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Short Communication

Bio-Degradation of Landfills by Plastic Eating Mushroom (*Pestalotiopsis microspora*)

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ABSTRACT

The aim of this article provides eminent information on bio-degradation of landfills by plastic eating mushroom (example: *Pestalotiopsis microspora*). By using this mushroom fungus, we can degrade the plastics (like polyurethane and Polyethylene Terephthalate (PET)) in landfills under both aerobic and anaerobic conditions. Polyurethane and PET polymers are commonly used for manufacturing the plastic products examples: beverage bottles, food bottles, peanut butter and polyester clothing. This type of plastic can degrade by *Pestalotiopsis* fungi in few days. We can also enhance plastic degradation by genetic modification of the enzyme.

Keywords: Landfills; *Pestalotiopsis microspore*; Polyurethane and Polyethylene Terephthalate (PET); Serine hydrolase; PETase

Abbreviations: PET: Polyethylene Terephthalate; CPCB: Central Pollution Control Board; MSW: Municipal Solid Waste; PUR: Polyurethane; TCA: Tri-Carboxylic Acid; ATP: Adenosine Triphosphate

DESCRIPTION

Plastic garbage is one of the most prevalent issue in the world today.

The Central Pollution Control Board (CPCB) reports that India currently produces an average of over 25,000 tonnes of plastic garbage every day. Municipal Solid Waste (MSW) is predicted by experts to reach 387.8 million tons by 2030 and more than quadruple its current value by 2050.

Presently, 18% of the garbage collected is composted, 5% is recycled and the remaining is dumped at landfill. Currently, the most popular method for dealing with waste that endangers the environment is landfilling. According to a CNN news article, more than 3,100 landfills may be found all over India [1,2].

According to an ISWA, states that by 2025, landfill sites will contribute 10% of greenhouse gas emissions, if current trends continue and action is not taken [3].

Landfills are dry and have very poor oxygen. This makes it impossible for anything to decompose properly, including organic materials like Polyethylene Terephthalate (PET or PETE), polyurethane plastics, etc.

Disadvantages of landfills

- **Climate change:** Landfills emit biogas into the atmosphere, it leads to global warming. Methane gas (CH_4) and Carbon dioxide (CO_2), are the main components of biogas forming. These two gases increase in the earth temperature. They may also result in explosions or flames.
- They are able to contaminate water and soil.
- Landfills change the wildlife. Certain birds consume common waste products such as plastic, aluminum, gypsum and other common compounds found in landfills, which can have lethal consequences.
- The unpleasant odors that come from landfills, it can affect the surrounding peoples.

To solve the growing problem of plastic pollution, researchers discovered so many plastic eating mushrooms. The primary reason for using *Pestalotiopsis* fungi (*Pestalotiopsis microspora*) is

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their ability to decompose plastic under both aerobic and anaerobic conditions. So, they will be able to be used for degrading plastic from the landfills and oceans.

In Buenos Aires, the endophytic fungus *Pestalotiopsis microspora* was initially found in the fallen leaves of common ivy [4].

Aerobic and anaerobic biodegradation of plastic

Aerobic biodegradation is the degradation of plastic in the presence of oxygen. During this process, fungi break down complex chemical molecules into smaller organic compounds by using oxygen as an electron acceptor. Frequently producing CO_2 and water as end products.

Anaerobic biodegradation is the degradation of plastic in the absence of oxygen. In this process fungi breaking down complex polymers into small pieces, producing biomass, CH_2, CO_2 and H_2O as by-products. In the absence of oxygen, anaerobic fungi use carbon dioxide, sulfate, nitrate, iron, manganese and other substances as their electron acceptors for biodegradation.

Under both aerobic and anaerobic conditions, *Pestalotiopsis* fungi were shown to grow on Polyurethane (PUR), PET.

Detailed description of plastic degradation by *P. microspora* fungi

Pestalotiopsis microspora breaks down polyurethane plastic in a few of days by using an enzyme called serine hydrolase as a carbon source and breaks down PET plastic by using an enzyme called PETase [5].

PETase has been identified in a few fungi, most notably the Amazon rainforest-dwelling *Pestalotiopsis microspora*, which Yale University identified in 2012.

General mechanism

The presence of plastic polymer induces fungi to secrete degradation enzymes that sequentially act on the polymer, producing low molecular weight polar oligomers and monomers which can enter cells across the cell membrane. Depending on whether the growth conditions are aerobic or anaerobic, the absorbed molecules are further broken down by intracellular enzymes, allowing them to enter the Tri-Carboxylic Acid (TCA) cycle in the mitochondrion, where energy Adenosine Triphosphate (ATP), CO_2, CH_4 and H_2O are created as metabolic end products.

Polyethylene Terephthalate (PET or PETE) degradation by *P. microspora* fungi

When the *P. microspora* fungi is administered to PET plastic, they secrete the PETase enzyme, which causes PET polymers to bind to the active site of PETase. During the reaction, the PETase enzyme breaks ester bonds in PET. At the end of the reaction, the PETase still completely exists but the PET has been broken down into two sub-products: Monohydroxyethyl Terephthalate (MHET) and Bis 2-Hydroxyethyl Terephthalate (BHET). BHET is a small molecule but MHET can be broken down further. An enzyme breaks the MHET into Terephthalic Acid (TPA) and Ethylene Glycol (EG), which are monomers. BHET, TPA and EG are the final products of the reaction and will be digested by the fungi as nutrition [6,7].

Another option to increase the enzyme's resistance to a variety of climates is genetic modification.

CONCLUSION

So many plastic products prepared by using Polyurethane and PET polymers, this plastic take too much of time for degradation in landfills, here we can reduce the plastic by using plastic eating mushroom. *P. microspora* contains plastic degrading enzymes, these enzymes have ability to degrade the plastic in the landfills under both aerobic and anaerobic conditions, so we can reduce plastic as soon as possible, and we can also enhance plastic degradation by genetically modifying the enzyme resistance. I think this is the one way of degrade the plastic naturally and reduce the global warming, we have to make the world a green.

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