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Dual-species cultivation of microalgae and yeast for enhanced biomass and microbial lipid production

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Abstract

Oleaginous microalgae and yeasts are well known as potential feedstocks for biofuels and other fatty acid-derived materials. Microalgae-yeast mixed culture has gained more attention recently for the improvement of microbial lipid production economically. In the present work, combinations of two *Chlorella* species with oleaginous yeast at different ratios by the mixed culture mode were evaluated for the improvement of biomass and lipid production. Yeast cells dominated in a dual-species cultivation system when co-cultivated with *Chlorella vulgaris*. Compared to the monoculture and other three studied consortia, the mixed culture of *Chlorella pyrenoidosa* and *Rhodotorula glutinis* with a ratio of 3:1 achieved maximum biomass concentration and lipid productivity. Further optimization of the C/N ratio in the medium was carried out using this consortium. At a C/N ratio of 64, biomass concentration and lipid yield reached 6.12 ± 0.31 and 2.48 ± 0.09 g L^{-1}, respectively. The highest total fatty acid (TFA) productivity (175.64 ± 2.32 mg L^{-1} day^{-1}) obtained in the mixed culture was twofold than that in the monoculture. Additionally, dissolved oxygen and pH were found to be adjusted synergistically in the mixed culture. These results demonstrated that an artificial consortium of microalgae and yeast is a promising approach for future applications in microbial lipid production.

Keywords *Chlorella* · Oleaginous yeast · Artificial consortium · Mixed culture · Microbial lipid production

Introduction

Reliance on traditional fossil fuels is causing serious issues including energy crises and global warming. With the worldwide growing global energy needs, the demand for renewable and sustainable alternative energy sources continues to rise. Green fuels which can be acquired from agricultural commodities have received the utmost attention in the last decades. However, there are debates regarding problems such as arable agriculture land usage and the uneconomical production process of plant-based biofuels. In this regard, a great deal of attention has focused on lipids produced by oleaginous microorganisms involving yeasts, bacteria, molds, and microalgae due to their smaller land requirement, short production cycle, and high lipid productivity (Subramaniam et al. 2010; Zheng et al. 2012). Additionally, microbial lipids are considered as an alternative not only to vegetable oil for biodiesel production but also to many other fatty acid-derived materials with a broad spectrum of potential applications in food supplements, cosmetics, and polymer productions (Béligon et al. 2016; Uprety et al. 2017).

Among oleaginous microorganisms, microalgae are considered to be potential biofuel producers that are sunlight-driven cell factories capable of producing methane, biohydrogen, and oils using carbon dioxide and other organic carbon sources (Cheirsilp et al. 2011; Holcomb et al. 2011). In addition, they have various industrial applications such as aquaculture feed, pharmaceuticals, and cosmetics (Pignolet et al. 2013). However, the establishment of economic processes for microalgae cultivation requires energy-efficient and cost-effective strategies (Moon et al. 2013). The major challenge currently is to improve the culture techniques for higher algae biomass production while simultaneously reducing costs. Even a slight improvement in culture techniques could

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