Potential use of microbial enzymes for controlling plastic pollution in Bangladesh

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Introduction

Plastic has become a part of modern day living, right from packaging to making toys etc. but now this plastic is becoming a problem.

Mainly plastic bags made of polyethylene are held responsible for current uptick in plastic waste generation. Some 14 to 15 million pieces of polythene bags are used everyday in Dhaka city alone and get discarded in trash, garbage or litter after their first use. The most mismanaged plastic waste is single-use plastics like shopping bags, packs, and wrappers. According to another study by the Environment and Social Development Organization, annually 87,000 tones of single-use plastics, including plastic bags, bottles, cups, plates, and straws, are thrown away in Bangladesh.

The most damaging effect by plastic litter to surrounding air can be attributed to intentional or incidental open-fire burning. In most cases, incineration of the plastic wastes is done to reduce the volume which causes not only environmental pollution but also energy loss since valuable fuel could be extracted from plastics through pyrolysis. The air pollution is caused by the noxious fumes released into the atmosphere during plastic combustion. Plastic burning generates highly toxic gases such as hydrogen chloride, hydrocyanic acid, carbon monoxide, carbon dioxide etc.

Biodegradation process

Ways to control plastic pollution:

Biodegradation is the process of decay caused by bacterial or fungal action. This term has close affinity to the sewage treatment, environmental remediation (bioremediation) and to plastic materials. The microorganisms plays important role in this process of decomposition. They are the real recyclers of the nutrient in the soil.

It is the breakdown of toxic chemicals (xenobiotic) to simpler non toxic or comparatively harmless compounds like CO2, H2O, CH4 etc. By microbes by synthesis of certain enzymes.

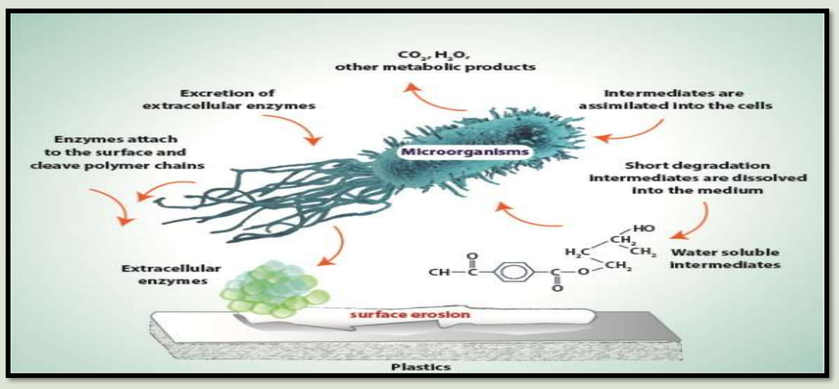


Figure: Plastic degradation by microbes.

Biodegradation rates are known to be affected by such factors as the availability of inorganic nutrients, the presence of multiple substrates, the redox environment, substrate concentration, temperature, water activity, and the adaptive response of the microorganisms

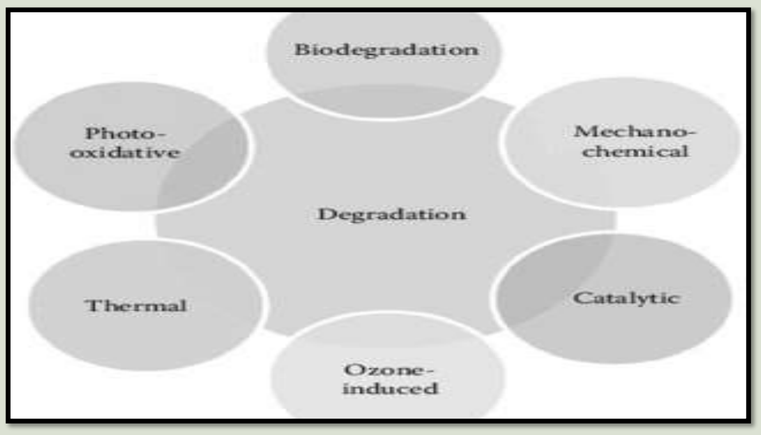


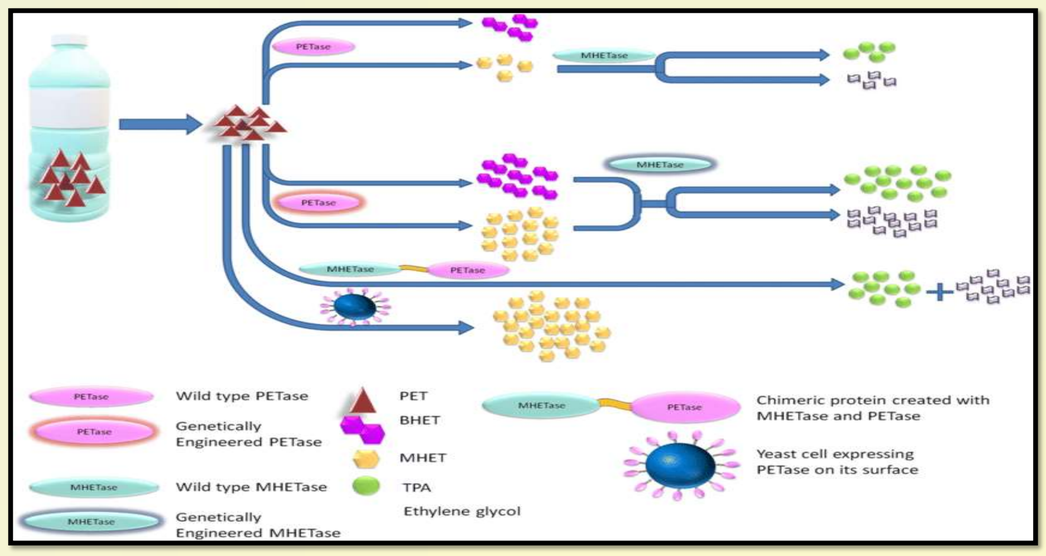
Figure: Factors affection biodegradation

It is the degradation of plastic by living organism. There are many microorganisms specially bacteria and fungi that have a mechanism to degrade large and complicated hydrocarbons into simpler biomolecules.

Mostly by fungi and bacteria such as *Bacillus sps.*, *Pseudomonas sps.*, *Streptomyces sps.*, *Staphylococcus sps.*, *Aspergillus sps.*, *Mucor sps*. Etc.

PETase and MHETase

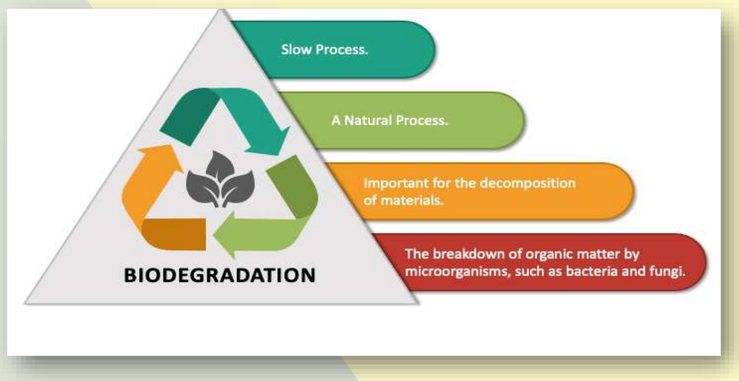
Today the world is facing problem related to spread of plastic all around us which cause infection and pollution. PET {poly(ethylene terephthalate)} is extensively used throughout the world. PET is made from petroleum and is widely used in textile industries and plastic bottles. Most of the PET product simply end up by land filling and never enter the recycling process. About 56 million ton of PET was produce worldwide in 2013 alone. Currently the only PET products being recycled are bottles, but the amount of recycled account are just 37% of the total production volume of PET bottle i.e. 6.13 million tons. Currently the chemical method is being used to recycle PET waste, which is quite energy consuming process and shows only assimilation of PET waste. Various microorganisms have also been reported to assimilate PET waste. However, assimilation is not the final solution of this problem as it is only a partial degradation. Recently, a novel microorganism Ideonella sakaiensis strain 201-F6 has been identified which uses PET as an energy resource and is able to produce environment friendly bi products such as ethylene glycol and terephthalic acid. Scientists also discovered two enzymes (PETase and MHETase) produced by the strain 201-F6 which hydrolyze PET. Based on the property of PETase and MHETase it is now understood that the strain 201-F6 is capable to use PET as its major energy source and convert it into easily degradable components.



Conclusion

Plastic have been industrially produced and widely incorporated into consumer products. However due to their rampant use and production, our government and Eco balance is being threatened. The best solution to this, is biodegradation of plastic by scavenging microbes. However, only a few fungi and bacteria having the ability to degrade plastic have been found.

Microbial degradation of plastics is better than chemical processes, burning or landfilling, because it consumes less energy and is environment friendly option in Bangladesh. But the diversity of microbes and enzymes that can degrade plastic is still limited. So the future prospects include identification, isolation and modification of microbes against all the synthetic plastics.



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