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Boosting biomethane yield and production rate with graphene: the potential of direct interspecies electron transfer in anaerobic digestion

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9

10 **Abstract**

11 Interspecies electron transfer between bacteria and archaea plays a vital role in enhancing  
12 energy efficiency of anaerobic digestion (AD). Conductive carbon materials (i.e. graphene  
13 nanomaterial and activated charcoal) were assessed to enhance AD of ethanol (a key intermediate  
14 product after acidogenesis of algae). The addition of graphene (1.0 g/L) resulted in the highest  
15 biomethane yield ( $695.0 \pm 9.1$  mL/g) and production rate ( $95.7 \pm 7.6$  mL/g/d), corresponding to an  
16 enhancement of 25.0% in biomethane yield and 19.5% in production rate. The ethanol degradation  
17 constant was accordingly improved by 29.1% in the presence of graphene. Microbial analyses  
18 revealed that electrogenic species of *Geobacter* and *Pseudomonas* along with archaea  
19 *Methanobacterium* and *Methanospirillum* might participate in direct interspecies electron transfer  
20 (DIET). Theoretical calculations provided evidence that graphene-based DIET can sustained a  
21 much higher electron transfer flux than conventional hydrogen transfer.

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