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Biodegradation of Polyethylene by Using Fungal Isolates

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ABSTRACT
Plastic wastes accumulating in the environment are posing an ever-increasing ecological threat. Plastics that are biodegradable can be considered environment-friendly. They have an increasing range of potential application and are driven by the growing use of plastics in packaging. In this study, the biodegradation of Polyethylene bag was analyzed for two months of incubation in the liquid culture medium. The microbial species associated with the degrading materials was 'fungal isolates', isolated from Polyethylene collected from garbage dumped soil. The efficiency of microbes in the degradation of plastics was analyzed in liquid (shaker) culture medium. The culture medium was kept for two months and media was changed after 10 days duration. This work reveals that fungal isolates possess greater potential to degrade plastics up to 16% within two months.
Keywords: *Biodegradation, degradation, plastics, polymers.*

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INTRODUCTION

Any physical or chemical change in the polymer as a result of environmental factors such as light, heat, moisture, chemical conditions and biological activity is termed as degradation. Biodegradable polymers are designed to degrade upon disposal by the action of living organisms. The microbial biodegradation is widely accepted and is still underway for its enhanced efficiency [1].

Plastics are defined as the polymers (solid materials) which on heating become mobile and can be caste into moulds. Approximately 30% of plastics are used worldwide for packaging applications and the most widely used plastics for packaging are Polyethylene (LPDE, MDPE, HDPE, LLDPE), polybutylene (PB), polystyrene (PS), polyvinyl chloride (PVC), polyurethane (PUR). Pure plastics generally have low toxicity due to their insolubility in water and relative chemical inertness. Some plastic products can be toxic due to the presence of some additives in them. For example, plasticizer like adipates and phthalates are often added to brittle plastics like polyvinyl chloride (PVC) to make them pliable enough. Traces of these compounds can leach out of the product. The compounds leaching from polystyrene food containers have been proposed to interfere with hormone functions and are suspected human carcinogens. The finished plastic is non-toxic, the monomers that are used in the manufacture of the parent polymers may be toxic. Polyethylene surface consequently enhances biodegradation of the polymers. Once the organisms get attached to the surface, starts growing by using the polymer as the carbon source. In the primary degradation, the main chain cleaves leading to the formation of low-molecular-weight fragments (oligomers), dimers or monomers. The degradation is due to the extracellular enzymes secreted by the organism. These low molecular weight compounds are further utilized by the microbes as carbon and energy sources. The resultant breakdown fragments must be completely used by the microorganisms, otherwise, there is the potential for environmental and health consequences [2-7].

Microbial degradation of a solid polymer like Polyethylene requires the formation of a biofilm on the polymer surface to enable the microbes to efficiently utilize the non-soluble substrates by enzymatic degradation activities. Development of multicellular microbial communities known as biofilm, attached to the surface of synthetic wastes has been found to be powerful degrading agents in nature. When the total biodegradation process of an organic substrate is considered, the formation of the microbial colony is critical to the initiation of biodegradation. Thus, the duration of the microbial colonization is an important factor that effects total degradation period.

MATERLA AND METHODS

Sample preparation:

Microorganism (fungus) was isolated from soil, air and thumb impression. Fresh potato dextrose agar Petri plate were prepared for isolation of fungus. Isolates from soil sample were utilized for further examination. The serially diluted soil sample was spread on Petri plates and incubated at 37˚C for 49 hours.

Isolation of fungus:

Further streaking on PDB plates was done with green coloured fungus obtained from a soil sample. This fungus was again inoculated in PDB broth and kept in shaker incubator for 49 hours.

Biodegradation of plastics by fungal isolate:

Polyethylene was inoculated with a purified fungal strain in PDB two months. Media was changed after every 10th day. Total degradation of Polyethylene was calculated using following formula:

Weight of Degraded Polyethylene, $W_0 = W_i - W_f$

Where, W_i = *initial weight of Polyethylene*

W_f = *Final weight of Polyethylene*

The degradation percentage by isolated fungus was calculated by following formula:

$$\% = (W_0 / W_i) * 100$$

RESULT AND DISCUSSION

It has been examined that fungus is compatible with degrading polyethene at a fast pace. According to our examination, the fungal isolate showed 33% biodegradation in two months. The initial weight of polyethene was measured .6g. On day1 of inoculation, low fungal growth with no change in fragility and texture was observed in the inoculated piece of PE. On day25, good fungal growth with little fragility and shrunk size was observed because the fungus started utilizing polyethene as its substrate. On day45, over fungal growth was observed with fragile pieces of polyethene in the culture medium. The final weight noted was .4g of the inoculated polyethene. With help of this study, it is clear that most recalcitrant polymers can be degraded to some extent in the appropriate environment at the right concentration [8-9].

Days	Wt. of P.E	Fungal Growth	Fragility	The texture of P.E.
1	Initial wt.-0.6g	Little turbid media	No Change	No change in P.E texture
25	-	Good fungus growth	Very little fragile	Fungus started using P.E. as a substrate due to which it shrank in size.
45	-	Over Fungal growth	Increase in Fragility	P.E. appeared in fragile pieces.
60	Final wt.-0.4g	Fungal sheath attached to P.E.	Broken into pieces	P.E. broken and shrank

This study has covered the major concerns about the natural and synthetic polymers, their types, uses and degradability also it has looked at the disposal methods. Another area examined has been the biodegradation of plastics by the liquid culture method.

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