



Composting: an effective technique for utilization of organic matter for solid waste management

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Abstract: Solid waste management (SWM) is a main challenge globally due to the several different yet drastic factors such as abrupt increase in population and mass production, which lead to the generation of high amount of solid wastes. Inadequate disposal and/or handling of solid waste imparts an adverse impact not only on the environment and the economy but also, the health of the residents at all the measures from local to global. Composting can be a viable alternative of organic waste utilization in the developing countries due to low cost. Its potential for environmental sustainability, cost-effectiveness and public acceptance is relatively well known. Bioconversion of the solid waste is an alternative and effective valorization tactic for the efficient treatment of solid wastes that necessitates waste management, social and ecological safety, and in turn resource generation in form of value-added products. Current developments in biomass valorization, study suggests that not only lignocellulosic i.e., plant based but also, chitin and keratin also show a chief role in bioeconomy.

Keywords: Solid waste management, Composting, Bioeconomy, Soil fertility, Biodegradation, Cost effective.

INTRODUCTION

In the recent development the generation of solid wastes within the country and outside the boundaries created a havoc. Distinct from the solid waste produced by the industrial or hospital sources has a clear and specific source of origin which is identifiable, and their management or disposal is regulated through governmental bodies, unlike to the solid waste produced by day-to-day activity of an individual is generated by all and sundry[1]. Solid waste management is acknowledged to deal with the one task i.e., to get rid of the waste out but also, in the optimal manner considering economical, human, and environmental safety[2]. Thus, it is bit challenging even for the government itself to cope with the handling of this enormous amount of waste at individual level. Recent studies suggests that 1.3 billion tonnes of solid wastes are generated worldwide yearly. This value is estimated to further rise by 2025 up to 2.2 billion tonnes per year. The evidence suggested that the generation of solid wastes will be doubled in the coming twenty years

along with the increase in the solid waste management costs i.e., \$375.5 billion in 2025 (>five-fold increase). These data are severe for the developing or one can say low economy countries. Furthermore, the ceaseless increase in the production of MSW (municipal solid waste) has limit the capacities of landfills and the solid waste management facilities. The massive increase in the MSW generation and production not only provide an indecorous vision but also, poses a high risk to soil, aquatic and animal health.

A majority of chunk in MSW is composed of biodegradable material generated mainly, from aquatic and terrestrial sources such as, weeds, litter (leaf, animal), vegetable and fruit wastes (crops) and if left untreated the weeds generated in aquatic and terrestrial regions may pollute the water as well as the land resources whereas the litters and crop wastes is burned openly which serve as the fertilizer to the soil but this practice of burning in an open air indirectly depletes the nutrient quotient in the soil such as carbon and nitrogen and also, increase the global warming by releasing the toxic gases[3].

Thus, the need of an hour is to find a method and/or technique(s) to manage MSW in an optimal manner possible. A methodology that can be operable at a wide scale range starting from a household solid waste to global level. Referring to all the scenario discussed above the most effective and potent methodology in existence for the management of solid waste is “**Composting**”. Composting is one of the cost-effective technologies that can be operated at all scales of operation. A skill that can be operated by the common to highly trained person[4].

Composting: the need of an hour

A straight forward and easy to use approach which, majorly deals with the anaerobic digestion of the organic waste and their bioconversion into value added products such as in biogas production, generation of the animal feed, fertilizer, amino acids, peptides, soluble proteins, manure etc.

This process primarily involves the bioconversion of the complex organic matter such as, plant and animal waste (leaf and animal litter, scraps of fruits and vegetables etc.) into value added by-products like fertilizer, manure, peptides, generation of animal feeds, amino acids, soluble oligopeptides, proteins etc. The process of composting is highly microbial dependent which mainly involves bacteria, yeast, fungi and actinomycetes[5] to convert the complex organic residues which acts as a substrate for the microorganism under action into simpler, digestible forms which are rich in humus and nutrients. The formation of humic substances (simpler form of organic matter) along with the production of some by-products such as carbon dioxide, water and heat. In the environment, composting takes place when the dried and decayed leaves reach to the soil, the microbes in the soil act on the organic matter and eventually the nutrients from the organic residues were converted into the simpler humic substances which are utilized by the plant for the growth and these substances also, increases the soil fertility. According to the studies reported, there processing of organic matter facilitates the resources. This process should be brought into the practice with the point of urgency as the available capacities of the landfills and other management facilities are decreasing at an alarming rate.

The fundamental needs:

The basic needs to carry out composting are as follows:

- **Formal preparations:** a site for composting should be decided where all the equipment's can be installed, a trash collection strategy and a final recovery plan should be designed prior to the installation.

- For supervision: skilled recruits should be positioned at the composting area to regulate the site planning and construction, for garbage collection, regular control and maintenance.
- Substrate positioning and analysis should be slated: organic waste should be spread out in layers and tamped. A simple workspace is needed that is used to keep pests and rodents out of the waste.
- Vessel maintenance: a quite contained vessel is needed with the probes to regulate the pH, temperature, agitation, oxygen, and moisture level of the compost.

REVIEW OF LITERATURE

S.GAJALAKSHMI (2008):

This review article provides an in-depth knowledge about the techniques to handle the organic (biodegradable) solid wastes through composting. The authors not only imparted a light on the benefits of the composting but also focusses on the need and necessity of the biological degradation of the solid waste along with an undeniable sight of alarming condition if the practice of composting is not implemented soon. This paper suggests an immeasurable benefits of composting that directly and indirectly serves to the mother nature as the compost is an important source of various micro- and macro nutrients for the plants, also provide a boundless market as a manure and fertilizer for the soil, it provides the plant growth promoting factors as well as suppresses the pathogenic microbes in the soil.

A M. Taiwo (2011):

Author suggested that the sustainability of the waste management can be achieved through ecofriendly approaches for that an effective, useful, and cost-effective techniques should be taken into consideration. Furthermore, this review emphasizes on the benefits of the composting over different other disposal methods such as, direct burning of the solid wastes, landfill disposal, pyrolysis and more as these methods are easy to carry out but it imparts negative effects on the environment. On the other hand, composting a biological process if handled properly not only dispose the wastes generated but also provide a positive impact on the mother nature as it can used for bioremediation purposes, dose not cause any water or air pollution and in turn the process is economically feasible.

S. Vigneswaran (2016):

This paper focuses on the optimal designing of the compost technology mainly in the municipalities where the space restriction is not the issue. It also emphasizes on the advantages and disadvantages of windrow composting techniques in the low economical countries. This paper further discusses the different designing aspects of the windrow facility involving mainly process optimization and designing components (i.e., recovery of solid wastes, preparation of feedstock, stabilization of composting, drying, processing and storage stability), sizing of composting area, collection of runoffs, cost estimation (capital and operating). The presented paper is likely to enhance fundamental understanding of the readers, towards the windrow composting and its implementation.

Y VFan (2017):

This study aims to assess the criteria to increase the actions of microorganism in order to elevate the efficacy of home composting of organic matter such as rice and wheat bran, leaf litter, dry wastes, food and vegetable waste etc. This research mainly focuses on assessing the role of effective microbes on composting and the efficacy of the inoculum in terms of composting. The study also

enforced the sight of the reader's in the direction of whether the composting can be done with or without the presence of the microorganisms. Authors has also done multi-scale experimentation such as Fourier Transform Infrared Spectroscopy (FTIR), pH estimation, temperature change, electrical conductivity, C:N ratio, color change, odour of the compost, humus content, presence of any pathogenic species in the compost under study.

M S Ayilara (2020):

This review article focuses on the need of composting and how the wastes are affecting our day-to-day life including health and the measures to be taken to reduce the amount of these wastes. Authors briefly explained the hazardous nature of these wastes and classified the solid waste according to their biodegradability index. They summarize the methods for the disposal of the wastes some of them are, refuse disposal by open dump, animal feeding, ocean, or river dumping, through direct heat, deep-well injection etc. They also provide an insight towards the different methods of composting and the use of the by-products generated through these processes.

M I. Rashid (2021):

Solid waste management presently follows the direct proportionality with the principles of economy . This study is an example to investigate the conversion of organic wastes into compost through monetary and ecological financial principles by saving the monetary on macronutrients by enriching the soil with the compost and its replacement values is reported in this paper. Article reported that there will be 1.60 million tonnes of increase in the organic food waste by 2030, whereas 0.23–0.40 million tonnes of compost is produced from organic food waste in 2015–2030 which is known to reduce around 0.043–0.076 million tonnes of methane emission.

A R. Al-Nawaiseh (2021):

Authors reported the compost formation through windrow composting technique by analyzing three different piles i.e., fruits, vegetables, poultry manure, garden wastes etc. The organic wastes were incubated with saw dust (bulking agent) to improve the oxygen circulation, micro- and macro-nutrient requirement necessary to degrade the organic matter efficiently. The physiochemical parameters were also analyzed such as, chemical, physical, and biological factors and the end product quality assessment was also conducted in reference to the given standards.

M F. al Ajlouni (2022):

The sudden and drastic changes in the human lifedue to rapid industrialization and urbanization (rise in population) not only affecting the availability of the resources but has been known to affect the overall growth and health of the society. One measure issue of industrialization is the increase in the production of solid wastes throughout the world. To encounter and imparting a light on this serious issue this research paper provides an important aspect and necessity of solid waste management and the solid waste so generated can be recycled to produce enormous and useful resource say, biogas production. This paper mainly focuses to fill the dividing gaps in this area of research and presenting an important aspect of solid waste recycling for our own good.The authors presented a general plan to approach the effective recycling of the organic waste for compost and biogas production.

STRENGTHS

- The benefits of composting do not limit only to providing landfills, proper disposal, increasing the land capacity to cope with the overpopulation but also it has many scientific values such as suppression of soil borne pathogenic microbes, promoting growth of the plants, improving the soil quality, being an excellent source of micro- and macro- nutrients most likely, nitrogen, phosphorus, magnesium, potassium etc. [6].
- Composting as an option for solid waste disposal leads to the waste reduction, green technology, do no harm the environment i.e., ecofriendly, provides job in this area of research and production of value-added byproducts [7].
- A comprehensive assessment of recent research paper that discussed the advantages and disadvantages of windrow composting. The usage and efficacy of this technology for treating solid waste were underlined in this report. The influence of optimal designing of windrow techniques, strategies, and constructions on organic matter treatment was also assessed and explored in the paper [8].
- The overall study suggests the positive effect of the inoculum (effective microorganisms) in the composting process. The major role of the microbes was suggested in the control of the odor, the humification, and N content of the compost [9].
- Researchers and industries have envisioned the possibility of solid wastes as a potent resource of natural materials which provide innumerable benefits to the society as well as in capital income [10].
- Executing this model in organic food waste effectively produces manure, which shows direct correlation with the reduction in waste and providing a source of extra money that adds up to the nation's economy [11].
- Different organic wastes like, fruit and vegetable scraps, poultry, leaf litter, animal wastes were taken for the experiment along with the bulking agent (saw dust) to maintain the C:N ratio for the improved efficacy of the decomposition process [12].
- This paper enlightens the path by providing an action plan to accelerates the decomposition of solid wastes and its use in biogas production as about 50% of waste generated in the particular area is considered as an organic waste which could be recycled to generate resources and in turn decreases the formation of leachates, emission of greenhouse gases[13].

FINDINGS

- The in-depth knowledge of the historical background, mechanistic approaches, production, and evaluation of compost is presented. The quality of the compost depends on the factors and the type of composting provided such as temperature regulation process, pH, moisture control, composting system like, windrow composting, static pile and contained pile, bin composting, in-vessel composting, vermicomposting etc. [6].
- The use of composting method for the waste disposal and generation of the value-added products will provide a feasible and low priced, healthy, and affordable organic goods [7].
- Windrow composting reduces 12% of waste generated, thus it reduces the amount of waste disposed. It is tested for handling large number of wastes; hence, this technique can easily implement on the small as well as large scale processes, providing a link between waste management efficacy and ecofriendly functioning conditions [8].

- The compost with the inoculum showed an effective control in the smell of the compost, there is no significant changes in the temperature in the presence or absence of the inoculum. The analysis also indicates the positive impact of C: N ratio with pH negative [9].
- The mono fertilizers extracted from the compound ones prevent the over and unnecessary use of the nutrients. Moreover, in order to fasten the process of the composting the microorganisms responsible for that purpose should be provided in the form of an inoculum. The method should also be implemented for trapping the CO₂ release to decrease down the emission of greenhouse gases [10].
- This groundbreaking study offers the possible recycling method of food wasteto generate green compost and its evaluation of circular market in recycling food waste. It provides an insight on a unified approach of economic and environmentalassessment of the manure [11].
- The elevation in temperature of the piles was reported with an increase from 50°C to 68°C within the incubation time of 2 weeks. Around 50% of moisture level was maintained initially, to safeguard the efficient degradation whereas the moisture content dropped down at the end of the decomposition process i.e., 30-36%. A significant reduction of 40% in C:N ratio was found in the piles during the course of the decomposition. To summarize, the overall study indicates that the compost formed is of firm quality, devoid of pathogens, and commercially viable manufactured good [12].
- 20-25% of greenhouse gas emission can be reduced through proper treatment and recycling of the compost and this practice could also reduces the disposal on the landfills. The methods of separating the organic wastes from the different kind of solid wastes through the bag system and fractionation of the organic wastes is also covered by this paper [13].

Conclusion and Future outlook

Inadequate management and handling of waste is a conventional way which is non reliable and should be replaced with the more practical and modern technique such as composting. The amount of solid waste generation and the havoc it creates in the environment is already well known, the rapid industrialization and urbanization has not only adversely affected the mother nature but also this abrupt rise in population created an undelightful situation to the people living till date and on their lifestyle. Moreover, the modernization and technologies were considered as a boon to the human race on the other side of the frame it has become the reason for our own destruction. In order to change the current situation of the organic waste accumulation one should switch towards the more effective and easier to handle technique such as composting instead of incinerating and/or dumping the wastes one can implement composting which not only provide a healthy environment around by reducing the pollution causes by direct burning, emission of greenhouse gases, uncontrollable water, soil and air pollution but also promotes the human health. This review suggests that the world is actually bending towards the green and more sustainable approaches where composting plays an important role in replacing the chemically infused fertilizers with the green and ecofriendly ones. In the current situation, the world is at the alarming state and the work towards this revolutionary change is still be needed to get implemented globally and the change towards green technology still awaits for its complete acceptance and potential use.

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