Biodegradable Plastics Made from Waste Biomethane

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Petroleum based non-biodegradable plastics have caused serious environmental and ecological problems globally. It is vital to develop sustainable ways to produce environmentally-friendly biodegradable plastics. Methanotrophic bacteria are known for assimilating methane while generating polyhydroxyalkanoates (PHA) biopolymers, potential candidates for biodegradable plastics. However, the feasibility and optimization of using methanotrophs to efficiently convert waste bio-methane and volatile fat acids generated from organic waste management to valued-added and biodegradable bioplastics has never been fully achieved. This project aims to evaluate the production efficiency of polyhydroxybutyrate (PHB) biopolymers, one of most common PHAs by co-metabolizing methane assimilation with acetic acid at different concentrations by a methanotrophic culture. The results showed the methanotrophic culture's capacity to produce PHB biopolymers from methane. Most importantly, the addition of acetic acid as co-substrate enhanced the generation of PHB biopolymer under pH-controlled conditions. With an acetic acid concentration of 300 mg/L, the maximum PHB production reached 34.8 ± 1.8 wt% compared to 26.4 ± 3.5 wt% in the treatment with methane alone. Moreover, the FTIR results indicated that the addition of acetic acid didn't change the functional structure of PHB monomers. The PHB biopolymers derived under optimal pH conditions showed better mobility of the polymer chain resulting from the higher melting temperature. This project provides new insight on the conversion of bio-methane and acetic acids to PHA biopolymers by methanotrophs, offering a sustainable paradigm for producing value-added biodegradable plastics from organic waste management while reducing greenhouse gas emission.

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