomposition. Too much moisture can lead to anaerobic conditions and unpleasant odors, while too little moisture can slow down the process.
3. **Oxygen Availability**: Composting is an aerobic process, meaning it requires oxygen. Proper aeration through turning or mixing the compost pile ensures oxygen reaches the microorganisms involved in decomposition.
4. **Temperature**: Composting is most effective within a certain temperature range (typically between 40°C to 70°C or 104°F to 158°F). Higher temperatures accelerate decomposition by speeding up microbial activity.
5. **Particle Size**: The size of compost materials can affect decomposition rates. Smaller particle sizes provide more surface area for microbial activity and can accelerate the process.
6. **pH Level**: A neutral to slightly acidic pH range (around 6 to 8) is optimal for microbial activity in composting. Extreme pH levels can inhibit decomposition.
7. **Presence of Pathogens and Weed Seeds**: Proper composting techniques, such as maintaining adequate temperatures and turning the pile, can help destroy pathogens and weed seeds present in the compost materials.
8. **Aeration and Mixing**: Regular turning or mixing of the compost pile ensures proper aeration and distribution of microorganisms, promoting faster decomposition.
9. **Presence of Inhibitors**: Some materials, such as certain chemicals or toxins, can inhibit microbial activity and slow down the composting process.
10. **Environmental Conditions**: Factors such as ambient temperature, humidity, and weather conditions can influence the composting process, especially for outdoor composting systems.

By carefully managing these factors, composters can optimize the composting process and produce high-quality compost efficiently.

## 4. CONCLUSIONS

From this current study it can be concluded that by using this new technique the rate of Decomposition Process will get increase and the degradable matter is converted into most stable end product. The generated manure will act like an Excellent Soil Conditioner and it will be a good saleable product. With this technique there will be the destruction of Pathogenic bacteria's which are harmful to human being. This May reduce soil-borne plant diseases with Lowers risk of pollution and nuisance complaints from the society.

In other words, it can be stated that household composting emerges as a promising solution to the challenges posed by urban waste management. Traditional methods of waste disposal are increasingly inadequate and contribute to environmental problems. By adopting household composting techniques, such as utilizing small bins and compost accelerators, organic waste can be effectively decomposed in a shorter time frame compared to traditional methods. This not only reduces the burden on existing waste management infrastructure but also contributes to minimizing the quantity of waste generated. Overall, household composting presents a practical and sustainable approach to managing organic waste at the household level, offering potential benefits for both urban and rural environments.

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