INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title	:	CO_2 Sequestration using Microalga *Scenedesmus obliquus* SA1 Isolated From Bio-diversity Hotspot Region of Assam
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SHORT ABSTRACT

Flue gases emitted from coal-fired thermoelectric plants is responsible for up to 7% (v/v) of global CO_2 emissions, about 10-15% (v/v) of the flue gases emitted from the power plants being in the form of CO_2. Increased CO_2 concentration in the atmosphere is responsible for global warming and climate change. The thesis focuses on the isolation and characterization of high CO_2 and temperature tolerant microalga capable of sequestering CO_2 from flue gas and subsequent cultivation of the microalga in bench scale open system and lab scale photobioreactor for enhanced CO_2 sequestration. Microalga strain SA1 was isolated from a freshwater body of Assam and identified as *Scenedesmus obliquus* (KC733762). At 13.8 ± 1.5% inlet CO_2 concentration and *25 °C,* maximum biomass of 4.975 ± 0.003 g L^{-1} and maximum CO_2 fixation rate of 252.883 ± 0.361 mg L^{-1} d^{-1} were obtained in the lab scale closed system studies. Also, at elevated temperature (40 °C) and 13.8 ± 1.5% CO_2 supply maximum biomass value of 0.883 ± 0.001 g L^{-1} and maximum specific growth rate of 0.54 ± 0.020 d^{-1} were obtained. . The carbohydrate, protein, lipid, and chlorophyll content of the CO_2 treated SA1 obtained in the lab scale closed system studies were 30.87 ± 0.64%, 9.48 ± 1.65%, 33.04 ± 0.46 and 6.03 ± 0.19% respectively. The inlet CO_2 concentration of 13.8 ± 1.5% was reduced to 0.5% during logarithmic growth phase of SA1. Since the power plant flue gas contains high concentration of CO_2 (around 12-15%) and is released from the power plant at high temperature (around 40-50 ºC after the desulfurization process), tolerance of high CO_2 concentration and high temperature of 40 ºC temperature by *S. obliquus* SA1 makes it a potential strain for CO_2 sequestration from flue gases.

SA1 strain was subsequently cultivated in bench scale open system at varying CO_2 levels ranging from 0.03-35% (v/v) and subsequently the carbonic anhydrase activity (CA) and the biochemical properties were monitored. Maximum biomass concentration (1.39 ± 0.023 g L^{-1}), CO_2 fixation rate (97.65 ± 1.03 mg L^{-1} d^{-1}) and total Carbonic anhydrase (CA) activity (166.86 ± 3.30 E.U. /mg chla) were obtained at 35% CO_2 at a culture depth of 0.17 m. The culture depth was varied at 15% CO_2 concentration from 0.0425 m to 0.17 m. Overall biomass productivity (54.33 ± 0.19 mg L^{-1} d^{-1}), CO_2 fixation rate (102.13 ± 0.36 mg L^{-1} d^{-1}) and maximum biomass productivity (156.8 ± 4.37 mg L^{-1} d^{-1}) were the highest at a culture depth of 0.085m. As evident from literature reports, CA activity is strongly induced when algae are grown in a low-CO_2 environment. This fact was evident from our experimental finding, as CA activity of control culture (grown at ambient CO_2 concentration) > CA activity of 15% CO_2 treated culture > CA activity of 35% CO_2 treated culture for most of the experimental period. CA inhibitors: acetazolamide and ethoxyzolamide inhibited the external and internal enzyme activity respectively in SA1, thereby confirming the presence of periplasmic (external) and intracellular CA in the SA1 strain. High CO_2 levels were favorable for the accumulation of lipids and chlorophyll in the SA1 strain the values of which were 41.17 ± 0.77% and 8.47 ± 0.15% respectively. The increased lipid content could make the SA1 strain useful in biodiesel production. Also, chlorophyll is a useful commercial pigment and is regarded as an economically valuable co-product of the CO_2 sequestration process.

Finally, the operational parameters were varied to maximize the CO_2 utilization efficiency by the SA1 strain. In these optimization studies, SA1 strain was cultivated in a lab scale cylindrical glass photobioreactor (open system) under 15% CO_2 concentration at varied operational conditions (light intensity, CO_2 sparging duration and CO_2 flow rates). At light intensity of 4351 lux, CO_2 sparging duration of 12 h per day and flow rate of 0.43 liter per hour, maximum biomass concentration of 3.32 ± 0.022 g L^{-1}, maximum specific growth rate of 1.24 ± 0.028 d^{-1}, maximum CO_2 fixation rate of 1035.25 ± 52.98 mg$L^{-1}d^{-1}$ and maximum CO_2 utilization efficiency of 10.23% were obtained which were higher than most of the relevant literature reports. These parameters were thus inferred to be the optimum condition for maximum CO_2 utilization by the microalga in lab scale photobioreactor. SA1 has high biomass productivity, fast growth rates, an attractive biochemical profile, high CO_2 fixation rates and utilization efficiency when cultivated in presence of 15% CO_2 (typical flue gas concentration). It can thus prove to be a potential candidate for CO_2 sequestration from flue gas as well as find commercial utility.