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Biodegradable High-Density Polyethylene- Polyester Material

Taylor Stefan*

Department of Chemistry, University of Konstanz, Germany

Abstract

High-density polyethylene (HDPE) is a highly robust and long-lasting substance. Its interior molecular chain arrangement, which is crystalline with additional attraction from van der Waals forces, is what gives it its thermoplastic qualities. The molecules' chains are entirely made of hydrocarbons. Microorganisms that would be able to destroy the plastic are unable to reach the chains and break them up because of the combination of crystallinity and hydrocarbon content.

We present a new polyester material made from easily available bio-based 1, 18-octadecanedicarboxylic acid and ethylene glycol that have a polyethylene-like solid-state structure and tensile characteristics equivalent to high density polyethylene (HDPE). Despite its crystallinity, high melting point (Tm = 96 °C), and hydrophobic character, polyester-2, 18 is vulnerable to rapid and total hydrolytic destruction in in vitro experiments using isolated naturally occurring enzymes. Under industrial composting settings (ISO standard 14855-1) the material biodegrades with mineralization above 95% in two months. Reference experiments with polyester-18,18 (Tm =99 °C) show that the type of the diol repeating unit has a considerable impact on degradation rates, which may be connected to the density of ester groups in the amorphous phase. Methanolysis depolymerisation suggests that it is suitable for closed-loop recycling [1-5].

Keywords: Biodegradation; Long-chain polyesters; Polyethylene-like renewable polymers; Sustainable chemistry

Introduction

Biodegradable additives are additives that help polymers degrade by allowing microorganisms to use the carbon in the polymer chain as a source of energy. After biofilm formation on the plastic product, biodegradable additives attract microorganisms to the polymer via quorum sensing. In general, additives are formed in master batch using carrier resins such as polyethylene (PE), polypropylene (PP), polystyrene (PS), or polyethylene terephthalate (PET).

The majority of popular synthetic plastics are not biodegradable, and both chemical and physical features of plastics play essential roles in the degradation process. The inclusion of biodegradable additives can change the chemical and physical properties of polymers, increasing the rate of breakdown. Biodegradable additives can change the plastic disintegration process from chemical to biological. Instead of being damaged solely by environmental forces such as sunshine (photo-oxidation) or heat (thermal degradation), biodegradable additives allow polymers to be degraded directly or indirectly by microbes and bacteria.

While some plastic additives only impact the surface of the plastic effective biodegradable additives must also change the interior of the plastic as well as its chemical properties. Good biodegradable additives speed up the rate of disintegration by weakening specific polymer characteristics and raising their appeal to microorganisms.

Plastics are utilised often in everyday things and are an integral part of almost all contemporary technologies. Consistent plastic garbage has collected in diverse receiving situations all around the world as a drawback. For some uses, biodegradable alternatives to traditional plastics are preferred together with, but as a backup to, more responsible waste management. The most frequent cause of polymers' exceptional mechanical toughness and ductility is crystalline organisation. High density polyethylene (HDPE), in which the linear hydrocarbon chains pack to form crystalline domains by van der Waals interactions, is a particularly well-known and pertinent example.

However, crystallinity generally prevents biodegradation of plastics because the polymer chains are inaccessible to extracellular enzymes, even in the presence of cleavable links. Poly (butylene adipate-co-terephthalate) (PBAT) films are an example of a low crystalline material that is commonly used in plastics that are intended to degrade. In the case of polyethylene, the hydrocarbon chains' chemical inertness as well as the material's hydrophobicity further prevents biodegradation. When compared to natural settings, the in vitro de-polymerization studies' high enzyme concentrations and the controlled composting test's biodegradation conditions favour enzymatic and microbial destruction. To further understand the behaviour and environmental destiny of this material in natural habitats, field research in the marine water column, sediments, and soils will be of interest. Despite this, our findings highlight the viability of plastics that can replace conventional poly-olefins by incorporating their advantageous characteristics and being biodegradable.

Plastics are widespread in everyday things and are critical components of almost any modern technology. As a result, persistent plastic garbage has accumulated in many receiving habitats around the world. Biodegradable alternatives to traditional plastics are desirable for specific applications in conjunction with, but as a backup to, more responsible waste management [6-10].

Discussion

The most common source of polymers′ extraordinary mechanical

***Corresponding author:** Taylor Stefan, Department of Chemistry, University of Konstanz, Germany, E-mail: stefantaylor@rediff.com

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toughness and ductility is crystalline organisation. High density polyethylene (HDPE) is a particularly notable and relevant example, in which linear hydrocarbon chains pack to form crystalline domains via van der Waals interactions. However, crystallinity, even in the presence of cleavable links, generally hampers plastic biodegradation due to extracellular enzyme inaccessibility to the polymer chains. Biodegradable plastics are often low crystalline materials, such as poly (butylene adipate-co-terephthalate) (PBAT) sheets. In the case of polyethylene, the chemical inertness of the hydrocarbon chains, along with its hydrophobicity, inhibits biodegradation. We present a novel material, polyester-2,18 (PE-2,18), that has high density polyethylene-like crystalline and material qualities while also being easily hydrolysable by natural enzymes and entirely biodegradable under industrial composting conditions. Because of the growing concern about environmental protection, polymers derived from renewable resources are receiving a lot of attention in order to increase their sustainability and lower their carbon footprint. Renewable materials are gradually replacing single-use items in many technical applications. However, due to the possible fire risk and their involvement in our daily lives, the flame retardancy of such polymers, among other applications, needs to be addressed for technological applications. To address this possible concern, different flame retardant (FR) chemicals were synthesised using traditional and non-conventional methods, including inorganic FRs, nitrogen-based FRs, halogenated FRs, and Nano fillers. Biodegradable polymers, which may be biodegraded into their basic components by microbial action, have been offered as a potential solution to plastic pollution. However, the decomposition rate of biodegradable plastics varies greatly among settings, raising the possibility of plastic particle accumulation, chemical co-contaminants, and/or degradation products. This research examines the toxicological effects of biodegradable plastics on species and ecosystems, and compares them to the effects of conventional polymers previously described. While the effects of biodegradable plastics and their co-contaminants on different levels of biological organisation have received little attention in comparison to conventional plastics, data suggests that individual-level effects may be generally similar.

Conclusion

The chemical structure of biodegradable polymers, which should enable enzymatic depolymerisation and the utilisation of the polymer carbon by the microbial population, may cause changes in the associated toxicity. Carbon intake can change microbial composition, resulting in an enrichment of carbon-degrading bacteria and fungi, which can have far-reaching consequences for carbon and nitrogen dynamics. Furthermore, harmful degradation products may arise during biodegradation; however, knowledge of the environmental concentrations and impacts of degradation products is limited. As the global manufacturing of biodegradable polymers grows, more research into their Eco toxicological impacts on species and ecosystem function is needed.

References

1. Wijesinghe JAAC, Wickramasinghe I, Saranandha K (2015) Kithul Flour (Caryota urens) as a Potential Flour Source for Food Industry. Am J Food Technol 3: 10-18.
2. Toole BP (2001) Hyaluronan in morphogenesis. Semin Cell Dev Biol 12:79-87.
3. Allison D, Grande-Allen K (2006) Hyaluronan: a powerful tissue engineering tool. Biomaterials 12:2131-2140.
4. Philip JM, Mahalakshmi K (2019) Antimicrobial effect of three Indian medicinal plant extracts on common denture plaque bacteria. Drug Discov Today 11(3): 584-586.
5. Geetha S, Vasuki R (2019) Anticancer activity of Cissus quadrangularis. Int j eng innov technol 8: 603- 605.
6. Anbuselvi S, Roshini Esther A, Punithavathy R (2019) In-vitro anti-urolithiatic activity of Theriophonum minutum and Remusatia vivipara. Int J Recent Technol Eng 8: 3088-3091.
7. Taylor G (2003) The phase problem Acta Cryst D 59:1881-1890.
8. Bedouelle H (2016) Principles and equations for measuring and interpreting protein stability: From monomer to tetramer. Biochimie 121:29-37.
9. Monsellier E, Bedouelle H (2005) Quantitative measurement of protein stability from unfolding equilibria monitored with the fluorescence maximum wavelength. Protein Eng Des Sel 18:445-456.
10. Park YC, Bedouelle H (1998) Dimeric tyrosyl-tRNA synthetase from Bacillus stearothermophilus unfolds through a monomeric intermediate. A quantitative analysis under equilibrium conditions. The J Biol Chem 273:18052-18059.