Evaluation of the microbiological decomposition of biodegradable, compostable and water-soluble plastic bags in a seawater inoculum

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It is estimated that 500 billion plastic bags are used every year around the world, being one of the plastic wastes that most frequently reach the sea, where they become a danger for marine biodiversity, and consequently for humans due to the presence of microplastics in the food chain.

New materials that seek to be an ecological substitute for plastic bags are constantly being made, but many times when they become waste they are not disposed of correctly, making their microbiological decomposition difficult. Therefore, it is important to evaluate the degree of biodegradability of plastic bags in different environments, in this case, in sea water.

The objective of this research was to evaluate the microbiological decomposition of biodegradable, compostable and water-soluble bags in seawater by exposing them to controlled laboratory and field conditions, in order to verify their degradation.

This work was carried out in the Environmental Engineering Laboratory of the Engineering Institute of the National Autonomous University of Mexico. Plastic bags sold in Mexico City labeled as biodegradable, compostable and water-soluble were collected and subjected to four exposure methods, three under controlled laboratory conditions and one in the field.

The first was the evaluation of biodegradation in a fish tank where the bags were exposed to marine conditions based on ISO 15314:2018 (E). Photographic evidence was taken, resistance and elasticity tests were performed, and color, brightness, texture and thickness were observed.

Under controlled laboratory conditions, the same bags were exposed to marine biodegradation tests in a respirometry equipment in accordance with ISO 23977-2:2020 to obtain the biodegradation percentage. They were also subjected to an anaerobic biodegradation test in seawater based on ISO 14853:2018 to obtain more representative results of the marine ecosystem.

The bags were analyzed by Attenuated total reflection infrared spectroscopy (ATR-IR), before and after their exposure to the seawater inoculum, for the case of fish tank exposure and respirometry tests, their composition was compared to verify if there was any biodegradation or if they were only fragmented into microplastics.

Approximately 50% of the bags showed signs of degradation over a period of 6 months. It is noteworthy that the water-soluble bag did not show significant changes. The thicker bags did not show any signs of degradation. Infrared analysis showed a decrease in the intensity of the peaks, indicating a biodegradation process of the material. Respirometry tests obtained quantitative data on biodegradation, monitoring the generation of biogas, indicating that bioplastics contain biodegradable organic matter.

Bags that were exposed to field conditions degraded faster. The fact that a plastic bag has a biodegradable or compostable label does not guarantee that this will happen under all circumstances. Even between different brands with the same label there are differences in terms of their degree of biodegradability. The bags that showed the best biodegradability results were those with various certifications of being compostable.

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