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The effect of different trophic modes on lipid accumulation of *Scenedesmus quadricauda*

Guili Zhao, Jiayi Yu, Feifei Jiang, Xu Zhang *, Tianwei Tan

Beijing Key Lab. of Bioprocess, College of Life Science and Technology, Beijing University of Chemical Technology, Beijing 100029, PR China

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ABSTRACT

In this study, the effects of different carbon sources on cell growth and lipid accumulation of *Scenedesmus quadricauda* were investigated. Results showed that *S. quadricauda* could grow on photoautotrophic, heterotrophic and mixotrophic modes. The lipid yield of *S. quadricauda* was much lower in the culture containing $NaHCO_3$ as only carbon source, while CO_2 and glucose concentration significantly influenced cell yield and lipid accumulation in photoautotrophic and heterotrophic culture, respectively. Furthermore, lipid content of *S. quadricauda* in mixotrophic culture (33.1% of cell dry weight) was much higher than that in photoautotrophic and heterotrophic cultivation (14–28%). Therefore, upon comparing these three trophic modes, present results revealed mixotrophy was the optimal culture method for *S. quadricauda* to produce lipid. Besides, it was a feasible and promising strategy to culture *S. quadricauda* using starch wastewater as raw material, which could reduce chemical oxygen demand (COD) of wastewater and the cost of biodiesel production.

1. Introduction

In last several decades, due to over consumption of fossil fuels such as petroleum fuels, coal and natural gas, they are to be exhausted in the future and the resulting energy crisis will become one of the largest challenge of the 21st century (Vasudevan and Briggs, 2008). Meanwhile, global warming is considered to be associated with burning fossil fuels. Biodiesel, an environmental beneficial and renewable resource, is well known as an alternative diesel fuel (Miao and Wu, 2006). Due to lack of conventional raw materials for biodiesel production, such as plants oils and animal fats, renewable microbial oils has been widely regarded as a potential material. Using microorganisms to produce lipid has many merits, such as high lipid content, short production period and less requirement of labor force (Brennan and Owende, 2010).

Recently, the study of biodiesel production from microalgae has become a hot topic with carbon dioxide emissions becoming an increasing concern as an environmental issue (Gouveia and Oliveira, 2009; Pruvost et al., 2009). Microalgae are considered as an attractive source for biodiesel production due to their high lipid content, photosynthesis efficiency and CO_2 reduction efficiency (Xiong et al., 2010). However, there are still some challenges in photoautotrophic culture of microalgae for biodiesel production. For example, in photosynthesis system, microalgal cells grow slowly and contain low lipid content. Heterotrophic microalgae can obtain higher lipid content and biomass productivity, but the extra feedstock cost is also higher and the energy transformation efficiency is low (Li et al., 2010). Some microalgal species can conduct mixotrophy in the culture containing both inorganic and organic substrates (Ip and Chen, 2005; Sun et al., 2008) which are simultaneously assimilated, with both respiratory process and photosynthesis occurring concurrently (Kaplan et al., 1986; Lee, 2004). According to a study (Marquez et al., 1993), the growth rate of mixotrophic culture is the sum of the photoautotrophic growth and heterotrophic growth. The mixotrophic growth of some microalgae produced 3–10 times more biomass yields as compared with phototrophy (Bhatnagar et al., 2011). Besides, it is reported that the *Chlorella protothecoides* in mixotrophic culture can accumulate 69% higher lipid productivity with 61.5% less release of CO_2 relative to typical heterotrophic growth (Xiong et al., 2010). Meanwhile, there are few references related to lipid production using *Scenedesmus quadricauda* strains and fewer reports covering trophic modes of *S. quadricauda*. Thus, one of the aims of this research is to confirm trophic types of *S. quadricauda*. In this study, *S. quadricauda* was cultivated in different carbon sources, and the effects of trophic modes on cell growth and lipid accumulation of *S. quadricauda* were investigated as well. Additionally, the best culture mode of *S. quadricauda* for lipid production was also determined in the research.

Moreover, according to report (Lu et al., 2009), amount of wastewater produced from starch manufacturing has been increasing annually and has already reached over 20 million tons in china. It must be discharged after some treatment processes because of

* Corresponding author. Tel./fax: +86 10 64446237.
E-mail address: zhangxu@mail.buct.edu.cn (X. Zhang).

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