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POSSIBLE PLASTIC DEGRADATION BY PSB (PHOSPHATE SOLUBILIZING BACTERIA): ANSWER WITH NOTICED DISSIMILARITIES IN PHYSICAL TEXTURE DURING THE COURSE OF THREE MONTHS INCUBATION INSIDE A CIRCLET SOIL

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Abstract

The significant studies of the texture by human hands of polyethylene carry bags [different types that are used for the experimentation are yellow paper plastic (polyethylene) bag sheet, pure transparent polythene carry bag sheet, yellow polythene carry bag sheet, and a piece of a hard plastic coffee cup] with and without incubation inside the crown of the soil part has been compared. The comparisons were tabulated with a conclusion that trivial fraction levels of degradation of polyethylene carry covers. The results are represented in a series so as to which variety resolve degrade greater (++++) percentage or lesser (+) percentage levels with an index parameter of 'texture' of feeling smooth or rough.

Key words: PSB, polythene degradation, texture, hard plastic

1. Introduction

Microbial organisms help in degrading several materials like paper, wood, by decay of plant and animal collection (bio-mass) etc., however, the degradation of any plastic bits and pieces by them is about trivial fraction (Lee et al., 1991). The reason could be that microbes using their enzymes (that are bio-catalysts) are not able to metabolize polymers and/or metabolize to the limit extent of their organic monomers which are nothing but the basic monomer units of synthetic polymers (Arutchelvi et al., 2008). At this situation of time the major environmental threat is the least rate of degradation and/or non-biodegradability of the organic materials in usual conditions. Examples for such materials are the synthetic polymers like nylon, polycarbonate, polyethylene-terephthalate, polyethylene, polypropylene, polystyrene, poly-tetra-fluoro-ethylene, polyurethane, polyvinyl chloride that are being continuously used in our routine life (Smith, 1964). The 64% of synthetic plastics waste produced on globe is polythene (Lee et al., 1991). The universal polythene is a 'linear hydrocarbon' consisting of long chains of the ethylene monomers and is synthesized from the cheap petrochemical stocks extracted from oil through catalytic polymerization (Fuhs, 1961). Polythene commodities got a wide range of applications in human's daily life and few of them are for moving food articles, for casing textiles, for manufacturing medical/laboratory instruments and automotive components (Smith, 1964). The polymers such as lignin (organic phenol polymer) and paraffin (synonymously with alkanes) were reported to be degraded by various microorganisms (Liyoshi et al., 1998). There are also reports that *Candida* strains (fungal microbes) were also shown the stimulated growth in different alkanes and alkenes containing liquid broth by utilizing their carbon source (Singh, 1979). It was concluded that microbes can degrade only low molecular weight polythene (MW up to 4800) and nineteen years later, degradation of high density polythene (HDPE) film (MW 93000) was performed and was documented that the main degraded component contained in HDPE film is the short-chain oligomers (Albertson and Banhidi 1980). Both polythene and lignin have carbon-carbon bonding which is being broken by these microbes by bio-catalysts and using the polymers as carbon source for their growth. Several reviews had been written on biodegradation of the plastic (Baruah, 2011; Shah et al., 2008; Gautam et al., 2007; Zheng et al., 2005) but few only deals with polythene. Yet comprehensive reports on the polythene biodegradation and/or degradation be lacking to say how to encounter the polythene pollution in future (Nayak and Tiwari, 2011; Sangale et al., 2012).

2. Materials and Methods

All kinds of plastic materials (colored and non-colored polythene and non-colored hard plastic cups) were collected from local market and made into small pieces. The polyethylene carry bags used for the experimentation

are different types (a) colored (yellow) paper plastic (polyethylene) bag sheet, (b) pure transparent polythene carry bag sheet, (c) colored (yellow) polythene carry bag sheet, and (d) a piece of a hard plastic coffee cup. These pieces were put into an earth's cavity which was excavating of 30 centimeters depth at 4 different corners at a distance of 20 meters. One corner is placed near to the water cooler where the there was constant wet soil. All depths were sprayed with one scoop full of dried up powdered PSB (that was grown in manual bioreactor and ready for agricultural fields, and was obtained from Sneha Biotech., Vijayawada-520010, India) was scientifically mixed with the soil. The crest's excavate was covered with the soil, pressed hard, and was allowed for incubation for 3 months. The incubation in the crown of soil is performed in four different methods. They are (i) Control that has neither been treated nor incubated (ii). Normal (only incubated within soil in the presence of PSB). (iii). Exposing Sheets to UV (early morning and late evening radiation by exposure to Sun) + incubation in soil in presence of PSB. (iv). Sheets boiled in a beaker for 10 minutes and incubated within soil in presence of PSB. (v). Sheets exposed to UV + boiled in a beaker for 10 minutes and incubated in presence of PSB. The pieces of polythene were tested manually the texture (to check for smooth in condition and/or hard in condition) with fingers at two different intervals. The first testing interval was after month time incubation and another was after 3 months. The texture was indexed as the mathematical signs +, ++, +++ and ++++ with an increasing order of smoothness that was used as an index of degradation.

3. Results and Discussion

Universally the plastic material polythene is made up of monomers of ethylene. All most all polymers made by means of ethylene are having the composition of 'C', 'H', and 'O'. They have the double bonds in their polymerization and these double bonds are able to untie with the help of physical, chemical and biological treatments. In this paper we have selected the physical treatment parameter as UV rays by exposing the sheets with morning and evening Sun rays, the chemical parameter as treating the sheets with boiling water followed by biological treatment with incubation in presence of Phosphate Solubilizing Bacteria (PSB). In this cumulative effect the results of all sorts of handling favored the degradation towards escalating percentage. In this publication we could not exactly differentiate the exact percentage digitally but we could confirm the degradation is possible with PSB incubation inside the burry of the soil. Here the PSB is playing an important role by eating away the polythene by utilizing 'C' for its growth and division.

3.1. Colored (yellow) PAPER PLASTIC (polythene bag) sheet:

The sheet of paper plastic (polythene bag) subjecting for 5 different process methods has been put into soil for three months. During these three months of hot summer (between April, 2016 and June, 2016) the occasional showers of rains followed by the treatment with PSB made possible degradation of polythene which was observed by manual test of texture (smoothness) with finger touches. The possible experimental set ups are in total 5 (five) that are subjected with treatment of PSB (i) normal paper plastic piece, (ii) only paper plastic sheet exposing to UV, (iii) only paper plastic sheet that was boiling in water, (iv) paper plastic sheet exposing to UV + boiling for 10 minutes in water, and finally the (v) control paper plastic sheet. The control was the plastic piece material stored in dark at room temperature with out any sort of treatment. The results of above set up proved amplified degradation after the 3 months of incubation inside the soil. The incubation less than 3 months of time did not affect the texture of plastic sheets. Surprisingly the degradation of paper plastic bags was around 90% where the bags were completely turned to dried decomposed powdered pieces when they were stored in dark without water washings for about 9 months including incubation period.

Normal	Only UV exposure	Only in Boiling water	Exposure to UV + boiling	Control
+	++	+++	++++	No change

3.1.2. Pure (transparent) POLYTHENE (carry bag) sheet:

As described above the pure transparent polythene carry bag sheet also added to incubation for three months into the soil cavity. The results on degradation after incubation of transparent polythene plastic carry bag indicated as below. The

Normal	Only UV exposure	Only in Boiling water	Exposure to UV + boiling	Control
+	++	++	++++	No change

3.1.3. Yellow colored POLYTHENE (carry bag) sheet:

Yellow colored polythene sheet added to incubation in the presence of PSB has shown the texture similar to that of paper plastic sheet. However, the transparency observed with naked stare at visibility and stretch with hands with normal pressure indicated that the pits formation may be more in yellow paper plastic when compared to yellow polythene sheet. The experiments in the order of elastic modulus are also in progress.

Normal	Only UV exposure	Only in Boiling water	Exposure to UV + boiling	Control
+	++	+++	++++	No change

3.1.4. Piece of Hard Plastic coffee cup sheet:

The degradation rate is minute in all cases with the 3 months incubation of hard plastic in presence of PSB by the every single one method of treatment. As observed in thin polythene sheets (colored and non-colored) and paper plastic sheets the difference in texture could not be observed in presence of PSB for hard plastic sheets. This may be probably the incubation time is insufficient for the pits formation, the parameter for degradation, on hard plastic sheet. One may expect the slight degradation after 2 to 3 years of exposure to PSB incubation for hard plastic if it is performed in the same scale. However, micro-level changes may be observed in short span of incubation only with texture.

Normal	Only UV exposure	Only in Boiling water	Exposure to UV + boiling	Control
No	No	No	No	No

4. Conclusions

Based on the literature survey, it be able to concluded that polythene is very useful in our day to day life to meet our preferred needs. It can be used for wrapping the goods, food material, medicine, scientific instruments etc. Outstanding to its good versatile uses to facilitate are increasing day by day with the exception of its degradation that is becoming a great threat. Only in the marine biota annually almost one million marine animals are dying due to their intestinal blockage (Derraik, 2002). Various polythene degradation methods are available in the literature but the cheapest, eco-friendly and acceptable method is degradation using microbes. The large numbers of microbes release the extracellular enzymes such as lignin peroxidase, manganese peroxidase to degrade the polythene. The detailed characterization of these enzymes in relation to polythene degradation is still needed to be carried out. It was also been known that microbes from various sources are responsible for the degradation of polythene. But efficient polythene degrading microbe is still needed to screen from all the sources. The characterization of efficient polythene degrading microbes at molecular level is still not available up to the mark, which can be multiplied at large scale to commercialize the polythene biodegradation.

There is a most recent effort of Chinese scientists that the "meal worm's" gut consists of some kind bacteria which are supporting the nature of 'smooth texture directly proportional ***to*** degradation of polythene. They also reported the formation of minute pores on the polythene indexed as 'degradation effect' by SEM studies (Kim et al., 2017). Further, their attempt on isolation of bacteria i.e., *Bacillus sp*. strain YP1, from the gut of wax worm (the larvae of *Plodia interpunctella*) which ate polyethylene (PE) plastic, be capable of degrading PE and utilizing PE as sole carbon source. In addition, the complete genome sequence of strain YP1 that is relevant to polyethylene de-polymerization and biodegradation was also reported by the same group (Yang et al, 2015).

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