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Biodegradation of polyethylene by microorganism isolated from garbage soil

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ABSTRACT

Polyethylene being xenobiotic compounds, resistant to degradation, constitute about 5-8 percent of dry weight of municipal solid waste. Polyethylene are resistant to biodegradation, leading to pollution, harmful to the natural environment. The objective of the research project is to isolate such a microorganism which are isolated from garbage soil and had the ability to degrade Polyethylene. Municipal Corporation in many constricts view the carry bags as the chief culprit behind the environmental pollution. Biodegradation of polythene were analyzed after 4, 6 and 8 months of incubation. The microbial species found associated with the degrading materials are *Pseudomonas* species (Gram negative) and three species of fungi (*Aspergillus glaucus, Aspergillus flavus* and *Aspergillus niger).* Among the bacteria *Pseudomonas* species degraded 22.70% of polythene in four months period. Among the fungal species, *Aspergillus glaucus* degraded 26.02% of polythene in four months period. Study of enzyme responsible for the degradation of plastics and its extraction will be observed later. This work reveals that microorganism isolated from garbage soil are capable of degrading polythene.

Key words: xenobiotics, biodegradation, *Pseudomonas sp.* , polythene and *Aspergillus glaucus.*

Plastic cause environmental pollution and there is an urgent need to develop efficient microorganisms to degrade to solve their global issue. There are different methods for disposal of plastics such as, incinerating, recycling, landfills, and biodegradation. The ability of microorganisms to degrade extracellular polymers depends on the secretion of specific depolymerases that hydrolyze the polymer to water soluble products. A very general estimate of world wide plastic waste generation is annually about 57 million tonnes[2]. The tests conducted were motility test, glucose oxidation, penicillin sensitivity, and glucose fermentation

for gram-negative bacteria, dextrose fermentation, catalase and glucose utilization for gram-positive bacteria. The fungal strains were identified after staining them with cotton blue, by following the keys of Raper and Fennell[8]. Polythene bags and soil samples were collected from the municipal garbage was rich in plastic wastes. Bacterium was isolated from these samples and was maintained on nutrient agar slants after culturing. The bacterium was identified by differential, selective, morphological, cultural, and biochemical tests, using Bergey's manual of systemic bacteriology.

Low density polyethylene (LDP) used in everyday life were obtained from plastic manufacturing factories. Low density polyethylene was used .The polythene were treated with conc. HNO_3 for 24 h at room temperature and then boiled for 4 h.The preweighed discs of 1cm diameter prepared from polythene bags were aseptically transferred to the conical flask containing 50 ml of culture broth medium and are inoculated with different bacterial and fungal species separately. Nutrient broth medium was used for bacteria and Rose Bengal broth medium for fungi. Control was maintained with plastic discs in the microbe-free medium. Four flasks were maintained for each treatment and left in a shaker. After four month of shaking, the plastic discs were collected, washed thoroughly using distilled water, shade-dried and then weighed for final weight.

Once the organisms get attached to the surface of the polythene it start growing by using the polymer as the carbon source. The degradation is due to the extra cellular enzyme secreted by the organism. Two types of the enzyme involve in the process namely intracellular and extracellular depolymerases. Exoenzyme from the microorganisms first breakdown the complex polymer giving short chain or monomer that are small enough to permeate through the cell walls to be utilized as carbon and energy sources. The process is known as depolymerization Dey, *et.al.,*[4]. Kathireson[6] has reported isolating fungi from the mangrove soil which has the potential to degrade polyethylene. In most studies fungi were considered for the degradation of LDPE due to their ability to form hydrophobic proteins that can attach to the polymer surface[9]. Their generation of degrading enzyme that are well matched to the insoluble LDPE (Shati *et el.*, 2008), the faster growth of fungal biomass compared to bacteria[6] and the growth intension and penetration into other location through the distribution of hyphae. Also fungi survive in the environment with low nutrient, low pH and low moisture as well. The ability of microorganism to degrade extracellular polymer depends on the secretion of specific depolymerase that hydrolyze the polymer to water soluble product.

From the data collected, weight loss of polythene bags, was calculated. This reveals that among microbe *Aspergillus glaucus*, *Aspergillus flavus* and *A. niger* are efficient in biodegradation. Ranging from 24.82 to 40.10% for polythene. Among the bacteria, *Pseudomonas* sp. were found most active in degrading 22.70% to 35.10% of polythene from four to eight months period. Among the species, *Aspergillus glaucus* was more active than *Aspergillus niger* and *Aspergillus flavus* in degrading polythene within four months. Among these microbes, the strains of *Aspergillus glaucus*, *A. niger*, *Pseudomonas* sp. are efficient in biodegradation.

Table-1. Comparative analysis of Polythene weight Loss with different Microbial species In Shaker Culture under Laboratory conditions

	Microbial degradation (% Weight Loss)		
Name of microbes (Bacteria)	**4 months**	**6 months**	**8 months**
1. *Pseudomonas* sp.	22.70±0.02	31.20±0.01	35.10±0.01
2. *Bacillus* sp.	10.09±0.01	19.10±0.12	25.02±0.02
(Fungi)			
1. Aspergillus niger	24.82±0.02	30.02±0.02	38.10±0.01
2. Aspergillus flavus	15.60±0.31	21.82±0.31	28.32±0.25
3. Aspergillus glaucus	26.02±0.18	30.01±0.01	40.01±0.01

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