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Short Communication

Application of nanoparticles as an enhancer in the degradation process of plastics using *Aspergillus niger*

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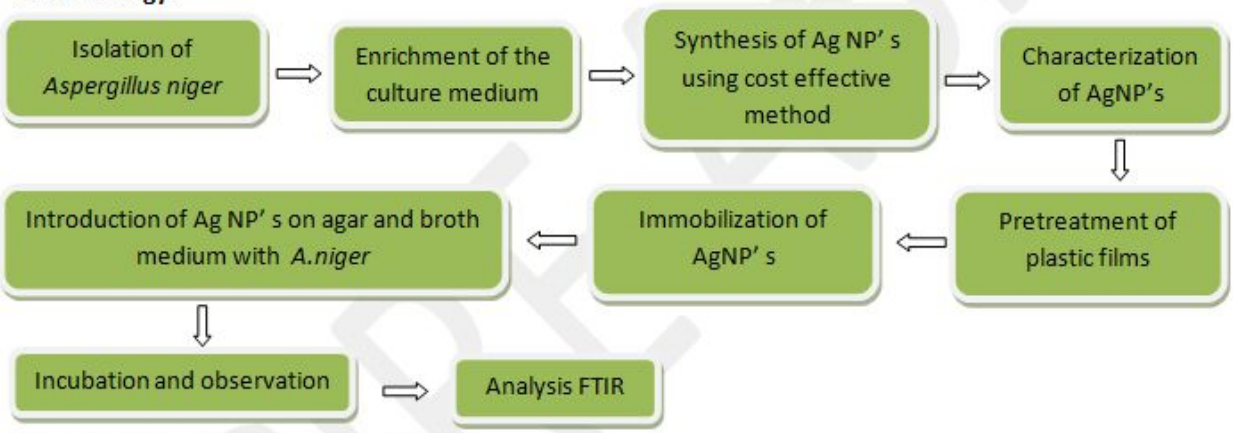
Objective: The synthetic plastic degradation has always being remaining as the most serious threat to the life and also the environment. The degradation of these non-degradable plastic using microorganism and combining with fullerene silver nanoparticle as an enhancer is an innovative idea implemented in this article.

Methodology:



Duration taken for the research: 7 months

Conclusion: The effect of silver nanoparticles (Ag NP's) as an enhancer has been promptly observed to increase the process of degradation by *A.niger*. The concentration of clay particle being the another parameter for the surface adsorption property that influenced the capability of the organism through the cell wall adhesion and further the enzymatic reaction to promote the degradation.

Applicable Industries: Waste management/Recycling

Expected outcome: Degradation of plastics using this idea may minimize its existence and harmful effects.

Abstract

The attempt has been made through this research work to degrade the polyethylene plastics using immobilized silver nanoparticles prepared from fullerene with reducing agents like NaOH & PEG as enhancers and were introduced with *A. niger* in both agar and broth medium. The NP's were characterized by SEM and FTIR analysis. The results show incredible degradation response by the silver fullerene nanoparticles with the micorganism in an enriched medium. The higher concentration of nanoparticles inhibits the growth or the organism. At lower concentration it promoted the degradation rate and also supported the organism to adhere on the surface through colonization process.

Keywords: Biopolymers, Fuellerene, Nanoparticles, Plastics

Introduction

To overcome the disposal problems of petroleum based products like plastics considered from many decades as non-biodegradable has become the toughest task in the solid waste management. The hydrophobicity, low density and chemical inertness, resistance to weathering and degradation, low cost and low energy consumption processibility and also due to the thermoplastic nature increased their use and demand in day- to- day life (Swapnil *et al.*, 2015). Synthetic plastics are resistant to biodegradation in the environment and pose a number of serious problems and are being an environmental threat (Baljit *et al.*, 2008 and Katarzyna *et al.*, 2010). Hence these preliminary experiments provided the strategy for the experimental design. Implication of NP's as enhancers for the degradation have been reported by many researchers in the various fields. Thus the concept of combination of NP's has been proving as per their kinetic modellings and chemical interactions with the organism and plastics (Raaman *et al.*, 2012). The potential interest increases with use of biodegradable NP's which can transform the chemical or biological behavior of the organism and converting the plastics into carbon dioxide and water after the break down. Therefore there is a need to have a biodegradable polymer as an alternative to these synthetic polymers.

Materials and Methodology

The fungi *A. niger* was isolated from spoiled food. It was identified and characterized by staining and observation. The Czapek Dox HiMedia was enriched with 1% starch, 1% Dextrose and 1% peptone to ensure the longevity life of the culture during degradation. The plastic samples were treated with 1% SDS and 10% NaOCl and then washed properly, and surface sterilized with 90% ethyl alcohol. The plastic films were placed on the agar plates and observed for zone of clearance. The 6% clay solution, 15mM $AgNO_3$ (made using phosphate buffer of pH 6.9) and 0.4 M NaOH were taken in ratios

1:2:1,1:2:2, 1:2:3 and 1:2:4 and another combination as 1:1:2,1:2:1,1:3:2 & 1:4:2 for a total volume comprising of 12 mL in 50ml beakers. The reaction mixture was kept for synthesis in microwave oven for 25 seconds till the colour changes to a constant yellowish brown colour. The NP's were characterized by SEM analysis (Figure 2). In the further process the synthesized NP's were later immobilized using 2% Na-alginate and 1M $CaCl_2$ with 1µL of the reaction mixture and were introduced into the enriched broth medium with *A.niger* incubated for 2-3 weeks. The degradation of the plastics samples were studied by using FTIR analysis.

Results and Discussion

The microorganism selected was found to be effective in the plastic degradation process. The plastic were treated prior to increase the brittleness so that it could provide ease to the organism during he process (Mukherjee *et al.,* 2014). The reaction mixture after exposing to microwave for 25 seconds showed the colour changed from light yellowish brown to dark greyish brown indicating the formation of nanoparticles (Figure 1). The agar plate with the treated plastic sample shows and clearance zone and the wrinkling of the plastic indicates the degradation process (Figure 3).

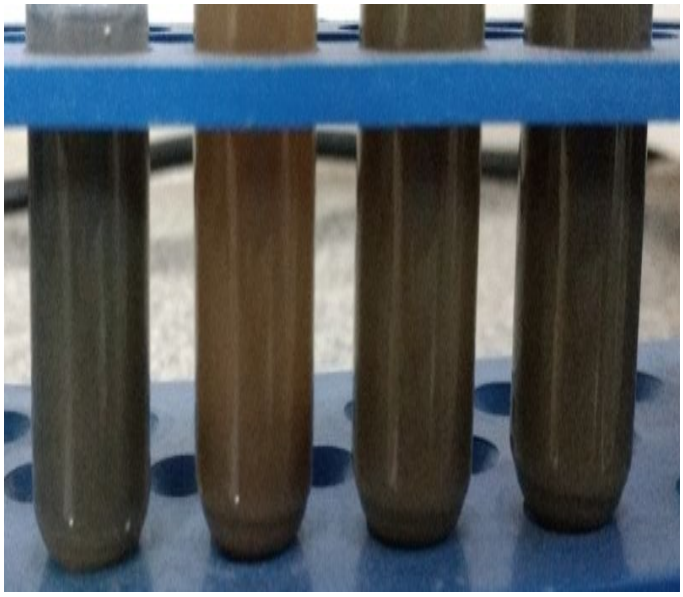


Figure 1: Microwave synthesis of clay $AgNO_3$ for various concentration

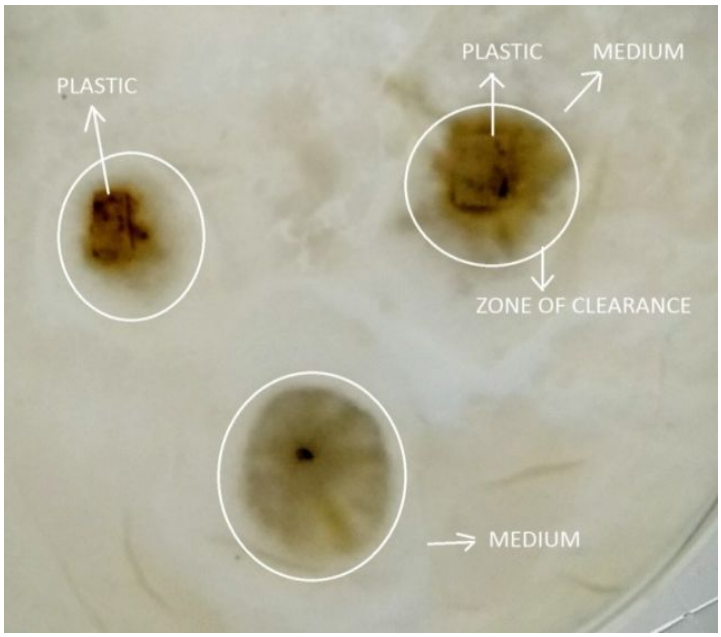


Figure 2: Zone of clearance observed during degradation of plastic using *A.nig*er in enriched medium

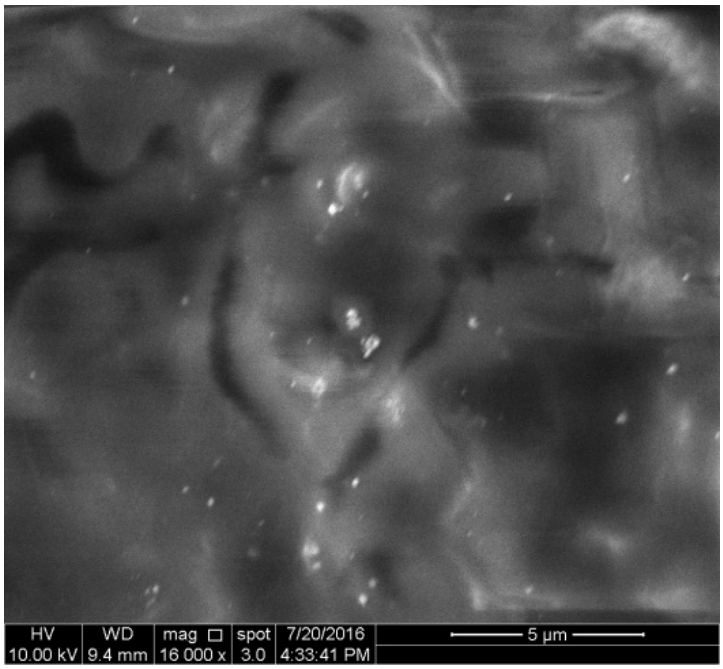


Figure 3: SEM analysis of Fullerene NP's

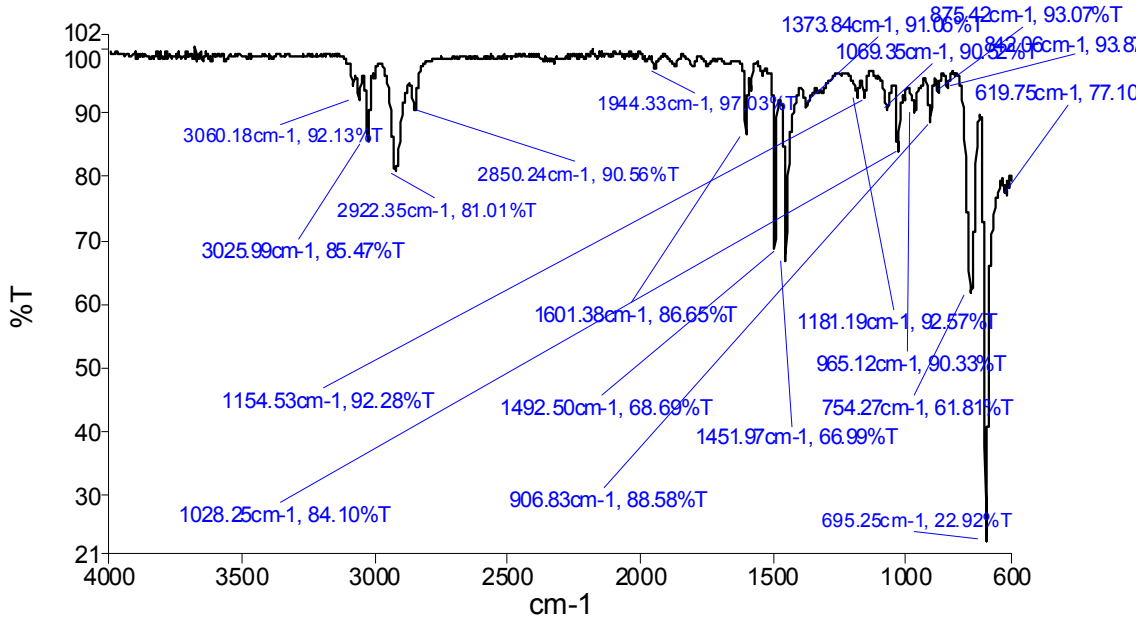


Figure 4: FTIR results of treated plastic before degradation

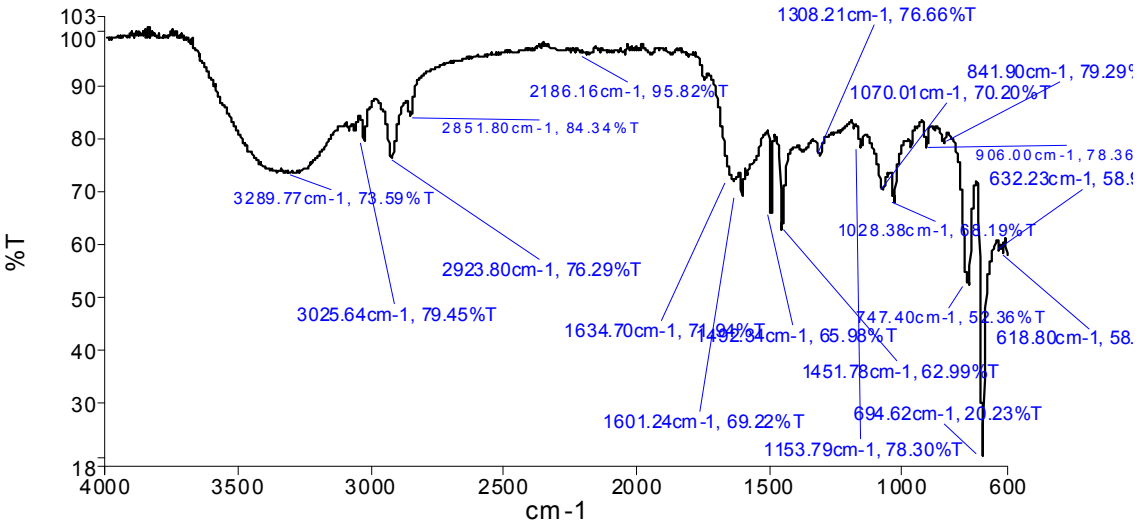


Figure 5: FTIR results of treated plastics degradation after 4 weeks of incubation by *A. niger* and Fullerene NP's

The FTIR results (Figure 5) interprets that between the 3500-3000cm-1 there is a big drop of the peak in comparison to the Figure 4 represents before degradation structure of the plastic film the presence of alcohol groups and alkene groups from sp^3 C-H to sp^2 C-H. Further down in the range of 1700-1200cm-1 the breakdown of alkyl group to further alcohol and alkenes, triple bond to single and

double bond indicates the effect of degradation by the organism and also clarifies the presence and absence of enhancer to the process to increase rate of degradation.

Conclusion

The effect of silver NP's as an enhancer has been promptly observed to increase the process of degradation by *A.niger*. The concentration of clay particle being the another parameter for the surface adsorption property that influenced the capability of the organism through the cell wall adhesion and further the enzymatic reaction to promote the degradation.

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