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Biosaccharification and ethanol production from spent seaweed biomass using marine bacteria and yeast

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ABSTRACT

In this study, fresh and different spent biomasses of agarophytes, alginophytes and seaweed industrial spent biomass were evaluated for ethanol production. Saccharification of spent biomass of seaweeds was carried out using two methods such as mild acid and/or marine bacterial consortia. Total carbohydrate was recorded maximum in the fresh seaweeds (30.71 ± 4.21 and 39.75 ± 3.25% DW in *Gracilaria corticata* and *Sargassum wightii*, respectively) than the spent seaweed biomass, whereas reducing sugar production was recorded maximum in the industrial spent samples (14.6 ± 0.57 and 15.27 ± 1.02 g/L in agar and alginate spent, respectively). The mild acid pretreatment followed by bacterial consortia recorded more sugar conversion and ethanol production than the samples directly subjected to bacterial saccharification. The isolated marine yeast *Meyerozyma guilliermondii* AY17 KJ754141, produced maximum ethanol from spent biomass (2.74 and 1.72 g/L in *Sargassum ilicifolium* and *Gracilaria corticata*, respectively). The spent biomass from agar and alginate industry recorded maximum of 2.34 and 2.60 g/L of ethanol respectively through ABC saccharification and marine yeast fermentation. Hence, the spent residues from agar and alginate industries, and seaweed spent biomass generated in the laboratory after pigment extraction were considered to be a good source of biomass for ethanol production based on sugar content.

1. Introduction

Seaweed–based industrial discharge contains marine organic wastes which remains unexplored. Proper utilization of these marine organic wastes for valuable products enhances the prosperity of seaweed farmers as well as it minimises the environmental discharge [1]. Seaweeds are the only source for industrial phycocolloids (agar, carrageenan, alginate and fucoidan) and they are being recognised as potential source of natural pigments [2–4]. Spent residues, after extracting pigments and phycocolloids, contain cellulose, and some left out phycocolloids were found as a potential raw material for sugar hydrolysis to ethanol production. On the other hand, using this natural biomass wastes for alternate fuel is advantageous because the amount of CO_2 utilised during the biomass production is released on burning resulted no net build up of CO_2 in the atmosphere [5]. The first-generation biofuels have resulted in a progression of troubles associated to food prices, land usage and carbon emissions whereas the second-generation biofuel invention suffers with cost efficiency, technological barriers and feedstock collection network etc. [6]. The major sources of alternate energy such as bio-renewable, hydro, solar, wind, geothermal and supplementary energies having their own pros and cons on political, economical and practical issues. To meet the energy demand, seaweeds (marine macroalgae) act as a potential renewable source for biofuel production [7]. As they are naturally grow in sea, it does not require agricultural lands, will not make a food to fuel struggle and do not contain pectin as other advanced feedstock [8].

Seaweeds are divided into three major groups as red (*Rhodophyceae*), brown (*Phaeophyceae*) and green (*Chlorophyceae*), which constitutes 50–70% carbohydrates on dry weight basis [9]. The red algae contain either agar or carrageenan as chief carbohydrates and whereas brown algae contains alginate, mannitol, laminarin or fucoidan. These water extractable phycocolloids have been used in a broad range of industrial applications as thickening, gelling or stabilizing agents [7,10]. Besides, cellulose and hemicellulose are

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