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Degradation Potential of Biodegradable Plastics under Laboratory Conditions

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Abstract

Conventional plastics are one of the greatest environmental issues due to their excessive usage and slow degradation. Biodegradable plastics have been introduced as a promising solution to the issue. However, the degradation potential and the best exposure conditions for biodegradable plastics are not well understood in the local context. Therefore, the present study was conducted to evaluate the degradation potential of some commercially available single-use plastics labeled as "biodegradable". Two brands of lunch sheets (LS1 and LS2) made from Polylactic acid (PLA), Polybutylene adipate terephthalate (PBAT), and corn starch, and one waste bag made from Low-density polyethylene (LDPE) and Linear low-density polyethylene (LLDPE) were tested against cellulose filter paper (FP) as a positive control. Degradation was tested using mass loss analysis, biogas production, and FTIR spectrum analysis together with visual analysis. The test materials were subject to different exposures, i.e., placed under seawater, beach sand, freshwater, sand with overlying freshwater, and under direct sunlight for 210 days, and anaerobic exposure for 60 days. LS1 had the highest mass loss of 73.3% in freshwater and the lowest of 9.5% in sunlight exposure. LS2 recorded the highest mass loss of 59.3% in compost exposure and the lowest of 2.9% in sunlight exposure. Waste bags recorded 1.5% as the highest mass loss in the sand with overlying freshwater and the lowest 0.3% under direct sunlight which is the lowest among all four samples. FP has shown the highest and lowest mass loss in composting and direct sunlight exposures at 79.7% and 6.2%. The degradation of FP indicates that the conditions required for biodegradation were present in the exposure environments. Direct sunlight exposure does not show a significant impact on the degradation of any of the test materials. The waste bag does not show considerable degradation under any exposure. The carbon dioxide gas production was 8.76×10^{-4} mol, 18.49×10-4 mol, and 2.88×10^{-4} mol in LS1, LS2, and waste bag, respectively. LS1 and LS2 showed visual damages and also changes in the FTIR spectrum. However, waste bags did not show any changes visually or in FTIR spectra. Therefore, it can be concluded that LDPE and LLDPE products did not undergo a detectable degradation though PLA, PBAT, and corn starch products show clear signs of degradation. The study needs to be repeated in situ to better understand the degradation behavior in actual exposure situations.

Keywords: Biodegradable plastics, Degradation, Plastic pollution