Full Abstract

Biogas, created from anaerobic transformation of organic matter, is a high-energy fuel that can substitute conventional fossil-based fuels. Yields of biogas can be greatly increased by optimizing anaerobic digestion. In addition to exploration of reactor designs to reach high biogas yields, use of the right combinations of microorganisms for different organic wastes can lead to process stability over longer periods of operation. The goal of this research is to develop and test an approach for optimization of biogas production by engineering microbial consortia. Specifically, a consortium that can digest algal biomass, collected from the wastewater lagoons or open waterbodies. Algal biomass is rich in Nitrogen and Phosphorous and can be used in anaerobic co-digestion of Nitrogen-poor substrates, in addition to just being digested as a sole substrate. However, breakdown of algal cell walls requires specific microbial enzymatic machinery, that is not readily available in many sources of inocula. The research described here addresses the problem of digesting algal biomass with novel algalytic bacteria isolated from sediments of local Logan City Wastewater Lagoons. Bacteria were used to augment microbial consortium that hasn’t digested algal biomass before, leading to an enhanced biogas production from this type of substrate. The research also addresses current state of the anaerobic microbiology field and expands on the previous efforts to analyze microbial interactions in wastewater treatment systems. Specifically, a computational model is developed to aid with in silico prognosis of anaerobic consortia ability to form complex aggregates in anaerobic reactors with upflow mode of feeding substrate. In addition, the model provides insights into bioaugmentation of the microbial aggregates with novel metabolic capabilities. Combining modeling predictions and laboratory experiments in anaerobic digestion will lead to more stable engineered systems and higher yields of biogas.