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“Biodegradable” plastics: A myth of marketing?

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Abstract

When compared to their petroleum based counterparts, bioplastics can be biodegradable, sustainable, more environmentally friendly (lower greenhouse gas emissions and fossil fuel usage) and/or should be a renewable option to plastic product production. Despite certain limitations, bioplastics remain a front runner as a suitable replacement for petroleum based plastics. This study aimed at investigating the biodegradability of bioplastic vs. petroleum based plastic under various conditions.

This experiment focused on bioplastic samples retrieved from a frozen yoghurt shop in Chile and its rate of biodegradability under different conditions by varying the temperature, pH and environment. A comparison was drawn between the bioplastic samples and petroleum based plastic samples with both sets being subjected to the same conditions. The spoons were subjected to three temperatures and seven different media (NaOH, NH₃, compost, Air, HCl, CH₃COOH and pond water) to determine their biodegradability.

Subsequent to exposing the available bioplastic to different conditions by varying the temperature, pH and nature of the environment, the bioplastic samples did not biodegrade but gained weight. These results were surprising, and were similar to that of the petroleum based plastics under the same conditions. This similarity could lead one to deduce that bioplastic samples labelled as such may in fact not be made from biological sources.

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1. Introduction

Just because something has the prefix ‘bio-’ (e.g. biodiesel, bioplastic and more) does not mean it is more environmentally friendly [1-3]. This work looks at the case of a plastic that claimed to be made from plant material

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and labelled as ‘biodegradable’. While petroleum plastics have numerous and valuable applications, typically they are not biodegradable [4]. As such, bioplastics could have environmental advantages.

Bioplastics, which can include polylactic acid, polyamide and bio-polyethylene, can be broadly described as plastics that are derived from plant material or materials that have the ability to biodegrade into natural components. They may be biodegradable (a natural mechanism which breaks the material due to the action of bacteria, fungi or algae) as well as compostable (a mechanism which breaks the material into carbon dioxide, water and inorganic compounds) [5]. They can be prepared from several biological sources, including plant and animal material, of which starch-based bioplastics are currently the most commonly manufactured bioplastics on an industrial scale. When compared to their petroleum-based counterparts, bioplastics are biodegradable, sustainable, more environmentally friendly (lower greenhouse gas emissions and fossil fuel usage) and are often a renewable option (Table 1). However, bioplastics have not reached their full potential as a viable and permanent solution to replace petroleum based plastics. Regardless of any limitations, bioplastics remain a forefront runner as a suitable replacement for petroleum based plastics as detailed in large volumes of literature on the topic [1, 3-11 and more].

Table 1. Comparison of features of bio- and petroleum based plastics [4].

	Bioplastics	Petroleum plastics
Renewable	Yes or partially	No
Sustainable	Yes	No
Breakdown in the environment	Biodegradable and/or compostable	Some degradable by polymer oxidation
Polymer range	Limited but growing	Extensive
Greenhouse gas emissions	Usually low	Relatively high
Fossil fuel usage	Usually low	Relatively high
Arable land use	Currently low	None

In this study, an investigation was conducted on proposed bioplastic products and petroleum based plastics to determine their biodegradability. By exposing the bioplastic samples to various controlled conditions (temperature and pH) it would be possible to identify the rate and extent of decomposition and thus compare these to petroleum-based plastic

2. Method

This experiment focuses on bioplastic samples retrieved from Chile and the rate of biodegradability under different conditions by varying the temperature, pH and environment. The plastics were marketed as being plant derived and labelled ‘biodegradable’. A comparison was drawn between the bioplastic samples and petroleum based plastic samples with both sets being subjected to the same conditions.

2.1. Materials

- Bioplastic spoons
- Petroleum based plastic spoons
- Sample trays with separate compartments
- Compost
- Pond water
- Hydrochloric acid (HCl) and Acetic acid (CH₃COOH)
- Sodium hydroxide (NaOH) and Ammonia (NH₃)

2.2. Experimental procedure and setup

The bioplastic and petroleum based plastic samples were prepared to have a similar shape and size. The samples were weighed and recorded. The sample trays were filled with compost and treated with chemicals to create either a

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