

Using the human gut microbiome as inoculum for anaerobic digestion of food waste to produce amino acids and useful metabolites

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Abstract

Sustainable and environmentally friendly approaches must be found for the management of food waste. One possibility is the use of anaerobic digestion for reducing the amount of final sludge that needs to be disposed off in landfills as well as producing methane gas which can be used for heating purposes and generation of electricity. While current anaerobic digestion methods could achieve the above objectives, possibilities exist of using human gut microbiome as inoculum for anaerobic digestion of food wastes. Anaerobic digestion is fundamentally a digestion process where complex molecules in food are broken down into smaller molecules. This is similar to the human digestion process where microorganisms in the human gut aids the digestion of food. But, herein lies an important difference, the human digestion process generates small molecules with nutritional value, which is in contrast to the current anaerobic digestion process that produces small molecule acids and methane. Hence, possibility exists of using the human gut microbiome as inoculum in anaerobic digestion of food waste to produce useful nutrients such as amino acids that could be recovered and purified. If proven to be successful, the concept would represent an upcycling of anaerobic digestion, which enables the process to move away from its traditional role of reducing sludge and producing methane. To this end, a synthetic consortium of microorganisms representative of the human gut microbiome would be cultured in the laboratory for investigating their functional diversity through RNA-seq and ribosome profiling. Though sequence-based, transcriptome analysis and ribosome profiling provide the repertoire of genes transcribed and translated, which can serve as a proxy of the consortium's functions. Assays of the metabolites secreted by the consortium would also provide clues to the functional compendium of the microbial community. But, what is most important of the co-culture experiment is to understand if the different microorganisms could be stably co-cultured in a consortium, and remain stable under different environmental and nutritional conditions common during the operation of an anaerobic digester. Upon confirmation that the consortia of microbes could be stably co-cultured, it would serve as an inoculum for bench scale anaerobic digester to further characterise their performance in starting up the digester, as well as the useful products that could be derived from the anaerobic digestion process. If proven to be useful at the bench scale, experiments could be further scaled up to the pilot scale to examine scaling effects and other possible process complications. Overall, use of synthetic microbial consortia representative of the human gut microbiome may be one direction in which anaerobic digestion could be further explored for producing useful compounds rather than its current role of reducing sludge and producing methane for energy applications.

Keywords: anaerobic digestion, microbial consortia, methane, organic acids, sludge, inoculum, nutrients, co-culture, RNA-seq, ribosome profiling,

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Conflicts of interest

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