Bioresource Technology 118 (2012) 431–437

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Enhancement of microalgal biomass and lipid productivities by a model of photoautotrophic culture with heterotrophic cells as seed

Feifei Han[a,1], Jianke Huang[a,1], Yuanguang Li[a,*], Weiliang Wang[a,*], Jun Wang[b], Jianhua Fan[a], Guomin Shen[a]

[a] State Key Laboratory of Bioreactor Engineering, East China University of Science and Technology, Shanghai 200237, PR China
[b] Jiaxing Zeyuan Bio-Products Limited Company, Jiaxing 314006, PR China

HIGHLIGHTS

- ▶ The PC-HS model is developed for large-scale biomass and lipid production.
- ▶ Rapid cell growth can be achieved in heterotrophic process for seed preparation.
- ▶ High biomass and lipid productivity can be achieved in photoautotrophic process.
- ▶ The fatty acids compositions of PC-HS are suitable for biofuels production.
- ▶ The PC-HS model was also carried out successfully outdoor.

ARTICLE INFO

Article history:
Received 1 March 2012
Received in revised form 13 May 2012
Accepted 14 May 2012
Available online 24 May 2012

Keywords:
Biofuels
Chlorella spp
Heterotrophic seed
Biomass and lipid productivities
Neutral lipid

ABSTRACT

For overcoming the long period of seed cultured photoautotrophically and inadequate cell supply for the inoculation of microalgae photoautotrophic cultivation, a model for the photoautotrophic culture of three *Chlorella* species with heterotrophic cells as seed was investigated. The model can not only take advantages of rapid cell growth in heterotrophic process for preparation of cells as seed but also increase the biomass and lipid productivities of the microalgae cultivated photoautotrophically. The results showed that biomass productivities of *Chlorella pyrenoidosa*, *Chlorella ellipsoidea* and *Chlorella vulgaris* cultured by heterotrophy were 20.9, 26.9 and 25.2 times higher than those by photoautotrophy in seed culturing period. In the subsequent photoautotrophic culture, the biomass and lipid productivities of *C. pyrenoidosa*, *C. ellipsoidea* and *C. vulgaris* with heterotrophic seed were 1.91, 1.51, 1.48 and 1.66, 1.37, 1.42 times higher than those with photoautotrophic seed. Furthermore, the culture model was also carried out successfully outdoor.

1. Introduction

Microalgae is one of the most prospectively feedstock for biofuels production and the development of biofuels from microalgae has become a hot topic in recent years (Chisti, 2007). Although the technology of biofuels from microalgae is feasible at lab-scale, the issue of efficiently culturing microalgae with high lipid productivity is still a key challenge. Moreover, the commercialization of biofuels from microalgae has been hindered owing to the high costs involved (Uduman et al., 2010). According to some prestigious reviews, the costs could be balanced by developing value-added products with high-value compounds including protein and pigments (Stephens et al., 2010) as well as easing and optimizing each unit in the system, such as cultivation, harvesting and oil extraction processing (Li et al., 2011).

Microalgae photoautotrophic cultivation for lipid production seems a promising culture model (Sheehan et al., 1998). The way for obtaining adequate seed for large-scale photoautotrophic cultivation is a major challenge in a certain period (Zheng et al., 2012). Microalgae seed was generally cultured by photoautotrophy (Hsieh and Wu, 2009; Liu et al., 2008); however, its disadvantages are low cell density and costing too much time. Additionally, it is still facing some economical and technical challenges, such as requirement of large area for culture systems, difficulty for algal species control (Sheehan et al., 1998), and being vulnerable to some climatic and environmental factors. Hence, the traditional photoautotrophic model for seed production severely hampers the development of large-scale photoautotrophic cultivation of microalgae.

* Corresponding authors. Address: Mail Box 301, Meilong Road 130, Shanghai 200237, PR China. Tel./fax: +86 21 64250964.
E-mail addresses: ygli@ecust.edu.cn (Y. Li), zxlaowang@yahoo.com.cn (W. Wang).
[1] These authors contributed equally to this work.

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.05.066