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Effect of CO_2 supply conditions on lipid production of *Chlorella vulgaris* from enzymatic hydrolysates of lipid-extracted microalgal biomass residues

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HIGHLIGHTS

- CO_2 supply conditions had a significant effect on lipid production.
- The most suitable CO_2 concentration for microalgal growth was 5%.
- Microalga grew best at a CO_2 aeration rate of 0.5 vvm.
- The fatty acids of the microalga are suitable for biodiesel production.

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ABSTRACT

The hydrolysates from lipid-extracted microalgal biomass residues (LMBRs) were used as a source of nutrients for the cultivation of *Chlorella vulgaris* for lipid production under various CO_2 supply conditions, including different CO_2 concentrations and aeration rates. Both parameters had a significant effect on lipid production. A CO_2 concentration of 5% was found to be most suitable for microalgal growth. Microalga grew best at a CO_2 aeration rate of 0.5 vvm. At this rate, biomass concentration and lipid productivity were at a maximum of 3.83 g L^{-1} and 157 mg L^{-1} d^{-1}, respectively, but decreased at lower or higher aeration rates. The present results showed that LMBRs utilization was effective in microalgal lipid production under suitable CO_2 supply conditions.

1. Introduction

Lipid-extracted microalgal biomass residues (LMBRs) are the residual biomass from microalgal biodiesel production processes. These residues are rich in proteins and carbohydrates, and making use of them is necessary to increase the economic and environmental feasibility of microalgal biodiesel production (Ehimen et al., 2011). LMBRs could be converted to products such as amino acids and sugars by enzymatic hydrolysis and utilized as nutrient sources for a new crop of microalgae (Zheng et al., 2012a). Since nutrient supplies have a sizeable effect on cost, sustainability, and site selection for microalgal cultivation (Stephens et al., 2010), the use of LMBRs could contribute to the economy of microalgal biodiesel production.

In a previous study, *Chlorella vulgaris* using both sugars from the hydrolysates of LMBRs and CO_2 supplied by aeration as carbon sources achieves much higher biomass concentration than without CO_2 aeration (Zheng et al., 2012a). This is because aeration supplies CO_2 as inorganic carbon source for *C. vulgaris* growth, and/or better mixing, resulting in a sufficient light distribution and better mass transfer (Camacho et al., 2011). Therefore, CO_2 supply conditions, including CO_2 concentration and aeration rate, are very important and deserve more detailed investigation in the mixotrophic cultivation of *C. vulgaris* for lipid production using the hydrolysates (mainly amino acids and sugars) of LMBRs as nutrient sources. Lastly, the suitability of the extracted microalgal lipids for biodiesel production was evaluated.

2. Methods

2.1. Microalgal strain and cultivation conditions

The microalga *C. vulgaris* (strain CCTCC M 209256) was obtained from the China Center for Type Culture Collection, Wuhan, China. The strain was preserved in 20% (v/v) glycerol at −80 °C. The

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