Chapter 7
Green Polymers and Biodegradable Plastics

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ABSTRACT

The spiked environmental concerns associated with conventional plastics have rushed the evolution and adoption of eco-friendly substitutes like green polymers and biodegradable plastics. These materials arise from green energy resources such as plants, animals, and microbes, offering a viable option to minimize plastic pollution and carbon footprints. This chapter delves into the classification, properties, synthesis, and applications of green polymers and biodegradable plastics, emphasizing their benefits over traditional plastics. It also addresses challenges such as high production costs, mechanical properties, and degradation under different environmental conditions. Emphasis is placed on innovative technologies and future trends that aim at improving the efficiency, production, and scalability of these biopolymers. This chapter delivers a thorough exploration of the crucial role of green polymers and biodegradable plastics in promoting a sustainable environment and advancing a more inclusive circular economy.

DOI: 10.4018/979-8-3373-1409-9.ch007

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1. INTRODUCTION

Plastics are essential in contemporary sphere because they are insubstantial, unreactive, highly versatile, and possess superior heat and electrical characteristics. These qualities make their prevalence in numerous sectors like home furnishings, circuit elements, equipment in the biomedical field, gadget making, and wrapping etc. The plastic output across the world is expected to increase by 450 megatons yearly by 2024 and anticipated to get twofold by the year 2040 (Sarah et al., 2024; ISW, 2024), and on the top, around 95%, being designed for single use and discarded after serving their purpose. The vast majority, i.e., 90% of the material used in packaging domain comes from plastics. A breakthrough has occurred during the 20th century (Bordes et al., 2009) in plastic mass production that transform manufacturing output. Derived from petroleum-based procedures, plastics being a byproduct is affordable to make and soon earned the title of "the wonder material". Some customary plastics employed in production domains are polyethylene terephthalate (PET), polypropylene (PP), polyvinyl chloride (PVC), high-density polyethylene (HDPE), and low-density polyethylene (LDPE). The utilization of plastics has been noted in nearly all sectors and transformed present-day life because of their adaptability, accessibility, and economic rates. Nevertheless, their extensive utilization has created notable threats to nature, such as inability of plastics to biodegrade, buildup in natural habitats, and excessive release of greenhouse gases (GHGs). These challenges have driven a global push towards eco-friendly substitutes, with green polymers and biodegradable plastics emerging as promising solutions. Made from alternative sources like vegetation, agricultural remains, and microbes, these materials not just intend to minimize dependence on carbon-based energy but also tackle the burning concern of plastic pollution. Within the habitat, these plastic debris breakdown into minute fragments known as "microplastics" due to sun exposure, weather-beaten, and flaming. Microplastics poses threats to both animals and the ecosystem as they interfere with food chains (Wabnitz & Nichols, 2010). Incinerating plastic trash liberates toxic gases like persistent organic pollutants (POPs), furan, and synthetic chemicals i.e., polychlorinated biphenyls (PCBs), into the surrounding. These noxious fumes can cause cancer, genetic mutations, nervous system failure, pulmonary disorders, cardiac infractions, shortness of breath, and affect genitals (Verma et al., 2016). Accordingly, there is an escalating interest in evolving sustainable alternatives like organic plastics. These materials can break down naturally, affecting the environment, delivering a viable alternative to the problems caused by non-decaying plastics. Biodegradable polymers (BDPs) have diverse characteristics, equipped them to compete with regular plastics. PLA and PHA, made from organic substances, are two frequently employed bioplastics (Averous, L. 2008).

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