

## One Possible Solution to Plastic Pollution: Mycoremediation

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Plastic pollution has become one of the most serious global issues. About 75 to 199 million tons of plastic debris is found in our oceans and an additional 33 billion pounds of plastic enter the marine ecosystem every year (Portilla, 2023). Plastic pollution affects the freshwater, marine, and terrestrial environments. It adversely affects the climate, ecosystems and their biodiversity.

### Effect of plastic pollution on climate change

The hydrocarbons required to form plastic are generally derived from coal, natural gas and crude oil (petroleum). These natural resources are mined and refined by the petrochemical industry into plastics, a method which consumes significant amount of energy and produces an immense quantity of greenhouse gas emissions. Our growing dependence on plastic goods makes it problematic. Thus, the process of producing plastic has a huge impact on climate change.

### Effect of Plastic Pollution on Ecosystem

The process of littering i.e., improper discarding of plastic goods into the gardens, sandy beaches, urban regions, and rivers affects the environment of ecosystem. This threatens animal and marine life in addition to reducing the scenic beauty of the surrounding area. Additionally, the single-use plastics bumps into rivers and oceans in the end. This marine waste gathers up in the ocean gyres and piles up as the floating waste. The world's biggest accumulation of plastic ever is in the north-central Pacific Ocean known as the Great Pacific Garbage Patch. Plastic waste can entangle or consume marine life, causing harm, oxygen deprivation and even death. However, the major contaminant is the microplastics. Microplastics can rapidly enter into the environment and remains there for many years as they include synthetic components with a high polymer content, solid particles smaller in size than 5 mm, insoluble in water, and non- biodegradable (Ziani *et al.*, 2023). Therefore, the accumulation of microplastics in the ocean's possess a threat to marine species as they can ingest microplastics as well as to the health of humans who consume them.

Above two images show that how our improper decomposing plastic waste has a huge impact

on the life of marine animals as well as on our ecosystem. Dr. Alava reported that "The turtles misunderstand the plastic bags with the jelly fish". Moreover, he mentions "They eat it and they feel full", however, their belly is filled with plastic, which causes hunger and interferes with the gastrointestinal tract.



**Fig 1:** Plastics in aquatic habitat Photo: Naja Bertolt Jensen Unsplash / iStock

### Mycoremediation

Mycoremediation is a type of bioremediation which uses enzymes produced by fungi particularly mushrooms, instead of other microorganisms to break down contaminants and reestablish equilibrium to the ecosystem. Bioremediation is a process that utilizes the living organisms such as bacteria and fungi for taking out the pollutants and toxins from the environment and also aid in nutrient cycling. Certain mushrooms, particularly *Pleurotus ostreatus*, *Agaricus bisporus*, *Auricularia auricular*, and *Pestalotiopsis* microspore, have potential for mycoremediation of plastics and polythenes (Ikhimalo and Ugbenyen 2023).

### How the Mycoremediation takes place?

Initially, the fungi get attached to the plastic surface with the help of hydrophobins, a protein secreted by fungi itself. These proteins are concentrated on the mycelia and spore's region of fungi

and serve a crucial role when fungi grow and develop and also help them to survive and adapt in any kind of environment (Linder *et.al.*, 2005). These proteins help in formation of hydrophobic aerial framework and further facilitates bonding of hyphae to hydrophobic part. Moreover, hydrophobins aid in attaching mycelia on the exterior of polymers, paving the path for biodegradation, as demonstrated by multiple researchers in cases of LDPE degradation by fungi (Santacruz-Juarez *et. al.* 2021; Zahra *et.al.*,2010).



**Fig 2:** Oyster mushrooms growing on a dead tree trunk. jessicahyde / iStock / Getty Images Plus

Then, the fungi after attachment fastly forms its colonies and enters the substrates with the help of hyphal network and the formation of biofilm begins. Biofilms are evolved as an outer layer in the presence of abundant nutrients, water and carbon source. They provide resistance to fungi cells in the stressful environment for growth. Further, degradation of plastic begins with the enzymes produced by fungi. The major enzymes produced during decay of plastic waste are hydrolases and oxidases. Hydrolases are enzymes that induce bond breaking by reacting with water. Oxidases are proteins that facilitate the oxidation of C-N and C-O bonds at the loss of molecular oxygen, resulting in formation of hydrogen peroxide. Other enzymes that help fungi for deterioration of plastic are pectinase, cellulase and amylase. These enzymes cause the breakdown of plastic debris into small fragments which then undergo further metabolism and also produces many free radicals. It is concluded that enzymatic degradation is a best plastic waste remediation approach, as it not only accelerates the process in a controlled way but also recycles hydrolysate substrate (Li *et.al.*,2011). At last, their oxidation takes place by the functional groups that penetrate the fungi cells and lead to the final degradation of the plastic waste (Khatua *et al.*, 2023).



**Fig 3:** Maitake mushrooms growing on a plastic-wrapped sawdust log. Lance Cheung/ U.S. Department of Agriculture

#### Advantages of mycoremediation

- Mycoremediation is environment friendly process. It is good for nature as well as human-beings as it eliminates the toxins from the surrounding.
- Fungi are easily available, safe and reuseable for further processes like, land scaling.
- It doesn't produce any kind of pollution or threat to the environment.
- It proves to be a better alternative than to any other way of decreasing plastic pollution in terms of method and time.
- It requires no prior set-up or after-cleaning process as no secondary toxins are produced.



**Fig 4:** Plastic spoon that was covered with *Phanerochaete chrysosporium* mycelium, a type of white-rot fungus. The remaining bio-matter no longer contains any toxic chemicals. Photo: Officina Corpuscoli.

Limitations of Mycoremediation

- The presence of particular pH and temperature is required for the fungi to grow.
- Fungi may be in risk if the level of toxins is significantly higher than their capacity to decompose.
- The continuous observation is required of the process of mycoremediation.

Conclusion

The rising issue of plastic pollution is of major concern for the environment along with living- beings. It requires the utmost attention to prevent our ecosystem. One of the better approaches to eliminate plastic pollution is the mycoremediation in the safe greener way. So, the plastic- eating fungi provides us an alternative to prevent nature from plastic pollution. By incorporating nature's power to degrade plastic garbage, we can safeguard our planet and also provides new source of survival for future generations. Overall, it is concluded that be aware and stop using plastics especially, single-use plastics and carelessly throwing the microplastics in the surroundings as its everybody’s sole responsibility towards the nature to keep it clean and green.

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