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Short Communication

Switchable hydrophilicity solvents for lipid extraction from microalgae for biofuel production

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HIGHLIGHTS

▸ We extracted lipids from microalgae using switchable hydrophilicity solvents (SHS).
▸ SHS extractions at room temperature yielded more intact triacylglycerols than at 80 °C.
▸ Extractions using SHS do not require drying of the solvents prior to use.
▸ Carbon dioxide is used to separate the SHS from the lipids rather than high energy distillation.

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ABSTRACT

A switchable hydrophilicity solvent (SHS) was studied for its effectiveness at extracting lipids from freeze-dried samples of *Botryococcus braunii* microalgae. The SHS *N*,*N*-dimethylcyclohexylamine extracted up to 22 wt.% crude lipid relative to the freeze-dried cell weight. The solvent was removed from the extract with water saturated with carbon dioxide at atmospheric pressure and recovered from the water upon de-carbonation of the mixture. Liquid chromatography–mass spectrometry (LC–MS) showed that the extracted lipids contained high concentrations of long chain tri-, di- and mono-acylglycerols, no phospholipids, and only 4–8% of residual solvent. Unlike extractions with conventional organic solvents, this new method requires neither distillation nor the use of volatile, flammable or chlorinated organic solvents.

1. Introduction

Oil derived from microalgae is an attractive alternative to petroleum. Microalgae have exceptionally high oil contents compared to those of terrestrial plant sources such as palm, coconut, castor bean and sunflower seeds (Demirbas, 2010), and can be cultivated on marginal land using non-potable water. Microalgae can be grown under a variety of nutritional regimes (autotrophic, heterotrophic, mixotrophic), and can make use of both inorganic and organic carbon sources for growth, in addition to absorbing other nutrients like nitrogen and phosphorus from wastewater sources (McGinn et al., 2011).

The economical production of bioenergy from microalgae is limited in part by the energy costs of the extraction process. Current extraction methods use volatile solvents that are ineffective with microalgae with high water contents (Cooney et al., 2009), thus the microalgae must first be dried. After the extraction, the organic solvents must be removed by distillation. The high energy cost associated with drying and the energy required for distillation and recovery of the solvents currently make the use of microalgae unfeasible. Additionally, the solvents normally selected are volatile and either flammable or chlorinated, none of which are desirable characteristics for health and environmental considerations. However, with the application of switchable solvents the energy barriers are greatly reduced, making the use of microalgae as a bioenergy source more attractive.

With switchable solvents it is possible to recover extracted material from the extracting solvent simply by the addition of carbon dioxide. Samorì et al. (2010) showed the use of one class of switchable solvents, switchable polarity solvents (SPS), for the extraction of lipids from microalgae. These solvents make use of the fact that a low polarity mixture of 1,8-diazabicyclo-[5.4.0]-undec-7-ene (DBU) and an alcohol, becomes more polar when CO_2 is introduced, and returns to its original polarity when the CO_2 is

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