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Anaerobic Biodegradation of Polymer

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Abstract

Melt blending polymer composites with natural fibers were examined. Poly (lactic acid), polyhydroxy butyrate-co-polyhydroxy vale rate, and low-density polyethylene were among the synthetic and natural macromolecules used. Flax fibers were used to fill these polymers. The mechanical properties of the composites, as well as biogas production and mass loss during anaerobic digestion, are discussed. After 28 days of biodegradation, the mechanical properties were found to be stable. Such materials can be found in packaging as well as in medicine as polymeric scaffolds, drug delivery systems, and other uses.

Keywords:* *Macromolecules; Polyethylene; Bio composites; Plastic; Polylactic

Introduction

Polymers reinforced with glass, carbon, and aramid fibers are commonly used in traditional composites. Composites' mechanical qualities are generally superior to those of the polymeric matrix. Extensive research on bio composites has resulted from a critical discussion regarding the protection of natural resources. Polymer materials made from a natural based matrix and reinforced with lignocellulosic fibers such as jute, hemp, sisal, abaca, and other lignocellulosic fibers, such as jute, hemp, sisal, abaca, and others, have recently sparked increased interest due to their higher sustainability when compared to petro chemically derived plastics. Bio composites are mostly used in the packaging business, where they compete with low-cost synthetic polymers. Packaging accounts for the lion's share of overall plastic consumption (39%). Because packaging has such a short lifespan, plastic packaging waste predominates in the post-consumer waste stream. As a result, plastic trash recovery and recycling technologies are progressing at a rapid pace. Apart from incineration, mechanical recycling is improving, but organic recycling is becoming increasingly important. Biodegradable polymers, whose physical and chemical qualities deteriorate when exposed to microbes, are suitable for this form of waste management. Biodegradation can take place in either an aerobic or anaerobic setting. Carbon dioxide, water, and biomass are the products of having access to oxygen. Methane, water, and biomass are the end products of anaerobic biodegradation. When contemplating the waste management of biodegradable polymers, knowledge of biodegradation efficiency in aerobic and anaerobic settings is critical. Polylactic Acid (PLA) and poly (3-hydroxybutyrate-co-3-hydroxy vale rate) (PHB/PHV), which were used as key components in the bio composites discussed in this research, are among the most promising polymers in this group. Natural fibers (flax) were added to the polymer matrix, making the composites completely biodegradable. Natural fibers have an advantage over glass fibers due to their lower density (1.5 g/cm^3) when compared to glass fibers (2.5 g/cm^3). Because of the density difference, polymer composites packed with cellulose fibers can be made lighter. Bio composites have traits that are a combination of all of the components or are unique properties that come from mutual interactions between the components.

The goal of this research is to see how anaerobic conditions affect the characteristics of biopolymers reinforced with flax fibers and biogas yield as a function of incubation time. Until recently, the great majority of biodegradation experiments were conducted in soil and/or compost. For example, increased biodegradation of these materials may occur in the presence of compost, a complex biological environment with a high microbial diversity and thus a higher breakdown potential for polymeric compounds. Until now, very little research has been done on the behavior of bio composites in anaerobic environments. The degradation of plastic materials is a major issue. On the one hand, the degradation process shortens the life of plastic products, but on the other side, it is critical for trash disposal. Plastics' mechanical properties diminish with degradation as the chemical and physical structure of the polymer changes. Chain scission or the additions

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of new chemical groups are examples of chemical transformations. Temperature variations, electromagnetic radiation, moisture, and biological activity all contribute to plastic degradation. Anaerobic digestion of organic molecules is a cost-effective waste disposal method that also provides energy recovery. It's a multistage procedure involving a diverse population of microbes. Biogas, a mixture of methane, carbon dioxide, and trace amounts of nitrogen, ammonium, water vapors, and hydrogen sulphide, is the major result of anaerobic digestion. Biogas is considered a renewable energy source since methane can be used to generate power or heat. The disintegration of organic particles is frequently the limiting phase in anaerobic digestion, which involves numerous steps. This process is thought to be surface limited since biodegradation of organic particles can only occur on the surface. The addition of natural fibers to polymers changes the material structure dramatically, and it may also affect digestion kinetics.

Conclusion

Despite a progressive loss of tensile capabilities, the material still has qualities comparable to virgin polypropylene after 70 days of biodegradation. This could be owing to scaffolding support made of flax fibers that did not degrade. A significant drop in tensile strength indicates that serum has broken a growing number of PLA chains. This could support the idea of an auto-catalytic mechanism for PLA and PET. After being immersed in anaerobic sludge, PLA's characteristics changed slightly. Biodegradation of polymer composites occurs faster than that of the matrix polymer; however, the extent of degradation is reduced if the fibers are more resistant to biodegradation than the polymer. Before the mass loss was discovered, microorganisms caused alterations in the internal structure of polymers. Tensile characteristics are a good way to gauge how far polymers have progressed in their biodegradation.