Development of Environmentally Friendly Biological Technologies for Plastic Waste Treatment

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Plastic waste, especially polyethylene (PE), persists in the environment and is difficult to treat efficiently by existing biological methods. This study evaluated a two-stage biological approach using Aspergillus niger, Bacillus subtilis, and black soldier fly larvae (Hermetia illucens) to improve PE degradation. Aspergillus niger, Bacillus subtilis isolated from landfill soil were cultured in Nutrient Broth or Potato Dextrose medium at 30°C, then transferred to 100 mL medium containing 15 g PE. Untreated PE and medium without PE were used as controls where appropriate. Black soldier fly larvae were reared on rice bran at 28–30°C and 70% humidity, and PE degradation in the larval stage occurred in the naturally alkaline gut environment. Each experiment was performed in triplicate. After 14 days of microbial pretreatment, PE showed clear surface alterations. When pretreated PE was added to larval substrate at 20%, consumption reached 13.2 g per 100 g larval biomass, compared with 3.9 g for untreated PE at the same ratio. FTIR analysis detected no PE signal in larval samples from the 10% and 20% pretreated-PE groups, whereas PE-related signals remained in the 40% and 80% groups. These results show that combining microbial pretreatment with insect larvae substantially improves PE degradation and supports a promising environmentally friendly strategy for plastic waste treatment. Keywords: Aspergillus niger, Bacillus subtilis, biodegradation, black soldier fly larvae, FTIR spectroscopy, PE.

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