Renewable Energy 165 (2021) 481–490

Contents lists available at ScienceDirect

Renewable Energy

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

A novel process for the coproduction of biojet fuel and high-value polyunsaturated fatty acid esters from heterotrophic microalgae *Schizochytrium* sp. ABC101

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ARTICLE INFO

Article history:
Received 23 March 2020
Received in revised form
22 July 2020
Accepted 24 September 2020
Available online 9 October 2020

Keywords:
Biojet fuel
Microalgae
Schizochytrium
Hydrotreating
Polyunsaturated fatty acid

ABSTRACT

Herein we demonstrated an economically beneficial process coproducing biojet fuel and high-value polyunsaturated fatty acids (PUFAs) from *Schizochytrium* sp. ABC101 microalgae. *Schizochytrium* is a promising biofuel source for its rapid growth, high cell density, and fast lipid accumulation via heterotrophic cultivation. The most important feature of *Schizochytrium* is that half of its lipids are composed of omega-3 PUFAs (i.e., docosahexaenoic acid and docosapentaenoic acid), which are currently commercialized as dietary supplements at a high price. We observed direct injection of PUFA-rich lipid into a high-temperature catalytic reactor can cause rapid catalyst deactivation via coke deposition. Therefore, the PUFAs were separated by short-path distillation after transesterification. The remaining esters of saturated fatty acids (SFAs) were catalytically deoxygenated into C_{13}–C_{18} *n*-paraffins, and then subsequently hydrocracked to produce *iso*-rich paraffins that are suitable as biojet fuel. As the result, 54.6 wt% PUFA-enriched esters (purity: 87.7%) and 20.4 wt% of qualified biojet fuel with respect to the initial lipids were obtained.

1. Introduction

Depletion of fossil resources and increasing environmental concerns about anthropogenic CO_2 emission have attracted enormous scientific attention to biorefinery [1–4]. In biorefinery, not only biofuels but also high-value chemicals can be coproduced [2–7]. Such coproduction of high-value chemicals is an important factor strongly influencing the overall economics and life-cycle assessments of biorefinery [8,9]. Microalgae are now considered one of the most promising resource among the various biomass because of their rapid growth, high cell density per area, and large lipid content [10,11]. The use of microalgae also does not interfere with food production or cause deforestation, and it is free of ethical and environmental issues [10]. In addition, various high-value chemicals (e.g., pigments, bio-plastics, and dietary supplements) can be coproduced [5–7], which is highly advantageous for improving the overall process economics [9].

From the lipids (triglycerides) extracted from microalgae or plants, fatty acid alkyl esters generally known as “biodiesel” have been widely produced through transesterification with short-chain alcohols [12–14]. Unfortunately, oxygen-containing biodiesels exhibit limited compatibility with conventional internal combustion engines, low oxidative stability, poor cold flow properties, and low energy content as compared with conventional diesel [15–17]. In this regard, oxygen-free biofuels with completely paraffinic structures, which often outperform conventional petroleum-derived fuels, have been recently gaining more scientific

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https://doi.org/10.1016/j.renene.2020.09.116
0960-1481/© 2020 Published by Elsevier Ltd.