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Biochemical features and bioethanol production of microalgae from coastal waters of Pearl River Delta

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HIGHLIGHTS

- ► Two native to Pearl River Delta algae were used for bioethanol production.
- ► Both strains exhibited highest growth rates in aerated cultures.
- ► Accumulation of cellular carbohydrates was highest in early stationary phase.
- ► Highest bioethanol yield from *S. abundans* was obtained after two step hydrolysis.

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ABSTRACT

This study describes identification, cultivation, monitoring of carbohydrate accumulation and bioethanol production from microalgal strains from the coastal waters of Pearl River Delta. Eighteen identified strains belong to the families *Chlorellaceae*, *Scotiellocystoidaceae*, *Neochloridaceae*, *Selenastraceae* and *Scenedesmaceae*. Of isolated strains *Mychonastes afer* PKUAC 9 and *Scenedesmus abundans* PKUAC 12 were selected for further biomass and ethanol production analysis. Comparison of three cultivation modes (stationary, shaken and aerated) resulted in the highest biomass productivity obtained for aerated cultures that yielded 0.09 g and 0.11 g dry weight per day per litre of medium for *M. afer* PKUAC 9 and *S. abundans* PKUAC 12, respectively. Carbohydrate accumulation monitored by FTIR showed that early stationary phase is optimal for biomass harvest. Microalgal biomass was successfully used as a carbohydrate feedstock for fermentative bioethanol production. *S. abundans* PKUAC 12 was superior feedstock for bioethanol production when pre-treated with the combination of dilute acid treatment and cellulase.

1. Introduction

Biofuels hold much promise in mitigating climate change and resource depletion as well as enhancing energy security. First generation bioethanol seemed to be the most feasible short-term alternative to fossil fuels due to well established production technology. However, increased production of ethanol from edible crops (mainly sugarcane and corn) raised concerns about the impact of first generation bioethanol on food prices and increased deforestation (Cassman and Liska, 2007; Fargione et al., 2008). As a result attention turned into second generation bioethanol produced from lignocellulose feedstocks (e.g., waste biomass) and dedicated lignocellulose crops like *Miscanthus* that can be grown on marginal lands (Daroch and Mos, 2011; Hattori and Morita, 2010). So far biochemical conversion of these feedstocks to ethanol did not live up to the expectations. The main issue that hinders lignocellulose conversion to biofuels is its resistance to saccharification caused by high content of lignin. Despite years of research it still remains an area for optimisation and development (Agbor et al., 2011). Bioethanol produced from microalgal feedstock can be an alternative, as algal biomass is less resistant to conversion into simple sugars than plant biomass. Moreover, several microalgal species e.g. *Chlorella vulgaris* (Branyikova et al., 2011), *Chlamydomonas reinhardtii* UTEX 90 (Choi et al., 2010) accumulate their energy reserves in starch, which is an efficient carbohydrate

Abbreviations: FTIR, Fourier transformed infrared spectroscopy; PKUAC, Peking University algae collection; GOD-POD, glucose oxidase-peroxidise; RFLP, restriction fragment length polymorphism.

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