Continuous Cultivation of Tetraselmis Chui in a Dual-tank Photobioreactor Using NaHCO3 as Carbon Source

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ABSTRACT

Global warning has become an international issue. Emission of carbon dioxide (CO2) by combustion of fossil fuel has been considered the main cause of the global warning. Integration of alkaline absorption and algae cultivation has been proposed by researchers to remove carbon dioxide from flue gas. Absorption of carbon dioxide by alkaline solution results in high concentration of NaHCO3 which can be used as the carbon source to cultivate microalgae. Effects of NaHCO3? concentration, light intensity and the dilution rate on the behavior of continuous cultivation of Tetraselmis chui in a dual-tank photobioreactor using a modified Walne medium were investigated in this study. For each culture, pH values, dissolved oxygen (DO) concentrations, optical density (OD), biomass, chlorophyll, CO32- and HCO3- concentrations were measured. Specific growth rate, specific respiration rate, CO2 fixation rate and CO2 fixation efficiency were determined. Biomass, chlorophyll concentration and CO2 fixation rate increased with the increase in NaHCO3 concentration. The highest biomass concentrations in light reactor and in dark reactor were 0.23 g l-1 and 0.15 g l-1, respectively. The highest chlorophyll concentrations in light reactor and dark reactor were 3.27 ?g l-1 and 2.9 ?g l-1, respectively. Under variation of NaHCO?3 concentration from 0.02 to 0.06 mol l-1, biomass productivity was fastest at 0.06 mol l-1 of NaHCO3 because the highest specific growth rate of 0.063 h-1 was found at 0.06 mol l-1 of NaHCO3. At steady state, among four different NaHCO3 concentrations, the highest CO2 fixation rate of 0.04 g h-1 was found at 0.06 mol l-1 of NaHCO3, but the highest CO2 fixation efficiency of 26% obtained at 0.04 mol l-1 of NaHCO3. With different light intensities in range of 10000~30000 Lux, the highest biomass concentrations were found at 30000 Lux in both light reactor and dark reactor were 0.21 g l-1 and 0.13 g l-1, respectively. The ratio of the highest biomass concentration to the lowest one was 1.9 : 1 for light reactor and 1.6 :1 for dark reactor. Both the highest specific growth rate of 0.065 h-1 and the highest specific respiration rate of 0.044 h-1 were obtained at 30000 Lux. Consequently, biomass productivity in light reactor and oxygen utilization in dark reactor of T.chui were fastest at 30000 Lux. The highest chlorophyll concentrations in light reactor and in dark reactor were respectively 2.79 ?g l-1 and 2.31 ?g l-1 which obtained at 30000 Lux. The highest CO2 fixation rate of 0.052 g h-1 and the highest CO2? fixation efficiency of 32.63% obtained at 30000 Lux by comparison with those at 10000 Lux and 20000 Lux. Variation of dilution rate from 0.03 to 0.16 h-1 indicated that the highest biomass concentrations obtained at dilution rate of 0.03 h-1 for both light reactor (0.24 g l-1) and dark reactor (0.20 g l-1). Among different dilution rates, the highest specific growth rate of 0.10 h-1 was found at 0.16 h-1. Chlorophyll concentration decreased with the increase in dilution rate. The highest chlorophyll concentrations were 8.82 ?g l-1 in light reactor and 6.83 ?g l-1 in dark reactor. In range of dilution rate from 0.03 h-1 to 0.16 h-1, the highest CO2 fixation rate of 0.09 g h-1 and the highest CO2 fixation efficiency of 23.1% obtained at 0.10 h-1 of dilution rate.

Keywords : photobioreactor ; Tetraselmis chui ; NaHCO3 concentration ; light intensity ; dilution rate

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