PRODUCTION AND CHARACTERIZATION OF HTC SOLIDS FROM LIGNIN-RICE BIOMASS AND DOWNSTREAM APPLICATION IN ANAEROBIC DIGESTION

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Lignocellulosic biomass is mainly composed of three pseudo components, namely hemicellulose, cellulose, and lignin. Of these three, lignin as a cross-linked network hydrophobic polymer has a strong resistance to biodegradation such as anaerobic digestion (Hatfield and Fukushima 2005, Fernandes, Klaasse Bos et al. 2009), but can be decomposed thermally. Hydrothermal carbonization is a promising method of processing biomass with high moisture content for value-added products. This study evaluates and compares the physicochemical characteristics of hydrochar derived from rice husk, wheat straw pellets, oil rape straw pellets and reference alkali lignin. The results indicated wide variation in the physicochemical properties and quality of hydrochar depending on biomass feedstock composition. Mass yields of lignocelluosic biomass increased with the increase of lignin content, however, higher lignin content biomass exhibited lower hydrogen/carbon ratio. The results of this study also identified that hydrochar were more acidic than biochar produced from same feedstocks, however, Kraft lignin hydrochar exhibited higher pH 9.52. The study also seeks to explain the role of biomass composition on surface functional groups of hydrochar via attenuated total reflection - Fourier transform infrared spectroscopy (ATR-FTIR). The ATR-FTIR spectra were used to identify the functional groups qualitatively. It would give further insight into surface functional groups of hydrochars and the changes in the chemical composition of lignin and biomass during the conversion process.

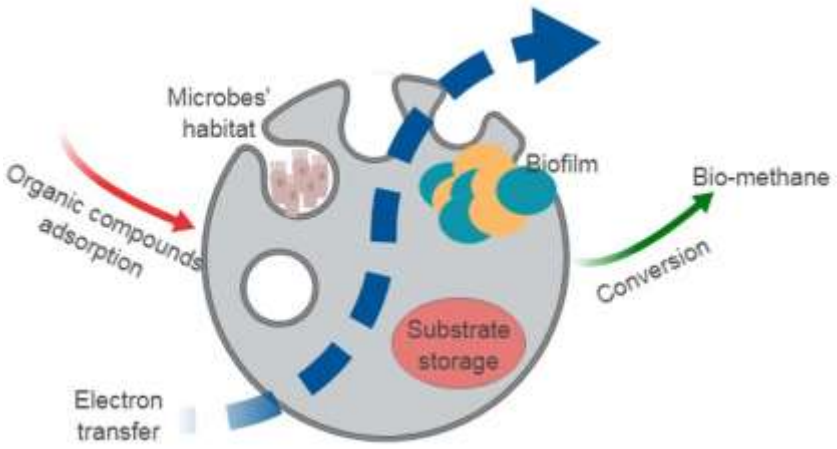

Figure 1 – propose functions of hydrochar in anaerobic digestion

We then further studied the effects of these hydrochars additions on the anaerobic digestion of sewage sludge. AD batch experiments were performed at an inoculum:substrate ratio of 1:2, at 37±1ºC and under agitating conditions. The hydrochar to inoculum ratio in each treatment condition was 2% weight basis. Graphene was used as reference material. The preliminary results showed that only the biogas volume produced by bioreactor supplied with Kraft lignin hydrochar was higher than the positive control with only sewage sludge as substrate. It had the highest biogas yield of 64.2±5.25 mL with 73% of methane at day 29. In contrast, the syringe bioreactor with treatment of rice husk, wheat straw pellets, oil seed rape pellets hydrochars and graphene generated less biogas volume compared to the positive control groups. These study results clearly indicated that the type of hydrochar and surface functional groups in hydrochar play a key role in determining the effectiveness of the hydrochar in enhancing biogas production from sewage sludge. Thus, a combined HTC-AD treatment provides a seemingly effective method for valorizing lignin-rice biomass.

Reference

Fernandes, T. V., et al. (2009). "Effects of thermo-chemical pre-treatment on anaerobic biodegradability and hydrolysis of lignocellulosic biomass." Bioresource Technology 100(9): 2575-2579.
Hatfield, R. and R. S. Fukushima (2005). "Can Lignin Be Accurately Measured? This paper was originally presented at the Lignin and Forage Digestibility Symposium, 2003 CSSA Annual Meeting, Denver, CO." Crop Science 45(3): 832-839.