CODEN (USA): IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

Available online at: http://www.iajps.com Research Article

STUDIES ON BIODEGRADATION OF PLASTICS BY *ASPERGILLUS SP.* ISOLATED FROM DYE EFFLUENT ENRICHED SOIL

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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. Improperly disposed plastic materials are a significant source of environmental pollution, potentially harming life. Microorganisms plays a major role for saving our environments by degrading plastic wastes, which are toxic either in their native form or modified to be toxic. Isolation of microbial strain may able to degrade plastic waste from polluted sources, such as soil. In the present research, an attempt has been made to identify the suitable fungal species for microbial degradation of polythene. The three fungal species namely Aspergillus niger, Aspergillus flavus and Aspergillus foetidus were isolated from dye effluent enriched soil using plating and staining technique. The biodegradation of plastic using three Aspergillus species was studied. Among the three fungal strains, A.niger gave the better degradation potential than A.flavus and A.foetidus.

Key words: *Biodegradation, Aspergillus species, Polythene bag, Weight loss, Isolation*

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Please cite this article in press as S. K. Mohan and B. Suresh, ***Studies on Biodegradation of Plastics by Aspergillus sp. Isolated From Dye Effluent Enriched Soil****, Indo Am. J. Pharm. Sci, 2015; 2(12).*

INTRODUCTION:

Plastics are defined as the polymers which on heating become mobile and can be cast into moulds. They are non metallic moldable compounds and the materials that are made from them can be pushed into any desired shape and sizes [1]. Plastics are used in packaging of products such as food, pharmaceuticals, cosmetics, detergents and chemicals. Approximately 40% of plastics are used worldwide for packaging applications and the most widely used plastics used for packaging are polyethylene, polypropylene, polystyrene, polyvinyl chloride and nylons.

The use of plastic, especially polythene is growing day by day [2]. Every year 25 million tons of synthetic plastics are being accumulated in the sea coasts and terrestrial environment. Polythene constitutes 64% of the total synthetic plastic as it is being used in huge quantity for the manufacture of bottles, carry bags, disposable articles, garbage containers, margarine tubs, milk jugs, and water pipes [3]. Most of the biodegradation studies on plastics are being carried out using microorganisms. Microbial degradation of plastics is caused by enzymatic activities that lead to a chain cleavage of the polymer into monomers. Microorganisms utilize polythene waste material as a sole source of carbon resulting in partial degradation of plastics [4] . Many authors reported the microbial degradation of polyethylene by various microorganisms such as *Aspergillus[5], Streptomyces* sp.[3], *Pseudomonas, Bacillus[6]*. Hence there is an urgent need to identify efficient microorganisms to solve this global issue [7]. The purpose of the present study was to isolate microorganisms from dye effluent enriched soil and screen out polythene degrading microorganisms and identify the high potential microorganisms.

MATERIALS AND METHODS:

Sample Collection

Dye effluent enriched soil samples were collected from Tiruppur textile dyes industrial area of Tamil nadu. The soil samples were collected from a depth of almost 5 cm in sterile containers and air dried in the laboratory at room temperature. Polythene carry bags were collected from the local market shops.

Isolation of Plastic Degrading Strain

The samples were serially diluted and pour plated in sterile Czapek-Dox medsium and isolate fungi. The plates were then incubated at 37°C for 48 h. After incubation, the turbidity of the medium was checked for growth.

Biodegradation testing

1 gm of plastic carry bag strips were aseptically transferred to three conical flasks, each containing 100 ml of Czapek-Dox broth and the broth was then inoculated with identified polythene degrading fungi namely *Aspergillus niger, Aspergillus flavus and Aspergillus foetidus*. The plastic strips were taken out from culture aseptically once in 20 days and washed properly with distilled water followed by 80% ethanol. The strips were then dried and weighed. The weight loss of polythene was calculated.

Determination of Plastic Degradation Potential

The percentage of degradation of polythene by *Aspergillus species* were determined by calculated the percentage of weight loss of polythene. The percentage of weight loss was calculated by the following formula.

$$\% \text{ weight loss} = \frac{[\text{Initial Weight} - \text{Final Weight}]}{[\text{Initial weight}]} \times 100$$

RESULTS AND DISCUSSION:

Screening and Identification of Polythene Degrading Fungi

Microorganisms such as bacteria and fungi are involved in the degradation of both natural and synthetic plastics. A total of ten soil samples of dye effluent enriched were collected from Tiruppur textile dyes industrial area of Tamil nadu. The collected soil samples from dye effluent area were processed for the isolation of *Aspergillus sp.* The isolated strains were identified as *Aspergillus niger, Aspergillus flavus and Aspergillus foetidus* based on the microscopic examination and morphological characteristics.

Degradation of Polythene by the Screened Microorganisms

The screened microorganisms were further tested for their ability for degradation of plastics in laboratory conditions. The microorganisms were incubated in suitable broth culture under shaking condition for time period of 2 months having 1 gm of polythene strips. After a time intervals 20 days, 40 days and 60 days the plastic strips were collected from the culture, washed thoroughly with distilled water followed by ethanol and air dried. The strips were then weighed to study their final weight. The three fungal species revealed partial degradation of plastic strips utilizing them as sole carbon source. From the data collected, weight loss of polythene strip was calculated and is shown in Table 1. The biodegradation ability of *Aspergillus foetidus* was found to be 7.1%, 15.2% and 26.1% for 20, 40 and 60 days respectively. Khan et al. [8] found out that on prolonged incubation, polyethylene strips showed perforations and disintegration. The potency of degradation of *Aspergillus flavus* was found to be 9.6%, 19.3% and 31.2% for 20, 40 and 60 days respectively. The biodegradation ability of *Aspergillus niger* was found to be 10.5 %, 22.5 % and 38.0 % for 20, 40 and 60 days respectively shown in Fig.1. Among the three

isolated fungal strain *A.niger* gave the better efficiency than *A.flavus* and *A.foetidus.* 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]. Similarly Usha et al., (2011) [10] reported the screening of polyethylene degrading microorganism of *A.flavus* from garbage soil was found to 20.63% weight reduction.

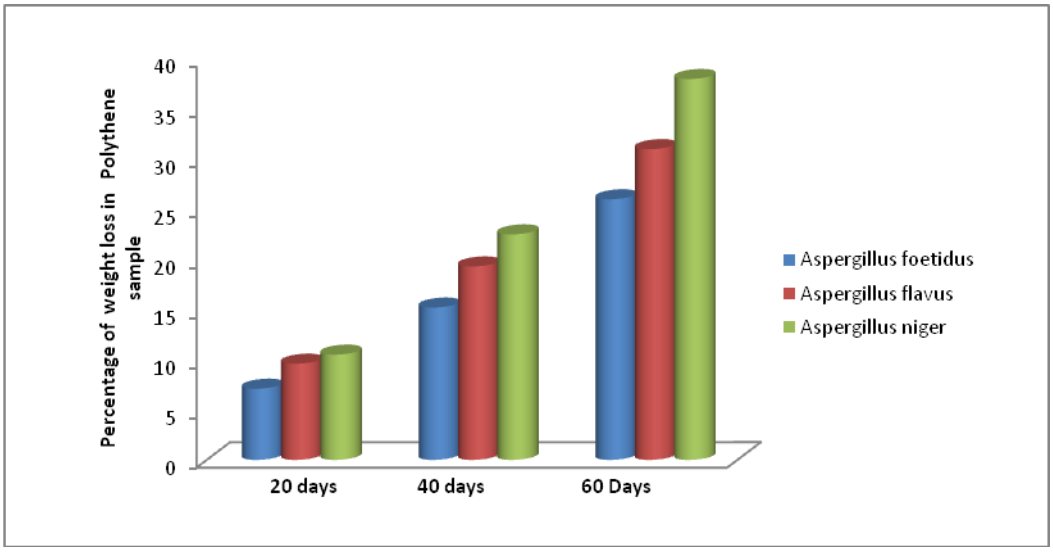

Fig 1: Rate of Biodegradation of Plastic Sample at 20 days Time Interval Using *Aspergillus Niger, Aspergillus Flavus and Aspergillus Foetidus*

Table 1: Biodegradation of Plastics using *Aspergillus niger, Aspergillus flavus and Aspergillus foetidus*

Duration	**20 days**			**40 days**			**60 Days**		
Species	Initial weight of Plastic sample (gm)	Final weight of Plastic sample (gm)	Percentage of weight loss (%)	Initial weight of Plastic sample (gm)	Final weight of Plastic sample (gm)	Percentage of weight loss (%)	Initial weight of Plastic sample (gm)	Final weight of Plastic sample (gm)	Percentage of weight loss (%)
A.niger	1.000	0.895	10.5	1.000	0.775	22.5	1.000	0.620	38.0
A.flavus	1.000	0.904	9.6	1.000	0.807	19.3	1.000	0.688	31.2
A.foetidus	1.000	0.929	7.1	1.000	0.848	15.2	1.000	0.739	26.1

CONCLUSION:

Biodegradation is one of the cheapest methods with no production of hazardous by-products. This method is generally preferred due to lower costs and possibility of complete mineralization. Biodegradation performances of all the three strains were evaluated. One of the strains namely *Aspergillus niger* was found to be highly effective for the degradation of plastic sample. The biodegradation ability of *A.niger*, *A.flavus* and *A.foetidus* were found to be 38.0 %, 31.2 % and 26.1 % for 60 days respectively. This work reveals that *Aspergillus niger* posses greater potential to degrade plastics when compared with other two fungus.

ACKNOWLEDGEMENT

The authors express their sincere thanks to the Management of The Kavery Group of Institutions and Principal, The Kavery College of Engineering for providing the necessary facilities for the successful completion of this research work.

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