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ORIGINAL RESEARCH

Investigation of degradation of polypropylene in soil using an enzymatic additive

Jéssica Pereira Pires[1,2] · Gabriela Messias Miranda[2,3] · Gabriela Lagranha de Souza[2] · Flávia Fraga[2] · Alessandro da Silva Ramos[1,3] · Gabriel Espindola de Araújo[2] · Rosane Angélica Ligabue[2,3] · Carla Maria Nunes Azevedo[2] · Rogerio Vescia Lourega[1,2,3] · Jeane Estela Ayres de Lima[1,2,3]

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Abstract
Polypropylene (PP) has been widely used industrially in several sectors, mainly in the use of packaging of different products. Thus, this has been accumulated in our environment due to the incorrect disposal and its high resistance toward degradation, causing an array of environmental impacts. With this, one alternative that has been explored to minimize the problems intensified by these residues is the use of pro-degrading additives. Therefore, the aim of this work is to evaluate the degradation process of PP blends in soil using enzymatic additive. The soil degradation experiment was done for 6 months; monthly collected samples were checked for alterations on the material properties during that time. The extent of PP degradation with enzymatic additive was compared to an organic additive by techniques of FTIR, TGA, DSC, carbonyl index (CI), and crystallinity. From the obtained results it was observed that the additives influenced the degradation of PP. In addition, the enzymatic additive caused more significant changes in the CI (increase of 3693%), crystallinity (variation of 18.7%), and structural characteristics, indicating a greater influence on the degradation process in relation to the organic additive. In this way, this work has had an important role in the research and development of biodegradable materials with the aim of minimizing the effects induced by plastic waste in the environment.

Keywords Polypropylene · Pro-degradant · Additive · Degradation · Enzymatic · Organic

Introduction

In recent years, the plastic consumption has gone up exorbitantly worldwide, because of the development of new materials based on synthetic polymers. A majority of these plastic products are used for short-term application and posteriorly discarded [1, 2]. Among the several plastic classes known in the world, the polypropylene (PP) shows a huge use due to its low cost, chemical resistance, effective water and gas barrier properties, being the second most used resin in Brazil (approximately 21.9%) [3–5]. On the other hand, PP is a petroleum-derived product, highly stable, and takes long time for degradation. Consequently, its low degradability and the incorrect disposal of its products, mainly in the packaging sector, impose the development of new technologies to provide the degradation/biodegradation of these polymers [6–8]. Currently, biodegradable polymers such as polylactic acid (PLA) [9], polyhydroxybutyrate (PHB) [10], and polycaprolactone (PCL) [11], are considered the alternatives to minimize the effects of these discarded materials. However, their use is still restricted due to several properties that are not equivalent to conventional plastics, such as low flexibility, low impact resistance, and high temperature, among others. In addition, biodegradable polymers have higher production cost compared to conventional plastics [12].

Another alternative that has been explored is the degradable polyolefin, which can be obtained with the addition of

✉ Jeane Estela Ayres de Lima
jeane.lima@pucrs.br

1 Institute of Petroleum and Natural Resources, Pontifical Catholic University of Rio Grande do Sul, Ipiranga Avenue, Porto Alegre, RS 6681, Brazil

2 Polytechnic School, Pontifical Catholic University of Rio Grande do Sul, Ipiranga Avenue, Porto Alegre, RS 6681, Brazil

3 Graduate Program in Materials Engineering and Technology, Polytechnic School, Pontifical Catholic University of Rio Grande do Sul, Ipiranga Avenue, Porto Alegre, RS 6681, Brazil