



Biodeterioration of Polyethylene High Density by *Aspergillus versicolor* and *Aspergillus terreus*

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Abstract: The present article investigates the biodeterioration ability of polyethylene high density by *Aspergillus versicolor* and *Aspergillus terreus*. Shake flask incubation for 30 days was done for the purpose of biodeterioration of polyethylene high density. The observations were recorded for initial and final dry weight of polyethylene high density before and after incubation in the culture medium were compared the percentage of biodeterioration of polyethylene. The strongest ability was observed by *Aspergillus terreus* with 7.59% biodegradability followed by *Aspergillus versicolor* with 3.79% of biodegradability. In conclusion, *Aspergillus terreus* was found to be efficient organism that degraded the polyethylene high density with maximum biodegradability as compared to *Aspergillus versicolor*.

Keywords: Polyethylene, *Aspergillus versicolor*, *Aspergillus terreus*, Biodeterioration.

1. Introduction

All sectors of our society generate waste in the form of polyethylene, the utility of polyethylene is expanding at a rate 12% per annum, and approximately 140 million tons of synthetic polymers are produced worldwide each year (Shimao, 2010). With huge amounts of polyethylene getting accumulated in the environment and their disposals evokes a big ecological process. Biodeterioration is a natural phenomenon that affects plastic materials due to the effect of humidity, rain, wind, UV radiation, thermal excursion and microbial degradation. Amongst the several degradation ways, microbial biodegradation is widely used and is still underway for its enhanced efficiency.

In the last few years, several workers have been conducted research on biodegradation of polyethylene by microorganisms. A study on biodegradability of polyethylene using *Brevibacillus*, *Pseudomonas* and *Rhodococcus* spp. was carried out by Nanda and Sahu (2010). Volke-Sepulveda *et al.*, (2002) work done on the biodegradation of low intensity polyethylene by two species of fungus i.e. *Penicillium pinophilum* and *Aspergillus niger*. So, it is interesting to note that both

bacteria and fungi can degrade the polyethylene of low as well as high density because microbial degradation leads to breaking down of polymers to monomers creating an ease of accumulation by the microbial cells for further degradation. The depolymerization results due to various physical and biological forces (Swift, 1997). Research also determined biodegradability of polyethylene by measuring changes in the physical properties such as changes in temperature, moisture, pressure, tensile strength and mass or electrical property during biodegradation. Thus, the need for systematic screening of degrading organisms with the potential for the degradation of polyethylene in natural as well as artificial conditions.

The present article has focused on the biodeterioration ability of polyethylene high density by *Aspergillus versicolor* and *Aspergillus terreus*.

2. Material and Methods

2.1 Collection of samples

The sample was collected from a waste disposal site dumped with polyethylene bags and plastic products (Fig. 1).

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Fig. 1. Figure showing dumping place at Agra (sample collection place).

2.2 Isolation of degrading fungi from samples

Isolation of fungi isolated from the degraded materials by using the Czapek Dox Agar medium. Degraded sample directly placed (in small pieces) in upper layer of the media, in the Petri-dish and it incubated at $28 \pm 1^{\circ}\text{C}$ for 7 days. After the 7 days incubation period, five fungal strain were colonized on the surface of the media and the *Aspergillus* sp. was principal colonizer i.e. *Aspergillus versicolor* and *Aspergillus terreus* were isolated and pure it by same media and procedure.

2.3 Pretreatment of polyethylene

The polyethylene was cut into small and fine pieces washed with ethanol chemical to remove any organic matter for surface sterilization and again washed it with distilled water and dried.

2.4 Inoculation of polyethylene with fungus

The isolated fungus i.e. *Aspergillus versicolor* and *Aspergillus terreus* were individually inoculated in 100ml of sabouraud broth in conical flask. Flask A blank as control while flask B contains polyethylene + *Aspergillus versicolor* and flask C contains polyethylene and *Aspergillus terreus* and all conical flask incubated in incubator shaker at 150 rpm for months at 28°C temperature (Fig. 2).



Fig. 2. Figure showing the degradation of polyethylene (high density) by *Aspergillus terreus* and *Aspergillus versicolor*.

2.5 Dry weight determination of recovered polyethylene

The polyethylene particles were recovered after one-month incubation period from culture and washed with methanol and finally washed with distilled water and taken results.

3. Result and Discussion

The results obtained on biodeterioration ability of polyethylene high density by *Aspergillus versicolor* and *Aspergillus terreus* have been shown in Table 1. After the period of incubation, all flasks were removed from the incubator shaker and observed for the viability of organisms and any contamination in the medium. The two species of fungus i.e. *Aspergillus versicolor* and *Aspergillus terreus* successfully formed the biofilm was clearly seen in the broth cultures and *Aspergillus terreus* was found to be viscous and slimy. It is clear from Table 1 that out of the two treatments, T1 (*Aspergillus terreus* + polyethylene) shows the best biodegradability of 7.59% followed by T2 (polyethylene + *Aspergillus versicolor*) which gave 3.79% respectively. During the 30 days of incubation, the system was maintained undisturbed with no addition or removal of nutrients to and from the medium. Therefore it might be assumed that nutrients from the medium were entirely utilized by the two species of fungus, polyethylene high density acted as the readily available source of carbon and energy.

Table 1. Comparative analysis of the polyethylene weights in different treatments before and after incubation.

Treatment	Weight of Polyethylene (g)		Weight of Polyethylene degraded (g)	Percent of Polyethylene degradation
	Initial	Final		
Blank	0	0	0	0
Control	15.8	15.8	0	0
T1	15.8	14.6	0.6	7.59%
T2	15.6	15.2	0.4	3.79%

Biodegradation of disposable polyethylene using fungi and *Streptomyces* species was carried out by El-Shafei *et al.*, (1998). Biodegradation depends upon polymer characteristics, organism type and nature of pretreatment (Shah *et al.*, 2008). Some pretreatment of polyethylene is very essential and significant for its biodegradation. Changes in physical properties such as temperature, moisture and chemical treatment such as washing with ethanol, methanol and other solvents might have played a role in degradation of polyethylene. Volke-Sepulveda *et al.*, (2002) showed that addition of ethanol to fungi cultures containing polyethylene improved the biodegradation rate of the polymer. Besides artificial conditions, bacteria and fungi might show some percentage of degradability of polyethylene in natural conditions because the microorganisms are native to the site where polyethylenes are disposed. On the basis of above discussion, it is concluded that present study gives some idea and clue that these fungi can be used in both natural and artificial conditions for the purpose of degradation of polyethylene high density as well as low density. Thus, the degrading polyethylene can be good source of carbon and energy and an urgent interest in examining the ability of other new organism to biodegradation of polyethylene is required.

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