UNVEILING BIOCHAR'S ROLE IN ANAEROBIC DIGESTION: MYTHS AND FACTS

G. Vayena[1], P. Ghofrani-Isfahani[1], A. Ziomas[1,2], A. Grimalt-Alemany[1], M.K.T.H. Lin[3], I. Angelidaki[1,*]

[1]Department of Chemical and Biochemical Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark

[2]Department of Chemical Engineering, University of Patras, Patras, Greece

[3]National Centre for Nano Fabrication and Characterization, Technical University of Denmark, Kgs. Lyngby, Denmark

*(*iria@kt.dtu.dk)*

ABSTRACT

Anaerobic digestion (AD) is a key enabler of circular bioeconomy, fulfilling the urgent needs for renewable energy sources and efficient organic waste management[1]. Nevertheless, process challenges, e.g., low stability and efficiency, impede the widespread application of AD systems[2]. The addition of biochar, a low-value biobased carbonous material produced through pyrolysis of biomass, has been increasingly highlighted as an effective method to enhance digestion processes. Its physicochemical properties allow it to act as an absorbent of inhibitory compounds, pH buffer, promoter of microbial immobilization, enhancer of microbial interactions, and stimulant of direct interspecies electron transfer (DIET)[3]. Although, based on literature, biochar addition can facilitate digestion and substantially increase methane yield[2], involved mechanisms remain unclear. This study aimed to assess the role of biochar in the AD process and provide an in-depth understanding of the involved mechanisms, starting from the simplest step, the digestion of simple organics. To do so, 5 types of biochar of different feedstock or production method were evaluated in terms of methane production under mesophilic conditions using cellulose as substrate, followed by a thorough characterization of their physicochemical properties (CHNOS, TOC, BET-specific surface area, QSDFT porosity, SEM, pH, EC[4]). Thermochemical treatment temperatures ranged from the lowest to the highest biomass treatment limits to assess the content of biodegradable organic matter in biochar and its impact on AD. The effect of biochar dosage and microbial distributions were also investigated. Experimental results indicated that biochar has a neutral impact on the AD process of model substrates. However, specific types of feedstock combined with high production temperatures allow the release of harmful substances existing within its structure, (i.e., polycyclic aromatic hydrocarbons (PAHs), phenolics, heavy metals) leading to process inhibition[5]. Meanwhile, incomplete thermochemical treatment of the feedstock, either due to low temperatures or process failures, can cause incomplete solidification of feedstock's components, leaving biodegradable organic matter in the produced biochar. This leftover organic matter is an available substrate for the microbes, leading to co-digestion with the currently added substrate, and hence to higher methane production. The obtained information contributed in clarifying the function and influence of biochar addition in the digestion process.

KEYWORDS: Biochar, Anaerobic Digestion, Biogas Production, Circular Economy, DIET

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