Novel pretreatment strategies of algal biomass for the production of bioethanol

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ABSTRACT

The goal of this research is to assess the possibility of dry algal biomass (DAB) residue as a biorefinery alternative for the production of bioethanol. Thermal pretreatment resulted in higher sugar solubilization (0.590 g/gDAB) and maximal bioethanol production was achieved at pH 5.5 (0.145 0.008 g/g AB)..

Keywords: Algae, biofuel, green process, sustainablity

1 INTRODUCTION

Bioethanol is a liquid biofuel that is both ecologically benign and sustainable. However, bioethanol production and commercialization are predominantly concentrated on first-generation food crops like sugarcane, maize, and beet, potentially leading to a food vs fuel conflict. The usage of bioethanol as a potential fuel substitute has piqued people's curiosity. However, availability of bioethanol to meet the country's demands is limited due to constraints in available methods for converting non-edible feedstocks such as lignocellulosic material.

Biomass-derived sugars from microalgae culture can be a cost-effective replacement for current planted-based biomass feedstock while also enhancing algal bio-refinery biodiversity (Chng et al. 2017). Polysaccharides including starch and cellulose, as well as traces of monosaccharides and nutrients, make up the majority of the carbohydrates in DAB residue (Shokrkar et al., 2017). DABs' complex polysaccharide content makes direct biological conversion to a sustainable resource difficult. To improve the transition of these resistant sugar polymers into functional monomeric forms, a pre-treatment step is required. As a result, the current research intends to assess the impact of the pretreatment method on bio-ethanol production

2 MATERIALS AND METHODS

2.1 Algal culture

For the generation of bio-fuel, a mixture of Chlorella Volgars, Chlorella SP, and Spirulina platensis was utilized (bio-f.). These strains were selected due to their high total lipids and fatty acid profile. The strains were grown for 21 days in anaerobic sludge centrate under natural solar light and at a constant temperature. The algal biomass was collected from the growing medium at the end of the cultivation, filtered, and dried overnight at 351 °C to remove the moisture content. After that, the algal strains were pretreated at high temperatures. The pH was then adjusted to 5.9 0.2 using diluted NaOH or H3PO4 solution, and the combination was allowed to react for a further 48 hours. The bio-f production from algal strains was conducted in separate 250 mL Erlenmeyer flasks. A 150 mL mixture of pre-treated algae with different sugar content was inoculated with 10 %v/v of Saccharomyces cerevisiae for 24 hr at 37°C and continuous agitation at 135 rpm. Samples were gathered at different time intervals, centrifuged at 5,000 rpm for 5 min and the cell-free supernatant was analyzed for ethanol and residual sugar concentration. Fresh culture of S. cer. was grown in agar plate containing agar, glucose, yeast extract, and peptone. Separate 250 mL Erlenmeyer flasks were used to produce bio-f from algal strains. A 150 mL combination of pre-treated algae with varying sugar concentration was infected for 24 hours at 37°C with continuous agitation at 135 rpm with 10% v/v Saccharomyces cerevisiae. Samples were taken at various intervals, centrifuged at 5,000 rpm for 5 minutes, and the ethanol and residual sugar concentrations in the cell-free supernatant were determined. In an agar plate containing agar, glucose, yeast extract, and peptone, a fresh culture of S. cer. was produced.

3 RESULTS AND DISCUSSION

3.1 Sugars solubilization

The total and soluble sugar contents in algae pre-treated increased from 0.088 0.03 to 0.588 0.02 to 0.488 0.02 g/gDCW, respectively. As previously stated, pretreatment at optimum temperature reacts with starch and cellulose by protonation of the oxygen in a 1,4-glycosidic bond or the cyclic oxygen in a glucopyranose ring, resulting in the breakdown of the glycosidic bond and the opening of the and transforming the polysaccharides to monosaccharides

in the case increase the concentration of soluble or total sugar.

3.2 Conversion of algal biomass to Bioethanol

The potential of algal cells for bioethanol production was investigated utilizing S. cerevisiae as a biocatalyst in a variety of fermentation processes. The goal of the project was to evaluate and improve bioethanol production from released algal sugars. Bioethanol yields are depending on algal sugars, operational temperature, and fermenter pH, according to preliminary tests. Figures 1a,b, and c illustrate sugar consumption and bioethanol generation as a function of time at three distinct pHs (4, 5.5, 6.5, and 7) and temperatures of 30, 37, and 43 degrees Celsius. Fermenters operated with algal pretreated algal biomass that has high sugar content at pH= 5.5 and a temperature of 37 °C exhibited the highest bioethanol production of 0.145 ± 0.008 g/g DAB, followed by pH = 5 and temperature of 33 and (0.122 ± 0.004 g/gDAB) and latest pH 6.0 and temperature of 42°C (0.102 ± 0.002 g/g). Fermenters operating with algal pretreatment algae biomas with high sugar content at pH= 5.5 and 37 °C produced the most bioethanol (0.145 0.008 g/g DAB), followed by pH = 5 and temperature of 33 (0.122 0.004 g/gDAB), and pH 6.0 and temperature of 42°C (0.102 0.002 g/gDAB).

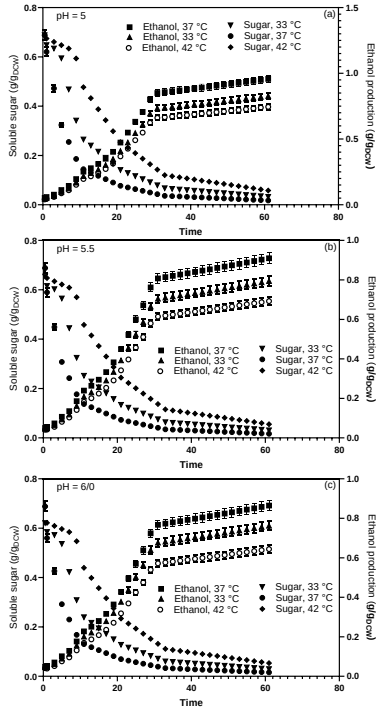

Figure 5: Sugar consumption and bioethanol production from pre-treated algal biomass as a function of fermenter temperature and pH

4 CONCLUSION

The findings of the study reveal that dry algal biomass (DAB) residue may be used to produce bioethanol. The sugar production was increased during the thermal pretreatment, resulting in increased cell solubilization. As a result, considerable bioethanol synthesis from DAB-derived sugars (0.145 0.008 g/g) was achieved. The utilization of AB residue as a renewable energy source Additional revenue can be generated through a variety of bio-based products. Existing algae refineries benefit, while long-term sustainability is instilled.

5 ACKNOWLEDGMENT

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