Research on the Mechanism and Control of Simultaneous Bisphenol A Degradation during Sludge Anaerobic Acidogenesis

The degradation pattern of BPA in the sludge anaerobic acidogenic system was obtained in this study. The alkaline acidogenic system (pH 10) demonstrated the highest BPA degradation efficiency (69.9%), which was 4.5 times higher than that in the blank acidogenic system (15.7%). Simultaneously, the acid production increased by 2.43 times (2,082 mg COD/L vs. 856 mg COD/L). The core taxa of the BPA-degrading microbiome in the acidogenic system were identified. Amplicon sequencing and metagenomic binning revealed that Gram-positive bacteria (Actinomycetota and Firmicutes) were the core taxa of the BPA-degrading microbiome in the alkaline acidogenic system. The representative strains Corynebacterium and Bhargavaea were enriched by 441-fold and 670-fold, respectively, during fermentation, while the abundance of Gram-negative bacteria significantly decreased as fermentation progressed. The BPA degradation characteristics of acidogenic functional strains were elucidated. The acidogenic strains Corynebacterium pollutisoli and Bhargavaea beijingensis achieved a BPA degradation rate of over 51% within 8 days without an external carbon source. Further studies found that polysaccharides and monosaccharides, as co-metabolic substrates, significantly enhanced degradation efficiency, increasing the 4-day BPA degradation rate by more than 47%. A dual-pathway model of "metabolism-co-metabolism" for BPA degradation by acidogenic bacteria was proposed. Acidogenic bacteria can directly metabolize and degrade BPA, while also hydrolyzing macromolecular organic matter to produce small molecules (e.g., glucose) that promote co-metabolism, forming an efficient BPA degradation network. A BPA anaerobic degradation process based on the enhancement of functional microorganisms was developed. Inoculating C. pollutisoli and B. beijingensis into the sludge anaerobic acidogenic system increased BPA degradation efficiency by more than 2.8 times and simultaneously enhanced VFA production by 2.1 times, providing an innovative solution for controlling emerging contaminants during sludge treatment.