PARALLEL NUTRIENT REMOVAL AND BIOGAS PRODUCTION BY *CHLORELLA VULGARIS* CULTURES

Ozgul Calicioglu and Goksel N. Demirer [*]

Environmental Engineering Department, Middle East Technical University, TURKEY.
* Corresponding author, goksel@metu.edu.tr

ABSTRACT

In aquatic environments, eutrophication causes algal blooms, oxygen depletion, increase in undesired vegetation, loss of plant beds, fish, coral reef and other species. Eventually, the water bodies become unavailable to utilize for agricultural, recreational, industrial and drinking purposes. Discharge of domestic sewage introducing high levels of nutrients to water bodies is one of the main causes of eutrophication. Secondary treatment may not be adequate for removal of these nutrients. In fact, tertiary treatment methods have been developing for their removal.

Considering their high nitrogen and phosphorus requirements, growth of algae is an alternate method for biological wastewater treatment with advanced nutrient removal. In addition, photosynthetic activity during treatment process requires carbon dioxide, which may be provided from atmosphere or flue gas. In turn, microalgal wastewater treatment aids sequestration of atmospheric carbon dioxide. *Chlorella vulgaris,* microalga from genus of single-cell green algae, *Chlorella*, has high photosynthetic efficiency, productivity and adaptable to severe environmental conditions. Owing to these properties, *Chlorella vulgaris* is a viable alternative for wastewater treatment systems, in order to provide system flexibility against variations in wastewater compositions.

Microalgal biotechnology has been developed not only for wastewater treatment, but also for a variety of consumer products such as pharmaceuticals and nutrient supplements. Apart from consumer products, microalgae can be used for production of biofuels. Extracted oil from microalgal biomass can be converted into biodiesel. The cell residues can then be converted into biomethane, bioethanol or biohydrogen. Biomethane production from microalgal biomass has received attention, since biogas obtained from anaerobic digestion can be used for electricity generation. In addition, biomass residues after anaerobic digestion can be converted into fertilizers. Utilization of these fertilizers provides sustainable agriculture and reduce production costs of microalgae.

Production cost of methane from microalgae is higher than other feedstocks, due to microalgae cultivation costs involved in these systems. Therefore, integrated wastewater treatment and biomethane production can be the most feasible approach to reduce production cost. When coupled with carbon dioxide sequestration and wastewater treatment, microalgae can provide possible solutions to environmental problems and simultaneously create valuable consumer products and biofuels. Although cellulose and lignin contents of microalgae are almost zero and anaerobic process stability is high, hydrolysis of microalgal cell wall is problematic. The biodegradation of algal biomass can be improved by different pretreatment methods. such as microwave pretreatment; ultrasound pretreatment; thermal pretreatment including drying, heating, thermal hydrolysis or high pressure thermal hydrolysis; chemical pretreatment and biological pretreatment.

This study investigated (1) the nutrient (nitrogen and phosphorus) removal from wastewater, (2) pretreatment of the produced algal biomass by heat, autoclave and thermochemical methods, (3) and anaerobic digestion of the pretreated and non-pretreated algal biomass to produce biogas. To this purpose, a semi-continuous photo-bioreactor was operated for investigation of nutrient (N and P) removal efficiency of unialgal culture, Chlorella vulgaris. Then, the produced algal biomass with and without pretreatment were subjected to Biochemical Methane Potential tests.

The results indicated that the heat pretreatment is superior at relatively lower COD values (19000 ± 500 mg/L), increasing methane yield by 83.0% Autoclave pretreatment was superior at relatively higher (34000 ± 1500 mg/L) COD values, resulting in 43.0% increase in methane yield.

Keywords: Algae, Chlorella vulgaris, anaerobic digestion, biogas, co-substrate, nutrient.