iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IV **Month of publication:** April 2020

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

Review on Different Composting Techniques to Convert Organic Waste to Compost

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Abstract: ***Composting process is the process to decay the natural waste using microorganisms. Various process such as vermicomposting, composting using black soldier flies, using effective micro-organisms and in vessel composting are studied. These techniques are found useful for composting and parameters affecting composting are studied. Parameters such as pH, temperature, moisture, C/N ratio are studied and efficiency of the methods are found. These composting process are environment friendly and there is less harms to human.***

I. INTRODUCTION

Composting is a process to convert the organic waste to mature compost. Organic waste management is the challenging tasks for many countries. While the methods like landfilling can have hazardous health effects, composting can be an effective method for conversion of natural waste to compost. Global warming is major source for climatic changes. Gases like methane, carbon-dioxide, CFC are emitted by landfills. This gas raises environment temperature by causing green house effect and global warming. By using composting method there is much decrease in the gases. Composting helps in reduction of harmful gases and destroy harmful pathogens. Most of the countries face the problem of organic waste disposal. Landfilling is the commonly used method by municipalities. But this process has disadvantages of harmful gas evolution, odour of gases, global warming. This landfilling cause various harmful diseases to the people living in the neighbouring areas. Hence composting of the organic waste can be an useful alternative to eradicate this disadvantages. Organic waste is the input for the composting process, various micro-organisms, earthworm, decomposing flies are used in decomposing the waste and a mature compost is formed. This micro-organism multiply while consuming the waste and breaking it into compost. The composting process has 3 stages as Thermophilic stage, mesophilic stage and maturation stage. Mesophilic stage is the first stage of decomposition. This is the preparatory stage for decomposition. Later comes the thermophilic stage. Here microbial activity is greater and hence there is maximum temperature rise in this stage. Many harmful micro-organisms are eliminated in this stage. Stabilization of compost starts in this phase. The last stage is the stage of maturation. The compost starts to stabilize in this stage. Bacteria, fungi, actinomycetes and enzymes are major constitutes of micro-organism. They play different role in composting process. Bacteria help in initial decomposition and rise in temperature. Fungi are dominant in curing phase as their growth is hindered at higher temperature. Degradation of lignin compound is done by actinomycetes. They also help in degradation of degradation. Various processes are studied and parameters are studied.

II. VERMICOMPOSTING

Vermicomposting is a technique used to convert organic waste into compost form. This can be used as an organic fertilizer in agricultural fields. This is the most common techniques for converting organic waste by decomposition into compost. Earthworm disintegrate the organic waste into compost of high quality. Earthworm has an ability to consume the substance 5 to 8 times its own weight. This ability is helpful in decomposition process. Earthworm multiplication takes place while the while composting process. The process normally takes place in one to one and half month. The common earthworm species used for vermicomposting process used is Eudrilus-Eugenia, Perionyx Excavates. Eiseniafoetida is also a common used earthworm for the process.

The vermicomposting process is efficient in removing dangerous pathogens, Earthworms release fluid which is called as coelomic fluid, this fluid has antibacterial properties. Although there is not removal of total pathogens but most of the pathogens are eliminated. In the vermicomposting process the substrate is divided into small fragments and then it is converted to compost by earthworm. The whole process is not an exothermic process. Hence the heat evolved is not so much in the process. The earthworm has an ability of humus consumption. They also have the surface dwelling nature. This makes them right choice for the composting process. This abilities make the composting process faster. The total organic carbon is reduced after composting process. The total

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organic carbon is reduced to 10 to 15%. This denotes that composting process has been done in proper manner and compost formed is stable. The lignin cellulose compound are difficult to break down by earthworms. Hence some inhibitor has to be added to break the lignin cellulose compound. When the vermicomposting process is done without adding nitrogen additives it yields less nitrogen in final compost. The higher nitrogen content is required for high quality compost. Earthworm do mineralization of nitrogen present in soil and then converts it into useful nitrogen. The nitrogen compost was reduced to 1.0% to 0.54% in final compost. Earthworm are able to convert carbohydrate to carbondioxide. This leads to stabilization and mineralization of waste. The carbon to nitrogen ratio was reduced to 58% in final compost when the rice straw were composted using vermicomposting. Cattle manure, olive powder are the additives which when added to the compost, increases the nitrogen content in final compost. When the vermicomposting process was observed there was seen a rise in potassium content. The rise was seen to a 2.5% rise in final compost. The compost formed during this process takes a larger span of time. The moisture content is to be maintained at 60% for most efficient composting process and earthworm survival rate.

III. COMPOSTING USING EFFECTIVE MICRO-ORGANISM METHOD

Use of Effective Micro-organism in application of composting has been increasing in recent days. In this method the organic waste is treated with Effective Micro-organism which is available commercially. The effectiveness of process is to be studied. Fertilizer has been prepared by mixing of effective micro-organism with the organic waste like crop remaining like rice straw and animal waste. These effective micro-organisms acts like an accelerator for the decomposition process. The commercial Effective Micro-organism available comprises of yeast, photographic bacteria and Lactic acid bacteria. This method increases the compost quality and accelerates the process which otherwise takes a long time. The solution of EM and water is made in proportion of 5% of EM to 20%water and kept in airtight container for fermentation. Now this is added with organic waste and decomposition process was studied. The water is added to the mixture until the moisture level reaches to 60%. Cover is needed for the process to avoid excessive loss of heat, there is loss of moisture if the mixture is not covered. Hence a plastic sheet was used to cover it. This process is physiochemical process. Care should be taken that there are no toxic compounds should not be present in surrounding for microbial degradation. The process takes the time of about 90 days for compost to manure.

The temperature observed during the thermophilic stage is about 40 degree celcius. Exothermic reaction usually occurs during this stage. Now after the thermophilic stage the decomposition starts and curing starts. The temperature drops to 30-35% in this stage. The thermohilic stage continued for 11 days and later on mesophilic stage and curing stage started. The heat increased during initial stages is due to the respiration and decomposition of sugar starch. The higher temperature at that stage promotes the microbial activity. The change in Ph was observed while initially increasing and later on decreasing in mesophilic and maturation stage. The Ph range from 6-8.5 for the process. The compost formed in this range with help of Effective Micro-organism yielded high quality compost. Proper ratio of Carbon to Nitrogen ratio is essential for proper degradation. The C/N ratio was growing during thermophilic phase and then in decreasing pattern. The C/N ratio is obtained lesser as micro-organism oxidises the carbon and carbon dioxide is released. The ratio obtained was 10.3 when rice straw was treated with EM, this ratio is between 10-20 implies that the mature compost is stable. There was seen a rise in nutrients after decomposition of waste. About 2.5% of nutrients were seen in the final compost. They were 50% more than the decomposition which did not included the EM. Potassium was found to be 0.2% in the final compost. The potassium content has been increased nearly half more with processing with Effective Micro-organism. Potassium helps in elongated roots, improves synthesis of proteins. It also encourages the enzyme reactions to take place and improved rate of photosynthesis. Additives can be added to increase more potassium in final compost.

IV. COMPOSITION BY BLACK SOLDIER FLIES(BSF)

Black Soldier Flies can be utilized in composting process to convert organic waste to mature compost. The high amount of organic waste that is problematic in disposing can be converted to compost through this method. Black Soldier Flies larve had been used for the decomposition purpose. The problem with many decomposition process is decomposition of lignin cellulose. This substance is hard to break in compound to form mature compost. This decomposition can be carried out by Black Soldier Flies Larvae. The BSF is from the stratiomyidae families. These flies are found mostly in tropical, subtropical and American area. The male fly has a bronze abdomen while the female comprises of reddish abdomen. The larve spread about 27mm long and 6mm in width. The larve is maturated in 2 month decomposing the organic compost and converting it into compost. Temperature has an effect on growth and survival of black soldier flies. The higher temperature hinders their growth and decomposition rate. 27-30 degree celcius is the optimum temperature for most efficiency of the process. Maintaining Ph is also important for the process. The Ph in the range 6-10 has been most suitable for the growth of black soldier flies.

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V. COMPOSTING USING IN-VESSEL COMPOSTER

In-vessel composting is an effective method for composting which can be done in house. Reduction in major amount is done in this method. As much as 70% of reduction is possible in organic waste in this method. This method comprises of a rotary drum used for constantly turning rather than manual turning in static pile and vermicomposting method. The organic waste is converted to compost using this method. The layout can be a horizontal or a vertical composter, aerated or non-aerated composter type. The organic waste is put into a composter, additives are added to increase the rate of decomposition and process is carried. Additives to improve nitrogen, potassium content in the final compost can be added to increase the compost quality. The composter vessel has mixing blades which cuts the organic waste and thorough mixing. This increases the speed the process. The parameters were studied further for the process. There occurs an exothermic reaction in the process. Carbon-dioxide and heat are released during the reaction. The temperature observed during the thermophilic stage was observed to be in the range of 60-700c. The temperature drops down in later mesophilic and curing phases. Many harmful bacteria are killed in thermophilic stage, as the microbial activity is most in this region, the heat evolved is maximum in this range. Moisture content plays an important role in maturity of compost. One of the reason for the moisture generation was the condensation of vapour during the heat evolution. Moisture control is done by adjusting turning frequencies. The large amount of moisture content makes the compost sluggish which reduces the compost maturity. Less amount of moisture contain yields to unmatured compost. 40-50% of moisture is essential for highest efficiency of growth. The Ph increases during initial phase and decreases in later stage. Ammonia release during the process increases the Ph of process. The decrease in CO2 level also increases the Ph. The nitrification process also influences the Ph. During the nitrification process, hydrogen ions are reduced and Ph is reduced.

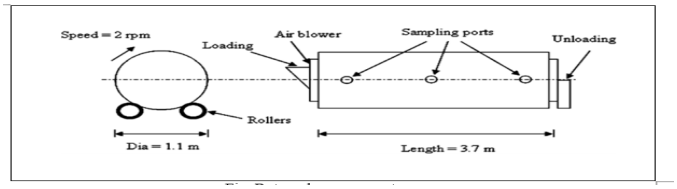

Fig. Rotary drum composter[4]

The pH value of compost was observed between range 6-8. This pH range was considered to ideal for the compost to mature and attain a stability. The amount of organic matter is determined by Total Organic Carbon. Initially the TOC reduced faster and later the reduction rate was slower. The TOC reduction is as a result of mineralization of organic matter. Nitrogen content increases as the compost moves towards maturation phase. Nitrogen fixing bacteria also helps in increasing the nitrogen content in later stages. The nitrogen content was found to be 1.2 to 2%. The nitrogen content increase when the total organic carbon loss is more than loss of NH3. Ammonia loss occurs due to high Ph, aeration and mixing in maturation stages. A good compost should contain higher amount of nitrates than ammonia. The organic ammonia increases as it approaches the maturation stage. The micro-organism utilize the carbon for decomposition and nitrogen helps in cell structure building. The C/N ratio was found in range between 10-20.

VI. CONCLUSION

Hence various methods of composting of vermicomposting, black soldier flies, Effective micro-organisms, in-vessel composter. Vermicomposting process is efficient method but takes a long time. This method also requires a large area for decomposition. The process temperature studied is about 50-60o C. Nitrogen content was found to be 1-0.5% nitrogen content. The moisture content was also found be 60% for efficient. The black soldier fly can be useful composting method for lignin-cellulose decomposition. The growth of the black soldier fly can be a challenging task in countries like India where these species are not found in common. The moisture content for this process was studied to be in range of 40-60% for maximum composting efficiency. The Ph range was in between 6 to 8. More research is needed for the study and evaluation of this process. The commercial Effective Microorganisms are used as an additive to boost composting process. The EM containing of lactic acid bacteria, yeast helps in fast composting process. The amount of nitrogen, potassium and sodium is increased when the composting process is carried with the help of Effective Micro-organism. The temperature range was observed between 50-60oC. The decrease in Total Organic carbon was also in acceptable range where the stable mature compost is formed. In-vessel rotary composter is also an efficient method for inhouse composting. Horizontal, vertical can be the various orientation of the rotor. The nitrogen content of the final compost is 1-1.2%. The temperature range for the process is 60-70oC. The moisture content for the process is 60-70%. Hence the process can be made more effective with using Effective micro-organism with invessel composting machine. While maintaining the required parameters the process of composting can be made faster.

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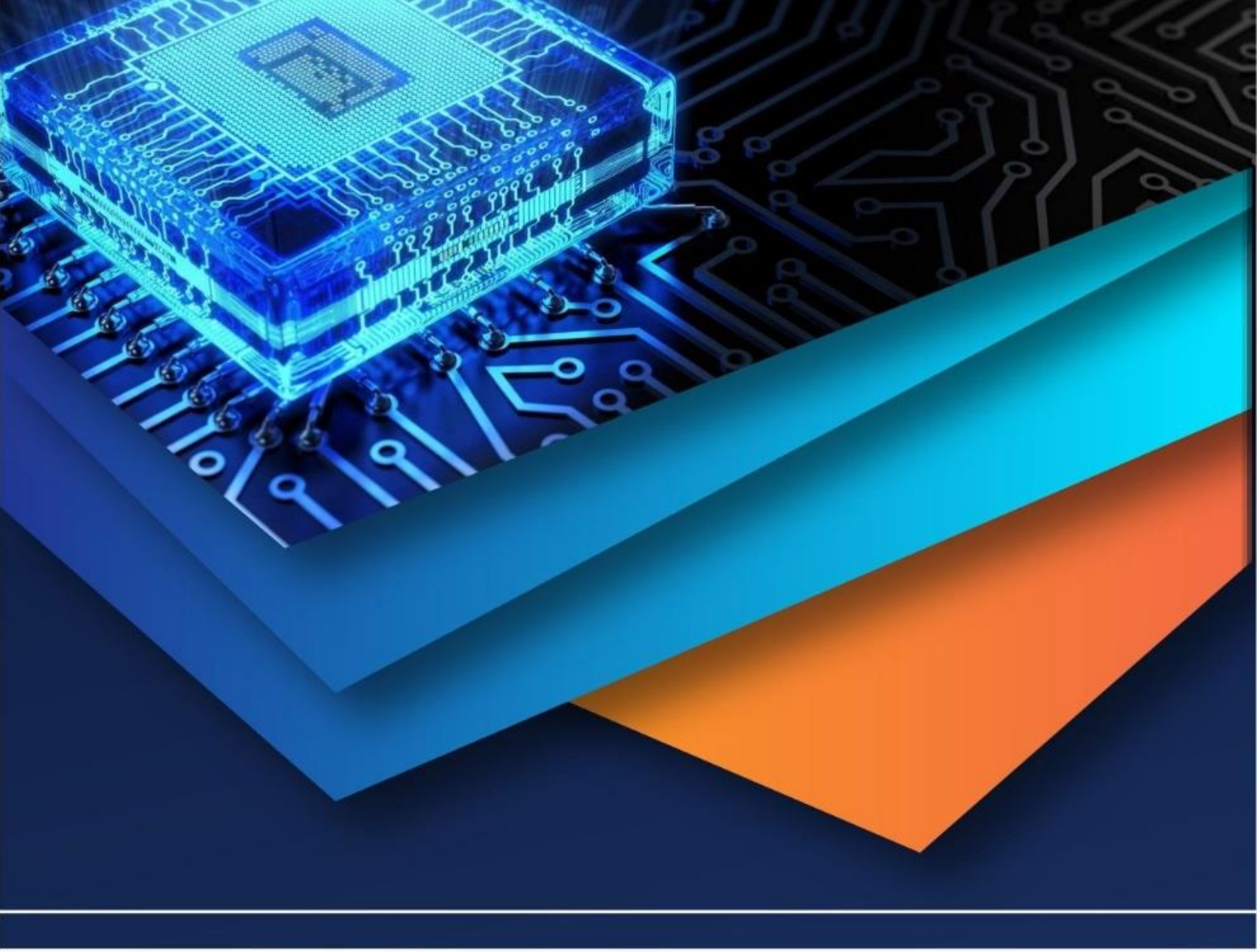

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