BIOCHAR AS AN ADDITIVE FOR ENHANCED DARK FERMENTATION AND ANAEROBIC DIGESTION

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Anthropologic activities have vastly increased greenhouse gas emissions, causing them to trap heat in the atmosphere and resulting in environmental damages. Biochar, has been identified as a negative emission technology for carbon sequestration. It is a porous and versatile carbon-rich biomaterial with excellent soil amending, adsorptive and catalytic properties. Biochar has also been shown to boost methane production in anaerobic digestion due to its impact on the microbial activity in the AD reactor. While most research has focused on biochar form terrestrial biomass, aquatic biomass, such as micro and macro algae offer a promising resource with minimal land footprint and potential environmental benefits in the oceans. Therefore, this study focused on developing a low-cost biochar additive to enhance the performance of fermentation systems. To boost the physicochemical properties of algal biochar, while simultaneously addressing another global challenge (marine plastic pollution), this work also utilised a blend of algal biomass (*Ascophyllum Nodosum* [AN] and *Laminaria Digitata* [LD]) with wasted plastics (polypropylene [PP]) at rates of 0, 0.5, 5 and 10%. The feedstock underwent pyrolysis in a lab-scale batch reactor at 500^{o}C to ensure complete conversion of the plastic components. For the LD/PP blend, the presence of plastic in the feedstock have resulted decreasing redox potential of biochar with the most distinct negative effect on 10LD/PP decreasing by 35.3%. Biochar LD/PP has greater redox potential with an average value of -127.15 mV, than that of biochar AN/PP (an average of -42.5 mV), which might be attributed to the difference in feedstock composition. Biochars produced from *Ascophyllum Nodosum* enhanced biohydrogen productions with biohydrogen yields of 2.05, 3.51 and 1.88 mL/g glucose for 0.0AN/PP, 5.0AN/PP and 10.0AN/PP, respectively, compared to the control without biochar addition (1.36 mL/g glucose). Whilst 0.5AN/PP with higher redox potential of -71.3 mV showed a reduction on biohydrogen and biomethane yields. This can be due to that hydrogen-producing bacteria *Clostridium* was out-competed by heterotrophic bacteria in the presence of high conductive material, leading to the preferential production of acids (Lu *et al*., 2020). Additionally, ethanol production increased with a decrease in the PP mass ratio for the AN/PP blend. The electrical conductivity and pH of biochar AN/PP were found to have a dominant effect on enhanced ethanol production, with Pearson's correlation r=0.88 and 0.86, respectively. Meanwhile, greater enhancements (90.0% - 465.9%) in biomethane productions were observed from biochar LD/PP amended systems with an average methane yield of 74.5 mL/g glucose. In this group, pH of biochar LD/PP was found to have a significant correlation with improved biohydrogen and biomethane yields with Pearson's correlation r=0.83 and 0.80, respectively. Ultimately, this study's results will be useful in determining the acceptable level of plastic contamination when managing contaminated biomass streams of marine, but also terrestrial biomass, indicating that plastic contamination in these feedstock may not necessarily be detrimental to use in fermentation applications.

Figure 1. Graphic abstract of biochar for enhanced dark fermentation and anaerobic digestion co-system