


# Chapter 10

## Bio-Based Plastic: A Remedy to Cleanup Environment

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### ABSTRACT

*The discarding of plastic has recently become an insistent and potentially dangerous environmental issue worldwide. Millions of animals have died as a result of inappropriate plastic disposal, which has also decreased soil fertility by depositing plastic garbage on land and in the ocean. The pollution caused by plastic trash has raised environmental concerns, which has accelerated the creation of eco-friendly products. One of the most cutting-edge eco-friendly materials with the benefit of a less carbon footprint is bioplastic. Biodegradable bioplastics that function similarly to traditional plastics, such as polyhydroxyalkanoates (PHA), polylactic acid (PLA), and polyhydroxybutyrates (PHB), have the potential to lessen reliance on petroleum-based plastics, which may pose a risk to the environment. Features of*

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*bioplastics, including their manufacture, use, recycling, and most recent advancements, will be covered in this review. For a world free of pollution, every nation must urgently develop the use of bioplastics and their appropriate waste management.*

## **INTRODUCTION**

Synthetic petroleum based or fossil fuels based plastics are produced and consumed at the large scale that creates the plastic pollution and serious waste management issues along with it has become a challenge at environmental and economic level. Nonrenewable and petroleum based plastics include polybutylene adipate-co-terephthalate (PBAT) polycaprolactone (PCL) and polycarbosilane (PCS) (Zhao, Wang et al. 2023). The first environmental issue of synthetic petroleum based plastic is “landfill”. According to estimation annual production of plastic is about 9.2 billion tons and it produces about 34 million tons of waste worldwide. The 93% of this plastic waste is disposed in landfills and oceans. Because the natural degradation process of petroleum based plastic is very slow that interrupt its remediation in landfills. The other environmental issue is that the plastics are accumulating in oceans that causing the damage of aquatic ecosystems. The study of seawater samples obtained from North Atlantic Ocean shows that it contained approximately 5,80,000 pieces of plastic per square kilometer. Also burning of petroleum based plastic produces harmful gases such as carbon dioxide ( $\text{CO}_2$ ) and methane ( $\text{CH}_4$ ). By burning of 1 kg of plastic produces about 2.8 kg of carbon dioxide ( $\text{CO}_2$ ). These are greenhouse gases (GHGs) and have severe effects on the environment by changing the worldwide climate. These are causing eco-toxicity, global warming, ozone depletion, eutrophication and the release of carcinogens in the environment (Ahsan, Hussain et al. 2023). The other environmental problem of plastic is that it is “non-degradable or durable”. Due to its non-degradable properties, the plastics will remain in the environment for hundreds of years. The economic issue produced by the plastic is the depletion of fossil fuels and crude oil, because the plastic is petroleum based polymer. So there is a need and also become a social concern to develop environmentally friendly materials to overcome the economic and environmental problems. Bioplastics have been suggested environmentally friendly as a substitute to traditional plastics and their demand has been predicted it is growing annually about 20 to 25%. A family of commercial polymeric products produced by renewable resources or natural sources such as from vegetable fats and oils, straw, corn starch, sawdust and rice starch, woodchips, recycled food waste, etc is called bioplastic. In bioplastic the term “bio” means living organisms or biological processes and “plastic” means a material that can be molded or shaped. So the term bioplastic means a plastic-like material that is derived from natural materials or biological sources and it can be used in the place of customary petroleum based plastics derived from fossil fuels (Nagarajan, Senthilkumar et al. 2024). According to European Bioplastics, bioplastics are either bio-based or bio-degradable or either have both properties. The polymer is to be considered as biodegradable when it is decomposed into methane, water, carbon dioxide ( $\text{CO}_2$ ), and inorganic compounds or into other biomass through an enzymatic process using microorganisms (Costa, Encarnação et al. 2023). Many resources and methodologies are used for producing bioplastics. Bioplastic is made from biological sources. It is completely or partially made of natural polymeric materials which are bio-based such as lipids, proteins, straw, corn, cereal crops, chitin, starch, or the cellulose found in wood, vegetable oils, chitosan, cotton, food waste and polyhydroxyalkanoates (Zhao, Wang et al. 2023, Chauhan, Kaur et al. 2024). All these bio-based materials have specific mechanical, thermal and physiochemical properties. These properties can be used in the manufacturing of bioplastics that

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