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Plastic Waste and their Management

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ABSTRACT

The plastic waste is a serious issue globally. The management of plastic wastes requires urgent solution. The biological approach for the plastic waste management is eco-friendly and economical. The microorganisms can degrade the plastics, which is economical and sustainable approach. The plastic generation types and their management is taken into consideration in this article. The different methods of processing of plastics are also described. The chapter will help to understand the need for plastic waste management.

Keywords: Bacteria, Biodegradation, Fungi, Landfills, Sustainable

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INTRODUCTION

Waste

Waste is anything which does not create value. Solid waste is generated on large scale. Solid waste is defined as organic or inorganic waste produced from household or any other commercial activities (Robinson, 1986). The amount of waste generated in India is increasing daily due to increasing population and GDP. The annual solid waste generation in Indian cities has increased from six million tons in 1947 to 48 million tons in 1997 with an annual growth rate of 4.25 percent, and it is expected to increase to 300 million tons by 2047 (CPCB, 1998). There may be different types of wastes viz., domestic, industrial, e-waste, construction, agricultural, food processing, biomedical, nuclear waste, slaughter house, etc. They are classified as follows:

- Solid waste- vegetable waste, kitchen waste, household waste etc.
- E-waste- discarded electronic devices such as computer, TV, music systems etc.
- Liquid waste - water used for different industries, tanneries, distilleries, thermal power plants
- Metal waste- unused metal sheet, metal scraps etc.
- Nuclear waste- unused materials from nuclear power plants
- Plastic waste- plastic bags, bottles, bucket, etc. The plastic waste is further classified as wet waste and dry waste, hazardous and non-hazardous waste.

Due to lack of proper disposal practices various types of environmental issues, human problems, pollution, and loss of precious resources occur. It is very important to focus on the proper management of wastes because otherwise it causes environmental problems which may be harmful. Management of solid waste involves proper segregation and scientific recycling of all the components is the most ideal way to solve the issues of solid waste. Basic principle of solid waste management includes 4Rs i.e., refuse, reduce, reuse & recycle (https://www.trvst.world/sustainable-living/importance-of-4rs-refuse-reduce-reuse-recycle/). This will help in proper management of plastic wastes. In India waste management practice depends upon waste generation, primary storage, collection, transportation, recycling, treatment and disposal.

Plastics

Plastics are long chain of organic polymeric units (Scott, 1999). These are repeating units of monomers. They are nonmetallic moldable compounds (which are nonmetals present in alloys) and the materials made from them can be of any shape and sizes (Saymour, 1989). These polymers are composed of carbon, silicon, oxygen, hydrogen, nitrogen, and chloride. The most common forms of plastics are viz., polyethylene, polypropylene, polystyrene etc. Plastics create environmental pollution because they are non-biodegradable. (Mukherjee *et al.,* 2011). During the last 25 years, plastics have gained lot of importance due to applications in various industries viz., food, clothing, shelter, transportation, construction and medical (Hidayat *et al.,* 2019).

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Types of Plastics

Plastics are classified based on the chemical structure of the polymer's backbone and side chains. Important groups in these classifications include acrylics, silicones, polyesters, polyurethanes, halogenated plastics. Plastics can also be classified by chemical process for synthesis and also depending on various physical properties. There are mainly two types of plastics, thermoplastics and thermosetting polymers. Thermoplastics are the plastics which when heated do not undergo any chemical changes. Thermosets have infinite molecular weight and can be molded in different shapes (Hidayat *et al.,* 2019). Elastomers are the plastics with netlike crosslinking between the molecules. The examples of elastomers are butadiene resin (BR), styrene butadiene resin (SBR) or polyurethane resin (PUR). The different types of plastics and its uses are mentioned in Table 1.

Table 1: Different types of plastics and its uses.

Description	*Uses*
Polyethylene Terephthalate (PETE)	Soda, water, and beer bottles; salad dressing containers
High Density Polyethylene (HDPE)	Milk jugs; household cleaner containers; juice bottles; yogurt tubs
Vinyl	Shampoo bottles; cooking oil bottles; medical equipment; piping
Low Density Polyethylene (LDPE)	Squeezable bottles; shopping bags; carpet; frozen food; food wraps
Polypropylene	Yogurt containers; ketchup bottles; syrup bottles; medicine bottles
Polystyrene	Meta trays; egg cartons; disposable plates and cups
Miscellaneous	Sunglasses; iPod cases; computer cases; bullet-proof materials

Composition of Plastic

Plastics are divided on the basis of their chemical composition. One category of plastics is made of polymers having aliphatic carbon atoms in their backbone chains and the other category of plastics is made of heterochain polymers. These compounds contain atoms such as oxygen, nitrogen, or sulfur in their backbone chains, in addition to carbon. Plastics are divided into three categories based on their size. The plastic materials with size > 5mm are macroplastics, 50 µm - 5mm are called microplastics and those with < 100nm size are termed nanoplastics (Hahladakis *et al.,* 2018).

Plastic Generation

The usage of plastics has increased sharply from 1.5 million tons in 1950 to 299 million tons in 2013 (Lebreton and Andrady, 2019). The global plastic production is expected to be triple by 2050 (Lebreton and Andrady, 2019). Plastic wastes are approximately 16% of the municipal solid waste. The plastic generated in different countries is represented in Table 2. India is 12th in the list of top 20 countries which disbursing maximum amount of plastic waste. China ranks first followed by Southeast Asia, Sri Lanka, Egypt, Nigeria, Bangladesh and South Africa. The study conducted by University of Georgia calculates that the 275 million metric tons of plastic waste generated by 192 countries in 2010, nearly 8.8 million metric tons entered the world's oceans and seas, including the Indian, Atlanta and Pacific oceans and Mediterranean and Black seas.

Degradation of Plastics

Microbial degradation is the best way for the management of plastic wastes.

Need for Plastic Management

Plastic waste generation poses numerous problems for the environment, humans, soil, animals and plants. So there is the need to manage plastic waste generation. The plastic wastes, thrown on the sides of road, open areas, riverbanks, in drainage canals, and common places results in death and health problems of cattle. Besides, the intake of plastic items by the cows and buffaloes has shown reduction in the yield of milk (Ramasamy and Sharma, 2011). The plastic wastes have become a serious threat to the aquatic life (Md-Jalil, 2013). Plastic factories produce a great amount of greenhouse gases and carbon dioxide which has led to increase in global warming. Many plastics diffuse toxic pollutants to the atmosphere, and also burning of plastics generates toxic fumes. These toxics leak to the soil and groundwater causing contamination of soil and groundwater and due to this the growth of the plants is affected. Plastic contains chemicals that cause damage to the nervous system and immune system and some genetic diseases also along with tumors, birth defects, genetic mutations. Plastic accumulation also affects the growth of many plants and crops. The plastics affect marine animals because they consume the plastics and this causes their death. It also affects wildlife by causing blockage of the gastrointestinal tract and lead to death. Due to serious environmental issues, pollution, and adverse effects of plastics on humans, plants, and animals it is very necessary for the proper management and degradation of plastics.

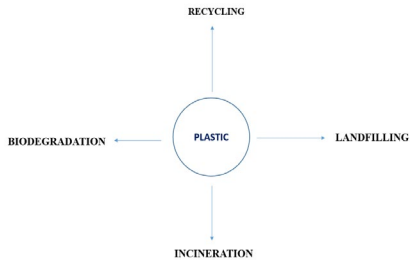

Figure 1: Different process of plastic management

Different Process of Plastic Management

There are different ways for processing of plastic wastes, i.e., chemical, biological approach, etc. (Figure 1).

Landfilling: Landfill is the traditional approach of management of plastic waste. But space for landfills is becoming issues in most of the countries in world (Hopewell *et al.,* 2009). The disadvantage is in the countries where landfills are poorly managed; plastic wastes are thrown into

Table 2: Plastic generated by different countries.

Rank	*Country*	*Coastal population (millions)*	*Waste generation rate (kg/ppd)*	*Plastic waste (%)*	*Mismanaged waste (%)*	*Mismanaged plastic waste (MMT/year)*	*Total mismanaged plastic (%)*
1	China	262.9	1.10	11	76	8.82	27.7
2	Indonesia	187.2	0.52	11	83	3.22	10.1
3	Philippines	83.4	0.5	15	83	1.88	5.9
4	Vietnam	55.9	0.79	13	88	1.83	5.8
5	Sri Lanka	14.6	5.1	7	84	1.59	5.0
6	Thailand	26.0	1.2	12	75	1.03	3.2
7	Egypt	21.8	1.37	13	69	0.97	3.0
8	Malaysia	22.9	1.52	13	57	0.94	2.9
9	Nigeria	27.5	0.79	13	83	0.85	2.7
10	Bangladesh	70.9	0.43	8	89	0.79	2.5
11	South Africa	12.9	2.0	12	56	0.63	2.0
12	India	187.5	0.34	3	87	0.60	1.9
13	Algeria	16.6	1.2	12	60	0.52	1.6
14	Turkey	34.0	1.77	12	18	0.49	1.5
15	Pakistan	14.6	0.79	13	88	0.48	1.5
16	Brazil	74.7	1.03	16	11	0.47	1.5
17	Burma	19.0	0.44	17	89	0.46	1.4
18	Morocco	17.3	1.46	5	68	0.31	1.0
19	North Korea	17.3	0.6	9	90	0.30	1.0
20	United States	112.9	2.58	13	2	0.28	0.9

Source: United States Environmental Protection Agency

water bodies. This causes pollution of the soil and surrounding environment.

Incineration: Plastics are derived from petroleum or natural gas, giving the stored energy value higher than any other material found in the waste stream. The disadvantage of incineration of the plastics is it releases toxic fumes and gases in the air, creating serious environmental problems (Hopewell *et al.,* 2009).

Recycling: Plastics can be recycled, but this method is not fully utilized, due to difficulties in collection and sorting of plastic waste. The effectiveness of recycling depends on public awareness, economic viability, and the infrastructures.

CONCLUSION

The degradation of plastic by microbes (bacteria, actinomycetes, fungi, yeasts) is the most effective solution for the management of plastic wastes. It has many advantages viz., eco-friendly, cheap, and also the microbial biomass is easily available in large amount. This will also be sustainable approach. Research needs to be carried out on a large-scale for the management of plastic wastes.

REFERENCES

1. CPCB 1998. https://nswai.com/docs/An Overview of plastic waste management by CPCB.
2. Hahladakis J, Velis C, Weber R, Iacovidou E, Purnell P. (2018). An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling. J Hazard Mat, 344:179-199.
3. Hidayat Y, Kiranamahsa S, Zamal M. (2019). A study of plastic waste management effectiveness in Indonesia industries. AIMS Energy, 7:350-370.
4. Hopewell J, Dvorak R, Kosior E. Plastics recycling: challenges and opportunities. Philosophical Transactions of the Royal Society B: Biological Sciences. 2009 Jul 27;364(1526):2115-26.
5. https://www.trvst.world/sustainable-living/importance-of-4rs-refuse-reduce-reuse-recycle/
6. Lebreton L, Andrady A. (2019). Future scenarios of global plastic waste generation and disposal. *Palgrave Commun* 5**,** 6 (2019). https://doi.org/10.1057/s41599-018-0212-7.
7. Md-Jalil A, Md-Mian N, Rahman M. (2013). Using plastic bags and its damaging impact on environment and agriculture: An alternative proposal. *Int J Learning Develop,* 3:1-14.
8. Mukherjee K, Tribedi P, Chowdhury A, Ray T, Joardar A, Giri S, Sil AK. (2011). Isolation of *Pseudomonas aeruginosa* strain from soil that can degrade polyurethane diol. Biodegrad 22:377-388.
9. Ramaswamy V, Sharma HR. (2011). Plastic bags - threat to environment and cattle health: A retrospective study from Gondar city of Ethiopia. The Official J Inst Integr Omics Appl Biotech J, 2:7-12.
10. Robinson, W.D. (1986). The Solid Waste Handbook: A Practical Guide, John Wiley and Sons, Chichester.

11. Scott G. (1999). Polymers in modern life. Polymers and the environment. Cambridge, UK: The Royal Society of Chemistry.
12. Seymour RB. (1989). Polymer science before & after 1899: notable developments during the lifetime of Maurtis Dekker. J Macromol Sci Chem, 26:1023-32.
13. United States Environmental Protection Agency.