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Bio-Remediation Of Plastic: Only Harmless Way Of Plastic Disposal

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Abstract: Plastic accumulation is now become one of the biggest threats to Planet Earth in this decade. As it is non-biodegradable and takes so many years in its natural degradation. So, its disposal becomes one of the biggest problems. Usually, for its disposal two ways are getting followed in practice. One is Incineration (Burning in furnace at higher temperature) and other dumping it for landfill. But both these ways are neither Bio-friendly or economical. Incineration of plastic pollutes the air adding Greenhouse and toxic gases while landfill makes that particular land area barren. So, in this context, only option is bio-remediation of plastic, in which plastic eating microorganisms and worms could help in getting rid of this menace. Some of the micro-organisms recognized to degrade plastic naturally are Pseudomonos, Escherichia and Bacillus genera. A newly discovered bacteria Ideonellaskaiensis has been identified to dispose plastic in 2016. Similarly, some worms have also been identified to eat plastic. This is probably one of the biggest and most essential area of research in this century. The present paper is a focus to use this biological system to make environment plastic free in an economical and bio-friendly way.

Keywords – Bio-Remediation, Incineration, Land-fills, Mealworms, Superworms.

Introduction

Huge piles of Plastics are a usual scene anywhere nowadays. This is horrifying for survival of entire living community. Its use has embedded so much in our life that it seems inseparable from our daily routine practices. But at the same time, huge accumulation of plastic is horrifying to all of us. As, we the man are creators of this problem, so we have to find its solution. All disposable methods like landfills and Incineration are costly and dampens other ecological components and resources like air and soil. So, in this context, bio-remediations could be the only safest process, favoring the natural cleaning of ecosystem from plastic. Microbial degradation of plastic is definitely a promising eco-friendly strategy which can manage waste plastic materials with no adverse impacts. Some other organisms like larvae of Darkling Beetle-Zophobea atratus worms, commonly known as 'Superworms' can eat plastic as its gut contains bacteria capable of breaking down common types of plastic. Similarly, Tenebriomolitor or mealworm beetle can also eat plastic. The Galleeia Mellonella larvae, also known as 'Wax Worms', can eat polyethylene which is a good sign for Bio-remediation. It has been proved experimentally that these worms have the capability to dissolve these plastics at an unprecedented rate (Federica B. 2022). One Indian mealworm can eat 0.13mg of plastic/day. So, 100 of these worms will take 308 days to eat a plastic bag. Like wax worms, Indian

mealworms have certain microorganisms in their gut, that certain microorganisms in their gut, that can breakdown the plastic. After digestion, only water -soluble products are left. The most remarkable thing that has been reported is if these worms are fed plastic and glycerol, they excrete the pillets which can be a good fish feed or plant manure like Vermi-compost. So, in this paper focus is how these organisms can be used for fixing the plastic waste and heaps from the society so that we can save soil and Air Quality also.

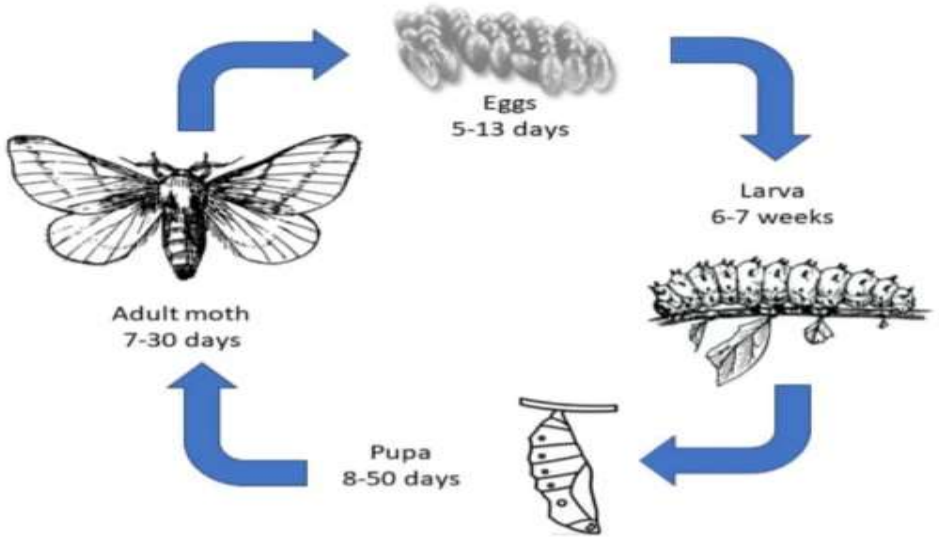
Discussion

As we know, bio remediation of plastic is a promising solution of using bacteria worms and other organisms capable of consuming plastic while bacterial bio-remediation typically involves bioreactors where mealworms like organisms can break strong C-H bonds of polystyrene even at room temperature. While another Bio-inspired remediation technology leverages the digestive power of Zophobes atratus worms (super worms) which naturally consumes plastic, thereby offering a scalable method for plastic degradation without the need for worm farming. (Yang S & et. al. (2021).

Plastic waste poses a serious problem to the environment as well as human and animal health. In recent years, in many samples of human blood microplastics has been reported, which can damage tissue and release toxic chemicals and plastics in the ocean killing animals, who accidently consumes or becomes entangled in plastic waste (Andrady, A.L., 2011, Vethaak & lestie nd. 2018). In a simple data, of the 6.3 billion tons of plastic produced since 1950, only 9% has been recycled and 12% has been incinerated, with the remainder ending up in landfills or the ocean.

The most dangerous figure is that, it is likely to quadruple by 2050, so an effective and environmentally conscious way to handle over plastic waste is perhaps the biggest challenge of their century. So, Bioremediation is offering the safest eco-friendly technique to fight this menace. Referring to use of mealworms in bio-reactors. They cannot survive on plastic alone and require an additional food source, like cornmeal, oat bran or wheat bran, which can enhance their microbiome and hydrolytic enzymes they produce. (prezemieniecki et al 2020). They are also working on cost-effective small-scale application of mealworms bioremediation systems such as in households, neighbourhoods and business.

Recent researches have also revealed that the saliva of galleria mellonella larvae (wax worms) is capable of oxidizing and depolymerizing polyethylene (PE), one of the most produced and sturdy polyolefin derived plastic. This effect is activated after a few hours' exposure at room temperature under physiological conditions of neutral pH. These enzymes are the first animal enzymes with the capabilities opening the way to potential solutions for plastics waste management through bio-remediation. This was first reported by Federica Bertocehini in 2016, a Spanish molecular biologist. The Greater wax moth is an invertebrate belonging to Pyralidae family, in Lepidoptera order. It is a worldwide paste of bee colonies that has spread to practically all continents. As a typical insect, G. mellonella goes through four development phases throughout its life cycle; the egg, larvae, pupa and adult.



Schematic representation of the life cycle of *G. mellonella*.

Figure 1.

Figure 2. Typical Indian Mealworm

Studies are going on whether these caterpillars who voraciously eat plastic along with glycol have their normal life cycle in next generation without any impact. If it has been found successful, then like vermicomposting pit, these moths can be seasoned in a small pit in a locality to dispose plastics of that area. But this needs more research on its innovation.

Conclusion -

Finally, it can be concluded that huge accumulation of plastics on earth, which is frightening the entire living world, can only be minimized in harmless way by Bio-remedation. Superworms, Mealworms and other microorganisms can serve as warriers in fighting this menace. But more intensive research and their implementation on ground level is the need of the hour to make it effective.

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