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A STUDY ON THE BIODEGRADATION OF MUNICIPAL SOLID WASTE

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ABSTRACT

An alternate method of managing or decomposing Municipal Solid Waste Management (MSWM) is biodegradation. Compared to other conventional methods like composting and incineration, it is far more economical and environmentally friendly. This paper's primary goal is to increase awareness of MSWM biodegradation in Indian cities. Municipal Solid Waste (MSW) includes a wide range of waste, including commercial and non-hazardous industrial waste, treated biomedical solid waste, building and demolition debris, agricultural waste, street sweeping, and domestic garbage and junk. These isolates may be important sources for the microbial variety, according to the review of this research, which focused on the features, collection, transportation, disposal, and various microbial processes of biodegradation. It also discussed their limitations and the process to microbial different MSW dumping sites.

KEYWORDS: *Municipal solid waste; Municipal solid waste management MSWM; biodegradation*

INTRODUCTION

The process by which organic matter is broken down into nutrients that other species can use again is called biodegradation. When used in a microbiological context, "biodegradation" refers to the breakdown of all organic materials by a vast array of living organisms, mostly bacteria, actinomycetes, fungi, algae, and protozoa, as well as the most significant microbe for break down garbage. After using wastes for their own metabolism, bacteria convert harmful toxic compounds into less toxic or non-toxic molecules that are essential for plant growth, soil health, and maintaining the natural ecosystem's equilibrium. Since practically everything in nature is recycled, there isn't any waste in a very broad sense. Furthermore, the intermediate molecules, secondary metabolites, or "waste products" from one creature serve as food or nutrients for other organisms, giving them energy while they continue to work on or break down the so-called waste organic matter. All organic compounds will eventually decompose, albeit some will do so far more quickly than others. [1] [2]

Compared to ordinary landfills, bioreactor landfills are becoming more and more popular for disposing of municipal solid waste (MSW) because of the improved degradation of MSW, which speeds up landfill stabilization and reduces the need for post-closure monitoring. In bioreactor landfills, leachate is recirculated into the MSW to raise the moisture content to the ideal level for improved biodegradation. The physical stability of bioreactor landfills and, consequently, the feasibility of different bioreactor designs are significantly impacted by the fluctuating moisture and solids contents of MSW during decomposition. There are currently several unresolved engineering difficulties pertaining to the design and operation of safe and efficient bioreactor landfills, as well as no standard design recommendations for bioreactor landfills. Inadequate bioreactor design and management have previously resulted in a number of landfill slope failures, raising worries about the technology's effects on the environment and public safety.

In India, one of the most important and mandatory duties of the Urban Local Bodies is solid waste management. Degradation of the environment, health, and sanitation are the results of this service's inability to meet the required standards of effectiveness and satisfaction. Acute solid waste-related issues plague the majority of the nation's cities. Garbage and its management have become persistent issues due to the absence of significant efforts by town/city authorities, even though the majority of municipal expenditures are allocated to this area. With the exception of a few forward-thinking municipal corporations around the nation, the majority of local bodies suffer from a lack of sufficient knowledge and experience, which leads to improper handling of solid waste, which creates health and environmental risks. The lack of proper institutional, managerial, administrative, budgetary, and technical arrangements in the local organizations is emphasized once more.

Maintaining the public environment is the responsibility of solid waste management, a significant, continuous public system that spans the whole city. The system must therefore be logically planned for both the short and long term. Furthermore, as the system manages enormous amounts of solid waste, comprehensive data on solid waste characterization and quantification is required for appropriate solid waste handling at various system stages. Most municipal corporations and councils now do not weigh their garbage; instead, the quantities are estimated based on the number of truck trips that transport the waste to the disposal location. Furthermore, because reliable and pertinent data on trash generation is not readily available, the solid waste management system is not logically planned or implemented. Concerns regarding the economic feasibility and environmental suitability of the current waste management techniques have been raised as a result of the growing amounts of solid garbage in all cities and towns brought on by urbanization and industrialization.[3]

BIODEGRADABLE SOLID WASTE

Biodegradable materials and substances are those that do not contribute to pollution and are easily degraded by bacteria and other natural animals. Microbes (bacteria, fungus, etc.) and abiotic elements (temperature, UV, oxygen, etc.) commonly degrade municipal solid waste, which includes biodegradable rubbish like kitchen waste, green waste, food waste, paper waste, and so on. They are broken down into carbon dioxide, methane, water, and other fundamental natural mixes via a range of processes such as soil fertilization, aerobic digestion, anaerobic processing, or similar approaches. Only when biodegradable rubbish is abundant does it have an effect on the ecology. They can produce a large number of bacteria in the waste, which can cause a variety of diseases to spread to humans, animals, and other organisms. They can also give off a terrible odor, emit specific gasses when burned, and serve as a breeding ground for vermin like rodents and mosquitoes, which can spread a variety of hazardous diseases. Biodegradable waste can be converted into electricity, heat, and energy by anaerobic digestion or combustion. [4]

MSW is defined as undesired material produced by a variety of operations in the commercial, institutional, residential, and agricultural sectors, among others. MSW, according to the US Environmental Protection Agency, is rubbish or garbage that includes common place goods from homes, businesses, hospitals, and schools, such as clothing, furniture, grass, cooking leftovers, appliances, and packaging. Figure 1 displayed the many MSW sources.

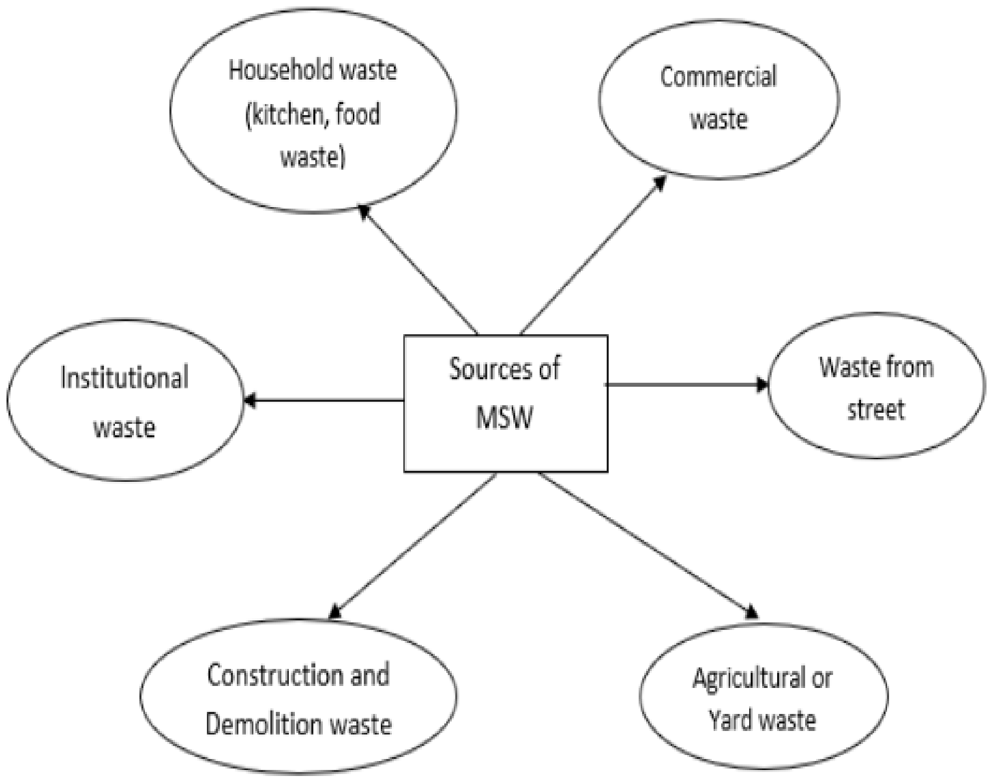

Figure 1: Various sources of MSW

MUNICIPAL SOLID WASTE

Household trash, market garbage, yard waste, street sweepings, and non-hazardous solid waste from commercial, institutional, and industrial facilities are all considered municipal solid waste. Liquid waste management systems are said to be in charge of semisolid wastes like sludge and night soil. It is typically very challenging to separate hazardous industrial and medical wastes from municipal solid trash, especially when their sources are tiny and dispersed, even though they are by definition not parts of municipal solid waste.

Whether it's the wood they cut to create their carts or the bones and other components of the animals they kill for food, humans have been producing garbage since the beginning. The garbage produced got increasingly sophisticated as society advanced. The world of consumers emerged around the end of the 19th century as a result of the industrial revolution. As more and more non-biodegradable solid waste was produced, the air and the ground itself became increasingly contaminated. The rise in municipal solid trash was also primarily caused by urbanization and population growth. consists of waste from roadways, construction and demolition waste, and home rubbish. The volume of municipal solid trash has been rising quickly, and its composition has been shifting due to urbanization, changes in lifestyle, and changes in eating habits. India's cities and towns produced an estimated 6MT of solid trash in 1947, compared to roughly 48MT in 1997. Over a quarter of all municipal solid garbage is not collected at all, and 70% of Indian cities lack the ability to transport it and dispose of it in sanitary landfills. The current landfills are poorly managed, poorly equipped, and improperly lined to prevent soil and ground water contamination.[5]

Characterization of Municipal Solid Waste:

1 Physical Characterization:

To categorize the various waste components, such as biodegradable and non-biodegradable, as well as others (cardboards, thermoscope, leather, textile, etc.), MSW is physically characterized. Adopting the appropriate treatment technologies for a sustainable waste management system depends on the classification of MSW components. Waste was physically characterized using a wet method without samples being dried beforehand. Then, it was separated into several components, such as organics, paper, plastic, wood, metal, leather, textile, and inert. Chemically non-reactive materials that cannot be broken down biologically, such as materials used for building or street sweeping, are categorized as inert materials. To calculate the percentage contribution to trash generation, each separated component was weighed independently. After that, the samples were sent right away to the lab to determine their moisture content.[6]

2. Chemical Characterization:

In order to determine the waste's moisture content, ash content, volatile matter, fixed carbon, and calorific value, the proximate analysis was conducted in accordance with ASTM standards, including ASTM E790, E830, and E897. A bomb calorimeter was used to calculate the waste's gross calorific value. Using a flame Atomic Absorption Spectrometer (AAS), the heavy metals in the MSW were identified using the procedure outlined in ASTM 2003. The elemental analysis includes figuring out the waste sample's C, H, N, S, and C/N ratio. [7]

REVIEW OF LITERATURE

The amount and physicochemical analysis of municipal solid waste in Coimbatore city were studied by Jeyapriya and Saseetharan in 2007. With an average value of 68.94 percent, the study's findings demonstrated that MSW had a high biodegradable proportion. The waste material's high organic content and optimal C:N ratio of 30:1 were indicated by the high percentage of volatile solid content. Additionally, they examined the MSW biocompost's biochemical characteristics. The MSW bio compost was found to contain a moisture content - 27.0%; pH - 7.66; EC - 1.13 dSm-1; total nitrogen - 1.34%; phosphorus - 0.58%; potassium - 1.12%; OC - 24.28%; C : N ratio - 19 : 1; magnesium - 1.33%; calcium - 2.36%; Bacteria - 58 (106 C F U g-1 dry soil); Fungi - 28 (106 C F U g-1 dry soil) and Actinomycetes – 22 (106 C F U g-1 dry soil). [8]

Anaerobic bacterial treatment, according to Sher Singh Gill et al., offers positive results such as removing a higher concentration of organic material, producing less sludge, removing more pathogens, producing more biogas, and using less energy. Sodium hydroxide must be added to the continuously fed digester in order to maintain the alkalinity and neutral pH (7.0). The anaerobic bacterial flora that breaks down kitchen bio-waste undergoes hydrolysis, acidogenesis, acetogenesis, and methanogenesis. [9]

In order to investigate the engineering characteristics of synthetic MSW at various degradation levels, Reddy et al. conducted an extensive laboratory investigation. The goal of the current study is to ascertain the geotechnical characteristics of real-field MSW at various stages of degradation brought on by leachate recirculation. In specifically constructed laboratory bioreactors, actual field MSW samples were gathered from the Orchard Hills Landfill in Davis County, IL, USA, and decomposed. At various stages of degradation, the changes in MSW's moisture content, organic content, and geotechnical characteristics (such as compressibility, shear strength, and hydraulic conductivity) were assessed. The outcomes were compared to previous research on field MSW. [10]

An investigation Paula B., Marta S.P., and Tomasz L. monitored the quantity of MSW disposed of in landfills and investigated the amount of compost and recyclables for recovery. Finding methods to deal with the enormous amount of waste generated has become challenging due to the rising waste output, which has become a serious concern for environmental issues. With the rise in garbage generation, MSW management has become problematic. According to the study's analysis of trash characteristics across various socioeconomic categories and seasons, the lowest income group generates less waste, while the winter months saw the least amount of waste production.[11]

Joshi R. and Ahmed S.'s study on the state of MSW management at the moment found that improper garbage treatment and increased trash creation were the results of rapid urbanization and population growth. According to the report, community involvement is crucial for garbage management. Large cities should establish decentralized waste treatment processing facilities, such as composting units, with community involvement. To be considered a resource, non-biodegradable components should only be recycled in official recycling sectors or industries. Numerous studies carried out in India's mega/metropolitan cities demonstrated the difficulties facing the waste management system as the population and per capita garbage creation increase.[12]

In the study, Reddy KR, Hettiarachchi H, Giri RK, and Gangathulasi J. examined how MSW behaved when leachate was recirculated. The recycling of leachate in MSW accelerates the biodegradation process and increases the production of biogas. From fresh to heavily degraded garbage, MSW's organic content dropped from 84 to 58% and its unit weight rose from 7.12 to 10.79 kN/m3, respectively. From fresh to degraded waste, the permeability decreased from 10-2 to 10-4 cm/sec. The primary compression ratio, which ranges from 0.24 to 0.32, was found to increase with degradation. For the first stage of degradation to the most deteriorated waste, the angle of internal friction drops from 30˚ to 12˚, and waste cohesiveness decreases with vertical tension [13].

OBJECTIVES

1. To study the impact of degradation on stress-strain behavior of MSW.
2. To evaluate effect of municipal solid waste dumping on geotechnical properties of soil.
3. The analysis of elemental composition of MSW.
4. To study of Particle size distribution of MSW at different stages of degradation

RESEARCH METHODOLOGY

The overall design of this study was exploratory. The research paper is an effort that is based on secondary data that was gathered from credible publications, the internet, articles, textbooks, and newspapers. The study's research design is primarily descriptive in nature.

RESULT AND DISCUSSION

The MSW's particle size distribution at different degrading stages is displayed in Figure 1. MSW initially had about 20% of particles smaller than 10 mm, but as it degraded, that percentage rose to around 38% in the severely degraded sample (S6). Particle sizes in the low degradation sample (S2) generally decrease as compared to the high degradation sample (S6), according to the results. Particles disintegrate as a result of degradation, which reduces their size. [14]

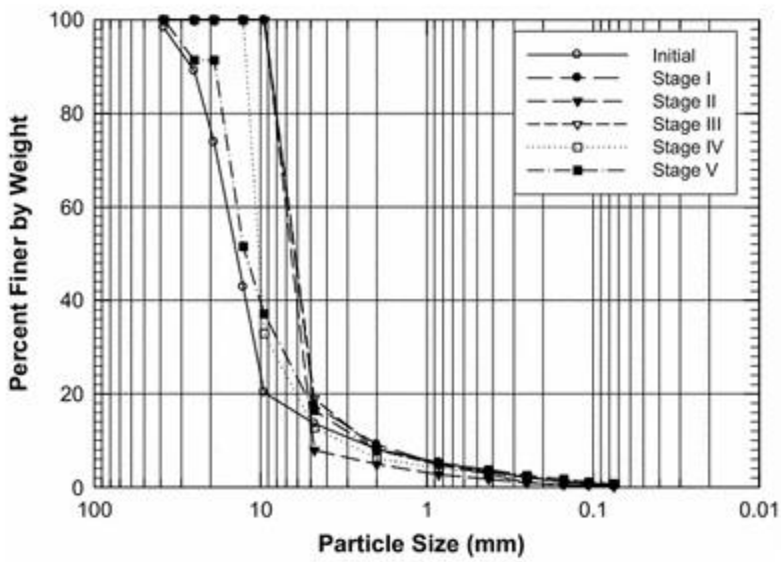

Figure 1: MSW particle size distribution at various degradation stages

Anaerobic biodegradation is a complicated process that necessitates the coordinated action of multiple trophic groups of microorganisms. Understanding this pathway is crucial to understanding how trash biodegrades in landfills.

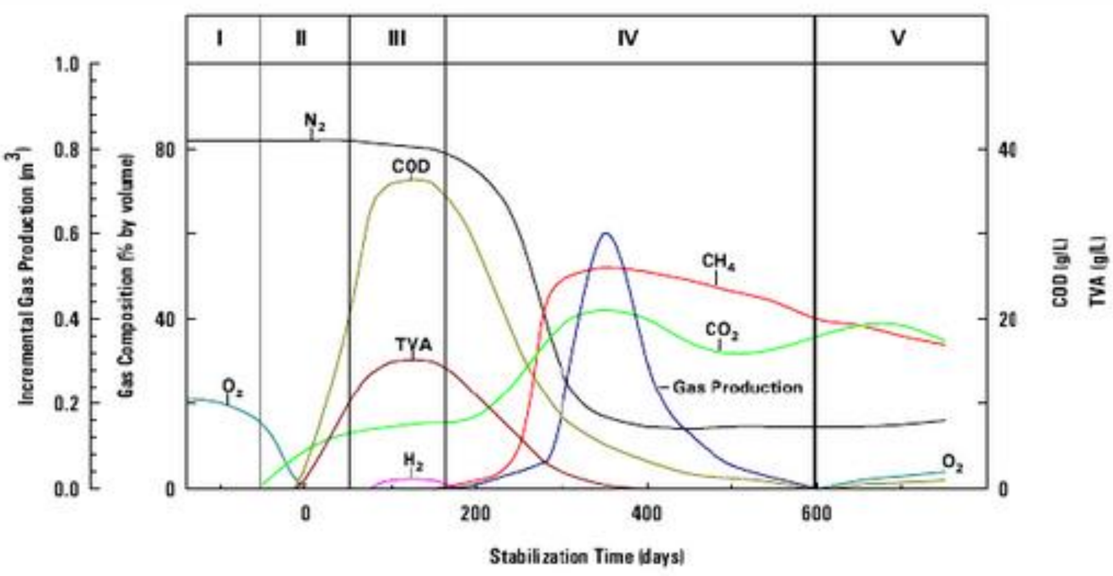

Figure 2: Analysis of Phases of MSW Degradation

Cellulose (C) and hemicellulose (H), which make up between 40 and 60 percent of MSW by dry weight and contribute more than 90 percent of its methane potential, are the main biodegradable components in MSW. However, under methanogenic circumstances, lignin, the other main organic component, is only slowly degradable at best. In household waste, the reported concentrations of

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cellulose, hemicellulose, and lignin vary from 28.8 to 54.3%, 6.6 to 11.9%, and 12.1 to 28% of dry weight, respectively. [15]

Using the ultimate analysis in Table 1, the elemental composition of MSW was examined. The findings showed that the carbon content of the garbage ranged from 28.59 to 37.29% throughout the course of three seasons, with an average of 32.46%. This is higher because the MSW has a higher amount of organic material. [16]

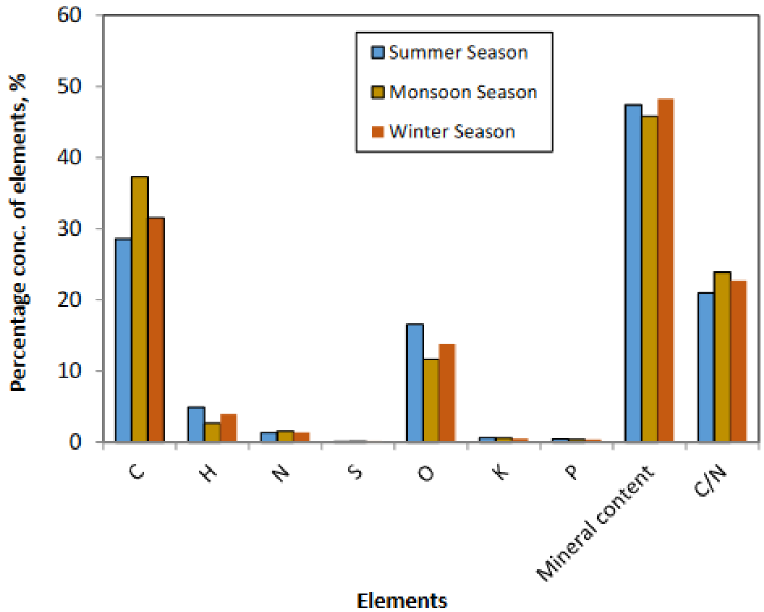

Figure 3: Variation in elements composition for three seasons.

CONCLUSION

An overview of the production of solid waste and the biological processes involved in its breakdown was the aim of this study. Anaerobic mechanisms that mimic landfill degradation were highlighted. High levels of cellulose and hemicellulose, which biodegrade in anaerobic environments, are found in solid waste. The anaerobic biodegradation of solid waste necessitates the cooperative efforts of many microbial populations.

REFERENCES

1. Alexander, M., “Introduction to Soil Microbiology”, John Wiley and Sons, Inc, New York, 1961.

2. Alexander, M., “Biodegradation and Bioremediation”, 2nd Ed.; Academic Press: San Diego, USA, 325-327, 1999.

3. Amar M. Dhere, Chandrasekhar B. Pawar, Pratapsingh B. Pardeshi and Dhanraj A Patil, (25 SEPTEMBER 2008) Municipal solid waste disposal in Pune city – An analysis of air and groundwater pollution, CURRENT SCIENCE, VOL. 95, NO.6.

4. "Why can't I put my leftover gyproc/drywall in the garbage?"; recycling council of British Columbia; 2008 September 19.

5.Municipal Solid Waste, Studies of CPCB. Caltrans Storms Water Quality Handbook Section 8, (March 1, 2003)

6. Rana R., Ganguly R., Gupta A.K., "Physico-chemical characterization of solid waste management from tricity region of northern India- A Case Study", J. Mater. Cycles Waste Manage. 20 (1): 678–689, 2017b

7. Tchobanoglous G., Kreith F., "Handbook of solid waste management", 2nd edn. McGraw Hill 2002

8. Jeyapriya, S.P., and Saseetharan, M.K., "Study on municipal solid waste refuse characteristic and leachate samples of Coimbatore city", Nature Environ. Poll. Techn, 6: 149-152, 2007.

9. Sher Singh Gill, A.M., Jana, and Archana Shrivastav., "Anaerobic Bacterial Degradation of Kitchen Waste – A Review", International Journal of Research and Development in pharmacy and Life Sciences, vol 3, No.2, pp 850-854, 2014.

10. Reddy KR, Hettiarachchi H, Gangathulasi J, Bogner JE (2011) Geotechnical properties of municipal solid waste at different phases of biodegradation. Waste Manag 31(11):2275–2286

11. Paula B., Marta S.P., Tomasz L., "The Analysis of Waste Management in Czestochowa City for the Year 2011-2014", Transportation Research Procedia 16- 24, 2352-1465, Doi: 10.1016/J.Trpro.2016.11.003, 2016.

12. Joshi R., Ahmed S., "Status and Challenges of Municipal Solid Waste Management in India: A Review", Cogent Environmental Sciences 2:1139434, 2016.

13. Reddy KR, Hettiarachchi H, Giri RK, Gangathulasi J., "Effects of degradation on geotechnical properties of municipal waste from Orchard Hills landfill, USA", Int. J. of Geosynth. and Ground engg. 1:24, 2015.

14. Gabr MA, Valero SN (1995) Geotechnical properties of municipal solid waste. Geotech Test J ASTM 18(2):241–251.

15. Wall, D. K. and Zeiss, C., 1995, "Municipal Landfill Biodegradation and Settlement," J. Environ. Eng., Vol. 121, No. 3, pp. 214–224.

16. Alibardi, L., and Cossu, R. (2015). Composition variability of the organic fraction of municipal solid waste and effects on hydrogen and methane production potentials.