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Role of microorganisms in municipal solid waste management -A case study

Nilu Kumari[a]*, Sneha Pandey[a] & Amit Kumar Pandey[b]
[a]Department of Biotechnology, RKDF University, Ranchi, Jharkhand, India
[b]Department of Microbiology, RKDF University, Ranchi, Jharkhand, India

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Abstract- Microorganisms play a vital roles in the maintenance of all the phenomenon whether manmade or natural. They makes survival easier for human beings. So microorganisms are used is in municipal waste management. The proper treatment of the municipal waste generated by humans in their day to day activities is a challenging task faced by government and environmental agencies. A vital way of successfully reducing this problem is by use of microorganisms. Thus, this paper contains many methods of microorganisms used in the management of municipal waste. And also their roles of used in the environment, such as in sewage, soil treatment & energy generation. It also discusses waste generation and its management methods, and some specific uses of microorganisms (bacteria, fungi, algae, virus and protozoa) in waste management. It examines by showing some recent activity in bio techniques waste management. A major challenge to all the countries world-wide is effective management of the waste generated. Waste can be categorized by many methods but by the classic classification is degradable waste, recyclable materials, inert waste, electrical and electronic, composite wastes, harmful waste and Toxic waste. Microbes can continue to exist in the extreme environmental can solve various types of problems of mankind. Municipal solid waste generation in India is about 42 million tons/year and in this microorganism plays an important role.

Key words: Microorganisms, waste management, composting, Fungi, Disposal.

INTRODUCTION

Microorganisms are very essential in nature where they have a variety of important functions. Many microbes are unique to specific environmental surrounding. Microbes play an important role in the naturally recycling of living materials. All substances that are naturally produced are biodegradable in nature, they are broken down by living organisms such as bacteria or fungi. Microorganisms have been used in finding solutions for many problems humans have faced in maintaining the environment such as they have played a beneficial role in human and animal health, genetic engineering, environmental protection, and municipal and industrial waste treatment. Microorganisms have enabled easy and affordable responses which would have been impossible via chemical or physical engineering methods in turn cost would have increased. Moreover, microbial methods have successfully been used to a large number of environmental issues, such as municipal waste management issues. In India with a population of 138Cr, Municipal waste management is a severe threat with various challenges to

*Corresponding author :
Phone : 8210590662
E-mail : nilusingh04@gmail.com

be faced. The municipal wastes in India is caused due to household, farming and commercial sources, which may be characterize into liquid, solid, gaseous which are dangerous and harmful too. But, the most troublesome are the liquid and solid wastes. A lot of harmonized effort must be put into the reduction of wastes at every stages of production, collection, transportation, treatment and at last disposal in order to achieve the results. The scenario of Municipal waste management (MWM) is significantly different between developed and developing nations because developing nations are lacking of proper collection, transportation, recycling and disposal mechanism of waste. So, MWM has become very critical and receives priority due to progressive concern related to environmental degradation and sustainability.[1] In present days it is very compulsory for every country to search the beneficial methods to overcome the problem of waste and issues related with it. Each and every product that are used and thrown away at open places contains very dangerous chemicals which can affect human health than ever before as more than 60,000 chemicals found entry in daily use consumer products.[2] Hence, this paper conclude how microorganisms act as agent of municipal solid waste management, by keeping in view their various roles in the environment, waste generation and management in India.

Role of microorganisms in the environment:

The activities of mankind in environment involve a lot of chemical process in the conversion of natural resources in the environment into other usable forms for consumption. In the process of creating products, pollution is also created by man. As a result, the most authentic solution to the generation of wastes in the environment is such that will conveniently put them back into the environment. That method involves the use of microorganisms (usually yeasts, bacteria, or fungi). These microorganisms or their products are integrated to yield desired industrial products such as bioleaching, biodetergen, biotreatment of wastes, biofiltrations, biomass fuel production, biomonitoring, and so on. Also, microorganisms are important to humans and the environment, as they play important role in the carbon and nitrogen cycles, and also in recycling other organisms' dead remains and waste products through decomposition. Microorganisms also have a vital place assymbionts. Some common examples of the uses of microorganisms in the environment are discussed below:

Sewage treatment:

The majority of all decaying waste treatment methods depend on a large number of microorganisms to decay organic waste matters that are not disposed to sedimentation or flotation. Anaerobic microorganisms are also used to lessen solid waste producing methane gas and a sterile mineralized residue. In potable water treatment, one method that employs, a complex layer is the slow sand filter composed of a wide range of microorganisms to remove all particulate material from water.

Soil treatment:

The nitrogen cycle rely on the fixation of atmospheric nitrogen. Diazotrophs play a vital role in this. This can occur in the nodules of the roots of legumes that contain symbiotic bacteria of the genera Rhizobium, Mesorhizobium, Sinorhizobium, Bradyrhizobium, and Azorhizobium. Nutrients and Minerals in the soil are available to plants with the help of microorganisms that produce hormones that cause growth, stimulate the plant immune system and trigger stress responses. In general, a more diverse soil microbiome results in higher yields and less plant diseases.

Energy generation:

Microorganisms are used in biogas reactors to produce methane and also in fermentation to produce ethanol. Researchers are researching the use of algae to produce liquid fuels, and bacteria to convert various forms of farming and municipal waste into usable fuels. Bacteria with tiny wire-like appendages called nanowires can digest toxic waste to produce electricity. For example Shewanella, can grow oxygen-seeking nanowires when placed in less-oxygen environments. Researchers discovered that when the microbes' nanowires are pierce with platinum electrodes, they carry a current. If these potential can be utilized properly, they can be used in waste treatment plants to simultaneously digest waste and produce power.

Waste generation and management in India:

Municipal Solid wastes is termed as non-liquid and nongaseous products which is caused due to mankind, which is termed as useless, waste, garbage and sludge. The municipal solid waste generation completely relies on the population of that area, Industries and commercial

activities being taking done in the area. India generates about 62 million tonnes of waste each year out of which 43 million tonnes (70%) are collected of which about 12 million tonnes are treated and 31 million tonnes are dumped in landfill sites without proper treatment which is causing problem every day. Most importantly, the amount of municipal solid waste is being generated continuously to and slower is the treatment process. Municipal solid waste management in some part of India is characterized by inefficient collection methods, transportation method and proper disposal system which are causing serious challenge in this era.

S. No.	Name of the state	No. of cities	Municipal population	Municipal solid waste (t/day)	Per capita generated (kg/day)
1	Andhra pradesh	32	10,845,907	3943	0.364
2	Assam	4	878,310	196	0.223
3	Bihar	17	5,278,361	1479	0.280
4	Gujrat	21	8,443,962	3805	0.451
5	Haryana	12	2,254,353	623	0.276
6	Himachal pradesh	1	82,054	35	0.427
7	Karnatka	21	8,283,498	3118	0.376
8	Kerala	146	3,107,358	1220	0.393
9	Madhya Pradesh	23	7,225,833	2286	0.316
10	Maharashtra	27	22,727,186	8589	0.378
11	Manipur	1	198,535	40	0.201
12	Meghalaya	1	223,366	35	0.157
13	Mizoram	1	155,240	46	0.296
14	Orissa	7	1,766,021	646	0.366
15	Punjab	10	3,209,903	1001	0.312
16	Rajasthan	14	4,979,301	1768	0.355
17	Tamil Nadu	25	10,745,773	5021	0.467
18	Tripura	1	157,358	33	0.210
19	Uttar Pradesh	41	14,480,479	5515	0.381
20	West Bengal	23	13,943,445	4475	0.321
21	Chandigarh	1	504,094	200	0.397
22	Delhi	1	8,419,084	4000	0.475
23	Pondichery	1	203,065	60	0.295
		299	128,113,865	48,134	0.376

Source: Status of MSW generation, collection, treatment and disposal in class-I cities (CPCB, 2000).[3]

Municipal Waste management methods:

Municipal Waste management includes collection, transport, processing or disposal, managing and monitoring of waste materials to lessen its impact on mankind and Nature. Municipal solid waste treatment methods reduces the volume and toxicity of solid waste, changes it into a more convenient and usable form. Waste management is seen as a method of source reduction, refuse recycling, controlled combustion and controlled landfill; energy generation from waste, solid waste disposal. A large number of techniques are used in properly managing municipal solid waste, which include supervising, collecting, transporting, processing, recycling, incineration, land filling and bio composting.

Use of microorganisms in waste management:

The microbes that live in the aerobic biological treatment systems include bacteria, fungi, algae, protozoa, rotifers, and other higher animals. The growth of all types of microorganisms in a given industrial waste disposal system rely upon the chemical characteristics of the industrial waste, the environmental limitations of the particular waste system and the biochemical characteristics of the microorganisms. All of the microorganisms which grow in a given industrial waste

disposal system contribute to its over-all characteristics, both good and bad. It is important to recognize the contributions made by each type of organism to the over-all stabilization of the organic wastes.

Bacteria:

The bacteria are the smallest units in aerobic waste treatment systems. The diverse biochemical nature of bacteria makes it possible for them to digest most, organic compounds found in industrial wastes. Aerobic bacteria and facultative bacteria are found in all aerobic waste treatment process. Growth of any species relies upon its competitive ability to obtain a share of the available organic material in the environment. Bacterial predomination will normally divide itself into two major groups: the bacteria using the organic compounds in the waste, and the bacteria utilizing the lysed products of the first group of bacteria. Characteristics of the bacteria, the most important characteristic is their ability to flocculate. All aerobic biological waste treatment process relies upon the flocculation of the microorganisms and their separation from the liquid phase for complete.

Fungi:

Fungi play vital role in the maintaining balance of organic wastes. Like the bacteria, the fungi can digest all organic compound found in industrial wastes. The fungi have the potential ability to predominate over the bacteria but they do not except under unfavorable environmental conditions. The filamentous fungi predominate over the bacteria of low oxygen concentration, low pH, and at low nitrogen. Low oxygen tension results from a low oxygen supply or from a high organic load which causes the demand to exceed its supply. Most of the fungi grow at pH 4 to 5 in comparisons to this some bacteria grow well in competition. But fungi require less nitrogen than bacteria per unit mass of protoplasm, fungi produces more active masses of protoplasm from the wastes than are the bacteria in the waste that lack nitrogen. Bacteria in average produces approximately 10 to 12% nitrogen but fungi range from 5 to 6% nitrogen. Under normal environmental conditions fungi will be present and will aid in the stabilization of the organic matter. But the fungi are of secondary importance and will not predominate. The degradation of plastic by *Bacillus subtilis* is analyzed using liquid culture method and observed that *Bacillus subtilis* degrade plastic in about thirty day or more time period.[4] The different microbes have capability to degrade types of plastic material in a different time span and in different environment. The microbial associated biodegradation has been accepted as a safe clearance of plastic waste but investigation is still ongoing for its enhanced efficiency. Microorganisms have the natural capability to degrade plastic in natural condition. But microbes able to decompose polythene are limited to 17 and 09 genera of bacterium and fungi.

Algae:

The algae are the third form of biological plants which play a part in the over-all stabilization of organic wastes. Since the algae obtain their energy that synthesis from sunlight, there is no requirement to metabolize the organic compounds in comparison like the bacteria and the fungi. To form protoplasm the algae primarily uses the inorganic constituents of the wastes, for example, ammonia, carbon dioxide, phosphate, magnesium, potassium, iron, calcium, sulfate, sodium and other ions. It is possible to have algae and the bacteria predominate together since they do not utilize the same waste components. During protoplasm synthesis the algae release oxygen which is taken by the bacteria to bring about complete aerobic stabilization of the organic matter. In the absence of sunlight algae is needed to obtain the energy required to stay alive from the metabolism of organic matter in the same manner as bacteria and fungi. This organic matter normally comes from stored food within the cell but in some algae it comes from the organic components in the wastes.

Viruses:

These are substances assembled from the biopolymers, which are efficient of multiplying and producing new virus particles in living prokaryotic or eukaryotic cells. Viruses are important as it is removed, retained or destroyed during water and wastewater treatment, bacteriophages can contaminate and degrade the bacterial cultures in the environment.

Protozoa:

The protozoa are the easiest animals found in waste disposal systems. The role that the protozoa play in stabilizing organic wastes has only recently been clarified by combining a study of pure culture protozoa with the natural observations in various biological treatment systems. This study showed that rather than being the primary mechanism of purification, the protozoa were responsible for reducing the number of free-swimming

bacteria, thus aiding in producing a clarified effluent. The succession of protozoa had long been observed in biological waste disposal systems.

Microbial waste management:

Generally, solid waste can broadly be categorized into biodegradable and non-biodegradable. The biodegradables (bio wastes) are those solid wastes generated, which could be decomposed by micro organisms and does not constitute major sources of pollution for a long period of time. They include paper products and wastes of plant origin, wastes of animal origin (faecal matter, carcass, droppings, and poultry waste products). These groups of solid waste even though they are easily degraded by microorganism in minimal time, give off offensive odour and constitute nuisance to the aesthetic environment more than the non-biodegradable solid wastes. On the other hand, non-biodegradable solid wastes are not degradable by microorganisms. This implies that other means of treatment such as incineration, landfill, and recycling are employed as ways of disposing them.

Municipal solid waste management:

Municipal solid waste management reduces or lessens its effect on the mankind and leads to increase in economic development of country and maintain the sustenance of life. Composting is used as biological solid waste treatment method which is the controlled aerobic decomposition of organic waste materials with the help of microorganisms. Composting is a method in which organic waste matte are decomposed and then recycled as compost for use in agriculture and landscaping applications. The most common composting techniques include static pile composting& vermin-composting.

Recent advances in microbial waste management:

The review of recent researcher activity which is applied in microbes to both environmental management and biotechniques is informed by the polluting effects on the world by soil erosion, harmful fertilizers and pesticides, and the improper treatment of sewage these harmful processes have caused in serious environmental and social problems around the world. Notably, biological methods are being used in sustainable environmental and waste management techniques. Some of the techniques are bioremediation, biostimulation, bioaugmentation, phytoremediation, and so on.

CONCLUSION

Waste is any material, which is of no use to anyone. Humans with nearly all activities produce waste. The major component of municipal solid waste is organic fraction, mostly from domestic, agricultural and industrial sources. There are many different methods of municipal waste management. These include physical, chemical and biological methods. Conventional waste management practices usually involve one negative consequence or the other. This necessitated the search for and development of biological methods, with the use of microorganisms which produce environmental-friendly results. Biological methods include the use of microorganisms such as bacteria, fungi, algae, virus and protozoa in process like composting, activated sludge, trickling filters and oxidation ponds. Recent scientific progress in applying microorganisms to environmental management includes hybrid techniques that combine microbial methods with physical and chemical ones; these include landfills, anaerobic digestion and vermiculture technology.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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