Influence of Gas-phase CO_2 Control on Lactate and Methane Productions from PLA (Poly Lactic Acid)-Degrading Thermophilic Anaerobic Digestion

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ABSTRACT: Poly (lactic acid) (PLA), currently the most used bioplastic material, is biodegradable by methane-producing thermophilic anaerobic digestion (TAD). If lactate can be recovered from PLA-degrading TAD process, it would be more circular, i.e., bioplastic-to-bioplastic cycle. Even though CO_2 can act as a reactant or a product in multiple reactions involved in (i) degradation of PLA to lactate, (ii) acidogenesis, (iii) acetogenesis, and (iii) methanogenesis, little is known about whether gas-phase CO_2 control can be used to enhance lactate production with or without a shift in methane production in PLA-degrading TAD. When gas-phase CO_2 was reduced via absorption into a separate NaOH solution in head space, a slight (~30%) decrease in methane production but significantly increased accumulations of lactate and VFAs (mainly acetate) were observed in the laboratory batch reactor of PLA-degrading TAD, compared to in the PLA-degrading TAD reactor without CO_2 control. The following microbiome analysis revealed a significant influence of gas-phase CO_2 control on bacterial community of PLA-degrading TAD while archaeal communities between in the PLA-

degrading TAD reactors with and without CO_2 control were similar exhibiting a dominancy of hydrogenotrophic methanogens (*Methanocobacter* and *Methanoculeus*). When CO_2 was reduced in the PLA-degrading TAD reactor, the preferentially cultivated bacterial members were *Defluviitoga* (32.7%), *Halocello* (8.4%), and *Xylanivirga* (5.3%), which is closer to the bacterial community composition of the cellulose-degrading TAD reactor than that of the PLA-degrading TAD reactor without CO_2 reduction. These findings support applicability of gas-phase CO_2 control in enhancing recovery of lactate in PLA-degrading TAD, which provides insight into high value up-cycle of PLA using TAD process.

Keywords *: Poly lactic acid (PLA degradation, thermophilic anaerobic digestion (TAD), lactic acid recovery, methane production, CO_2 control*

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