Bioresource Technology 120 (2012) 19–25

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Process optimization for microwave-assisted direct liquefaction of *Sargassum polycystum* C.Agardh using response surface methodology

Jingxue Guo [a], Yingbin Zhuang [a], Limei Chen [b], Junhai Liu [a,*], Demao Li [b,*], Naihao Ye [c,*]

[a] Shandong Provincial Key Laboratory of Chemical Energy Storage and Novel Cell Technology, School of Chemistry and Chemical Engineering, Liaocheng University, Liaocheng 252059, China
[b] Shandong Provincial Key Laboratory of Chemical Energy Storage and Novel Cell Technology, School of Agriculture, Liaocheng University, Liaocheng 252059, China
[c] Key Laboratory for Sustainable Utilization of Marine Fishery Resources, Yellow Sea Fisheries Research Institute, Chinese academy of fishery Sciences, No. 106, Nanjing Road, Qingdao, China

HIGHLIGHTS

- *Sargassum polycystum* C.Agardh was liquefied to produce bio-oil.
- Response surface methodology was used to optimize the liquefaction technology.
- The bio-oil was composed by organics with long-chain (C_{17}–C_{20}).

ARTICLE INFO

Article history:
Received 14 April 2012
Received in revised form 6 June 2012
Accepted 10 June 2012
Available online 16 June 2012

Keywords:
Sargassum polycystum C.Agardh
Liquefaction
Response surface methodology
Bio-oil
Microwave

ABSTRACT

Response surface methodology (RSM) was used to optimize the microwave-assisted direct liquefaction of *Sargassum polycystum* C.Agardh in ethylene glycol (EG) with H_2SO_4 as a catalyst. Based on the results of single factor experiments, EG-to-feedstock ratio, temperature and catalyst content were chosen as independent variables for a central composite rotatable design (CCRD). The optimal liquefaction conditions were estimated as: the EG-to-feedstock ratio of 18.50:1 (w/w), the temperature of 170 °C, the reaction time of 15 min, catalyst content of 9.6% (catalyst/EG, w/w%) and microwave power of 400 W with the liquefaction yield of 87.70%. The bio-oils were mainly composed of fatty acid methyl ester and alkane with a long chain from C_{17} to C_{20}.

1. Introduction

With the depletion of non-renewable fossil energy resources and environmental deterioration, the exploitation of renewable and environmentally friendly energy resources is urgent and significant. Bioenergy, one of the renewable energy resources which playing an important role in the energy system, has attracted more and more interests (Demirbas, 2001; Field et al., 2008). Biomass can serve as an excellent alternative source to meet present and future fuel needs. Now, most of biomass energy mainly comes from terrestrial organisms. As the useful supplement of biomass, algae are one of the families of ocean biomass resources (Singh et al., 2011). Algae can fix carbon dioxide through photosynthesis, which was converted to algae biomass. And it is meaningful to use the algae as energy resources from the viewpoint of resources recycling.

Sargassum polycystum C.Agardh is an important alga in the ocean. It belongs to the brown macroalgae, Sargassum genera. It is a good candidate for biomass energy because of its mature mass cultivation techniques, lower breeding cost and easy to be harvested. On the one hand, the eutrophication in seawater body provides favorable conditions for algal growth and reproduction. On the other hand, *S. polycystum* C.Agardh could be harvested in short time because of its fast-growing and easy to harvest. If the development and utilization method for the algae is appropriate, algae farming have no negative impact to the marine environment; on the contrary, it could be protected.

Bio-oil production from direct liquefaction of biomass at normal pressure is a widely used technology (Alma et al., 1995; Lee and Ohkita, 2003; Kržan and Kunaver, 2006; Rezzoug and Capart, 2003). In the liquefaction process, macromolecules are decomposed into fragments of light molecules in the presence of a

* Corresponding authors.
E-mail addresses: jhliu@lcu.edu.cn (J. Liu), demaoli@gmail.com (D. Li), yenh@ysfri.ac.cn (N. Ye).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.06.013