Degradation of Polymer by using Fungi: A Review

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Abstract

Polymer is an essential cause of environment pollution. plastic is a widely name given to different polymers with high molecular weight, which can be degrade by various process. Literature survey shows that investigates the possibility of various plastic degradation by various fungi and various microorganisms. Polymer are highly resistant to degradation by using fungi and microorganisms is a great challenge. Important chemical chain wear detects by Fourier transform infrared spectroscopy(FTIR). The degrading ability of fungi and microorganisms was evaluated by Scanning electron microscopy (SEM), co2 production.
Keyword- Polymer Degradation, Fungi, Microorganisms

I. INTRODUCTION

A polymer Greek word poly means "many" and mer means "parts" is a large molecule, or macromolecule, composed of many repeated subunits. Because of their wide range of properties, both synthetic and natural polymers play an essential and universally role in everyday life. Polymers range from familiar synthetic plastics such as polystyrene to natural biopolymers such as DNA and proteins that are fundamental to biological structure and function. Polymers, both natural and synthetic, are created via polymerization of many small molecules, known as monomers. Their consequently large molecular mass relative to small molecule compounds produces unique physical properties, including toughness, viscoelasticity, and a tendency to form glasses and semi crystalline structures rather than crystals.

Approximately 140 million tonnes of synthetic polymer are produced worldwide each year. In many countries, plastic are disposed of through open, uncontrolled burning and land filling. Open burning releases pollution in to the air that could cause various health problems. Lack of degradability and the closing of landfill site as well as growing water and pollution problem have led to concerns about plastic. Many degradation techniques have been applied but biologically degradation technic is not more expensive competitively chemical and thermal degradation.

A. Types of Polymer

1) Natural Polymer

Natural polymeric materials such as shellac, amber, wool, silk and natural rubber have been used for centuries. A variety of other natural polymers exist, such as cellulose, which is the main constituent of wood and paper.

2) Synthetic Polymer

The list of synthetic polymers includes synthetic rubber, phenol formaldehyde resin (or Bakelite), neoprene, nylon, polyvinyl chloride (PVC or vinyl), polystyrene, polyethylene, polypropylene, polyacrylonitrile, PVB, silicone, and many more.

B. Polymer Degradation

Polymer degradation is a change in the properties—tensile strength, color, shape, or molecular weight of a polymer or polymer-based product under the influence of one or more environmental factors, such as heat, light, chemicals and, in some cases, galvanic action. It is often due to the scission of polymer chain bonds via hydrolysis, leading to a decrease in the molecular mass of the polymer.

Although such changes are frequently undesirable, in some cases, such as biodegradation and recycling, they may be intended to prevent environmental pollution. Degradation can also be useful in biomedical settings. For example, a copolymer of polylacticacid and polyglycolic acid is employed in hydrolysable stitches that slowly degrade after they are applied to a wound.

C. Types of Degradation

1) Photoinduced degradation
2) Thermal degradation
3) Chemical degradation

– Solvolysis
– Ozonolysis

– Oxidation
4) Galvanic action
4.Biological degradation

Biodegradable plastics can be biologically degraded by microorganisms to give lower molecular weight molecules. To degrade properly biodegradable polymers, need to be treated like compost and not just left in a landfill site where degradation is very difficult due to the lack of oxygen and moisture.

Biodegradation is the chemical dissolution of material by bacteria, fungi or other biological means although often conflated biodegradable is destined in meaning from compostable.

II. VARIOUS FUNGI AND MICROORGANISMS USED FOR DEGRADATION OF VARIOUS PLASTIC

Immanuel O. M., Ibiene A. A. and Stanley H. O.,at carried out an study The biodegradation of naturally weathered polyethylene films by two Aspergillus species isolated from Niger Delta mangrove soil. Low-density polyethylene (LDPE) and high-density polyethylene (HDPE) films were exposed outdoor for 24 weeks. The two Aspergillus sp. utilized the polyethylene films as sole carbon sources. The isolates were identified as Aspergillusjaponicus and Aspergillusterreus. The mean heterotrophic fungal count in the mangrove soil ranged between 1.5 x 10 3 - 6.5 x 10 4 respectively. The rate of degradation was determined by measurement of the residual weight of the polyethylene films. The result of biodegradation by the molds after 45 and 60 days of incubation showed reduction in dry weight of the films ranging between 10.70%-22.54%.(1) Vishnu sing and manishdubay et.al carried out experiment Microbial Degradation of Polyethylene (Low Density) By AspergilliusFumigatus and Penicillium Sp. Polyethylene degraded ability checked by using Aspergilliusfumigatus and Penicilliumsp . During the incubation period for 30 days at o28±1 C temperature, find out the degraded percentage of polyethylene (low density). The initial and the final dry weight of polyethylene (low density), compared and calculated the percentage of degraded percentage polyethylene (low density).Penicillium sp. was found most effective in degrading polyethylene (low density) with 6.58 % degradation respectively.(2) Dede Mahdiyah1, Elpawati and BayuHariMukti carried out an experiment Bacteria was isolated used NA medium and TSA medium were incubated for five days. Isolates were resulted towards analyzed 1 month of incubation in liquid culture method at 37ºC with agitation 130 rpm. The biodegradation of polyethylene was resulted by isolate of 22 TSB (used medium Tryptic Soy Broth) were 17% in 1 month. Microbial counts in the degrading materials were recorded up 3.08 x 106. Phanerochaetechrysosporium has been found to degrade LDPE blended with starch incubated in soil. P. chrysosporium was able to degrade LDPE more than 50%, then P. chrysosporium grown on media other than soil degradation occurs only 12%. (3) v.mahalakshmi and s.niren Andrew, carried out experiment, Three different pretreatment strategies were employed for the present study. In the first, PE films were thermally treated at 100ºc in an atmosphere of air for 30 days to induce oxidation and in the second they were subjected to UV light (UV-C,>300nm wavelength) for 10 days. Thirdly, they were suspended in concentrated nitric acid to enhance percent elongation for 10 days. These pretreated samples along with the untreated PE films were used as the sole carbon source for isolation of PE degrading strains. Submerged cultures with PE as the sole carbon source were inoculated with the isolated fungal strains and assessed for polymer biodegradation by weight loss, estimation of total carbohydrates and total protein in the culture supernatant.(4)

Chondesonal G et al,2012 carried out an experiment to study on degradation of nylon 6. The analysis was carried out using I.R spectroscopy and mechanical techniques. Nylon sheet wear inserted in fermentation broth which was incubated on a rotary shaker at 30ºc and 90 rpm for 90 days. reduction in weight was found to be 0.006 gm after degradation of 90 days and reduction of thickness 0.035mm. reduction in weight and thickness after degradation of 75 and 90 days was found to be 0.006gm and 0.035 mm.(5) Jozefafriedrich, polonazalar et al,2007 carried out an experiment 58 fungi have been tested for their ability to degrade a recalcitrant synthetic polymer -6, generally known as nylon-6. Most of them wear isolated form a factory producing nylon-6. After preliminary screening, 12 strain were selected llecsubmerged culture in a medium with nylon fibres as the only N-source. No degradation was observed with the isolates from the factory, wood degrading fungi from a culture collection, however, degraded nylon after incubation for several weeks. Bjerkanderaadusta disintegrated the fiber most efficiently. Starting with the small transverse grooves, which deepened into cracks. The superficial layers crumbled to leave a thin inner core of the fiber, which finally broke down into fragment. The reaming insoluble part of the nylon showed a decrease in number average molecular mass from 16900 to 5600 during a 60 days' incubation. After 50 days, the total nitrogen content of the soluble fraction was 10-fold higher than in the control sample. Manganese peroxidase, presumable responsible for the degradation, was detected in the liquid phase. The study shows that only white rot fungi are able to break down nylon-6(6). Koichirotachibana, kazuhikohashimoto**,** et.al (2010) carried out an experiment two kinds of microorganisms, a bacterium and fungus, degrading nylon 4 (polyimide 4), which was easily prepared by the anionic ring-opening polymerization of 2-pyrrolidone, wear isolated from the composted soil with the utilization of enrichment cultures and the culture using nylon 4 as a carbon source. Bacterium &fungus strain wear identified as neighboring species to stenotrophomonas sp. And fusarium sp., respectively, by their morphological properties and the nucleotide sequences. These strain were confirmed to grow in the culture medium containing nylon 4 powders as a carbon source. Nylon 4 film was decomposed in both mineral media containing bacterium and fungus strains, respectively, and disappeared within two months. At least fungus strain in inferred to recognize the acyllactrum or carboxy type chain end structure and degrade them or their neighboring amide bond in nylon 4.(7)

Sachin sakhalkar and Dr.R.L Mishra, carried out an study deals with the isolation of polyethylene degrading fungi and to test their ability for plastic degradation in laboratory condition. PVC is used as plastic material. Fungal organisms with the

ability to degrade poly vinyl chloride were isolated in synthetic medium supplemented with PVC powder and these organisms were used for degradation study. Several methods are employed to monitor the biodegradation of the polymers. Colonization study with the fungi showed a result of visible decrease in the polymer weight of fungus after 04 to 12-week incubation. The difference in before and after treatment weight of polymers by respective fungi species are given in table. This data reveals the highest degradation potential is by Aspergillusflavus Link. and least by Chrysoniliasetophila (Mont) Arx.(8)

Sr.no	*Name of fungus*	*Weight loss of polymer in gm PVC*
1	*Aspergillusversicolor gr.*	*0.210*
2	*Aspergillusniger gr.*	*0.241*
3	*Aspergillusflavus link.*	*0.419*
4	*Chrysoniliasetophila*	*0.145*
5	*Penicillium sp.*	*0.182*

III. CONCLUSION

The summery of review carried out degradation of polymer is possible by fungi and microorganisms. Soil contains microorganisms that are able to bring about some degradation of polymers. Pseudomonas spp, streptococcus spp and moraxella spp are able to degraded polymer. aspergillus Niger, penicillum sps , aspergillus flavus link this three fungi give better result compare to other fungi.

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