Renewable Energy 153 (2020) 456–471

Contents lists available at ScienceDirect

Renewable Energy

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

Pretreatment and process optimization of spent seaweed biomass (SSB) for bioethanol production using yeast (*Saccharomyces cerevisiae*)

M.P. Sudhakar [a, *], K. Arunkumar [b], K. Perumal [c]

[a] *Marine Biotechnology Division, National Institute of Ocean Technology, Ministry of Earth Sciences (Government of India), Chennai, 600100, Tamilnadu, India*

[b] *Department of Plant Science, Central University of Kerala, Periye, Kasaragod, Kerala, 671 314, India*

[c] *Biodyne Research Institute, Annai Lea Community College, The School of Biodynamic Farming, Inba Seva Sangam, Sevapur, Kadavur T.K, Karur Dt, Tamilnadu, India*

ARTICLE INFO

Article history:
Received 23 July 2019
Received in revised form
20 January 2020
Accepted 8 February 2020
Available online 11 February 2020

Keywords:
Spent seaweed biomass
Acid pretreatment
Saccharomyces cerevisiae
Bioethanol

ABSTRACT

The study aimed to utilize the industrial spent seaweed biomass (SSB) for effective ethanol production using yeast as a fermenting microorganism. Pretreatment of SSB was optimized using different acids. The highest percentage of spent biomass was obtained from *G. corticata* (12.53 ± 2.66% DW). The proximate, ultimate and biochemical constituents of spent biomass were calculated. The total sugar (440 ± 40 mg/g DW), reducing sugar (129.85 ± 10.23 mg/g DW) and protein (11.08 ± 0.11 mg/g DW) content of SSB were analysed. Pretreatment was optimized using three different acids. The effect of different pH (4.5, 5.0, 5.5 and 6.0) and temperature (30 and 35 °C) on ethanol production using baker's and MTCC yeast was studied. At 35 °C, the maximum (4.85% w/w) ethanol production was achieved in a fermentation process maintained at pH 4.5 and 5.0 at 24 h and 72 h, respectively. Substrate fermented with MTCC yeast recorded the maximum production of ethanol (4.98% w/w) at pH 4.5 within 48 h. The fermentation process was scaled up to 300 mL for ethanol production, and achieved 3.75% w/w ethanol (72 h, pH 5.5). To conclude, in future SSB would be a potential renewable novel substrate for bioethanol production when compared to other lignocellulosic substrates.

1. Introduction

As world energy demand continues to rise and fossil fuel resources are getting depleted, seaweeds are receiving increasing attention as an attractive renewable source for producing fuels and chemicals [1]. Growing demand for fuel (3.0 million barrels per day in 2040) to meet the technological advancement and decrease in natural oil resource due to overexploitation urged researchers to find an alternate way for fuel generation by renewable and green energy production technology methods [2–4]. Algae (micro- and macroalgae) emerged as potential renewable biomass that has enormous photosynthetic efficiency, generate and stored sugars in it [5]. Macroalgae (also called seaweeds) are classified into three types: brown algae (*Phaeophyceae*), red algae (*Rhodophyceae*), and green algae (*Chlorophyceae*). Each type has its own food storage mechanism and generates polysaccharides through photosynthetic light harvest and nutrients available in the sea [6]. Red seaweeds mainly contain agar polysaccharides and some cellulose. The breakdown of agar into linear polymer gives agarose which is comprised of galactose subunits [7].

Seaweeds are abundant throughout the world, especially in countries with the more covering area of coastlines such as Japan, Philippines, Malaysia, Singapore, Thailand, most of the European countries, the United States and Australia. The macroalgae production during the year 2008 was 15.5 million tonnes fresh weight and 93% of it had good commercial value [8,9]. The total annual production value is estimated at almost US$ 6 billion, of which food products for human consumption represent US$ 5 billion [10]. Seaweeds are found abundantly in the south-east and west coastal areas of India (08.04–37.06 N and 68.07–97.25 E) with a coastline of about 7500 km comprising of 271 genera and 1153 species. Nearly, 7 lakh tonne of standing stock (wet weight) of seaweed is

Abbreviations: SSB, Spent seaweed biomass; YPD, Yeast potato dextrose; MTCC, Microbial Type Culture Collection; DW, Dry weight; HMF, hydroxymethylfurfural.

* Corresponding author. Marine Biotechnology Division, National Institute of Ocean Technology, Ministry of Earth Sciences, Government of India, Velacherry-Tambaram Main Road, Narayanapuram, Pallikaranai, Chennai, 600 100, Tamil Nadu, India.

E-mail address: mpsdhkr@gmail.com (M.P. Sudhakar).

https://doi.org/10.1016/j.renene.2020.02.032
0960-1481/