Title

Investigation of microalgae cultivation and anaerobic codigestion of algae and sewage sludge for wastewater treatment facilities

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Abstract

The main goals of this research are to investigate the anaerobic digestibility of algae and to investigate the effects of growth media on the growth rates, nutrient removal kinetics, and extracellular polymeric substances (EPS) characteristics of wild type green algae. Anaerobic co-digestion of algae with sewage sludge is proposed to improve the digestibility of algae. It is hypothesized that the addition of sewage sludge improves the hydrolysis rate of algae, which is often the rate-limiting step for anaerobic digestion. It is also hypothesized that the composition and concentration of nutrients in growth media will affect the kinetics of nutrient removal and the content of EPS, which will influence algae flocculation and subsequent anaerobic digestion.

In this research, algae collected from a local wastewater treatment plant were cultivated in synthetic medium, primary wastewater effluent and pure or diluted anaerobic sludge centrate. Light cycles and the level of CO_2 addition were varied at different stages of cultivation for nutrient removal and physiochemical properties of algae. Harvested algae were then anaerobically co-digested with varying proportions of sewage sludge under mesophilic condition.

Results showed that when algae were digested alone (i.e. no sludge addition) with a small amount of seed sludge, algae were poorly digested. When algae were co-digested with sewage sludge, the gas yield was improved and the gas phase (CH_4 generation) was reached faster. The biogas yield of algae increased to a comparable level to that of digestion of waste sludge when 44% (by VS) of seed sludge was inoculated for digestion. The addition of sewage sludge improved the hydrolysis rate and the overall digestibility of algae. Algae grown in primary effluent, which had a balanced N/P ratio showed a higher nutrient removal efficiency. The P-limitation in sludge centrate led to lower nutrient removal efficiency and higher EPS production compared to algae grown in primary effluent, indicating that sludge centrate was a harsher medium for algae growth.

In conclusion, microalgae can grow in primary effluent and anaerobic sludge centrate for nutrient removal. Anaerobic co-digestion of algae withwaste sludge was strongly recommended to enhance the biogas generation.

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