



Simultaneous production of bio-ethanol and bleached pulp from red algae

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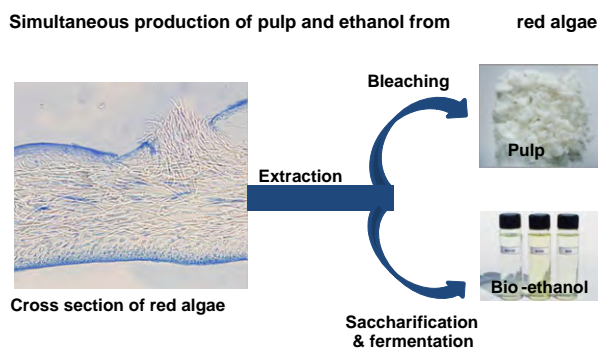
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HIGHLIGHTS

- ▶ High quality pulp and ethanol were produced simultaneously from red algae.
- ▶ Bleached pulp yield was 10–11%, and ethanol 10% (w/w) by dry weight of red algae.
- ▶ Sodium thiosulfate was an effective additive in red algae extraction process.
- ▶ Commercialization of red algae pulp may enable low cost ethanol production.

GRAPHICAL ABSTRACT



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ABSTRACT

The red algae, *Gelidium corneum*, was used to produce bleached pulp for papermaking and ethanol. Aqueous extracts obtained at 100–140 °C were subjected to saccharification, purification, fermentation, and distillation to produce ethanol. The solid remnants were bleached with chlorine dioxide and peroxide to make pulp. In the extraction process, sulfuric acid and sodium thiosulfate were added to increase the extract yield and to improve de-polymerization of the extracts, as well as to generate high-quality pulp. An extraction process incorporating 5% sodium thiosulfate by dry weight of the algae provided optimal production conditions for the production of both strong pulp and a high ethanol yield. These results suggest that it might be possible to utilize algae instead of trees and starch for pulp and ethanol production, respectively.

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1. Introduction

Bleached red algae pulp fibers were first prepared by Seo et al. (2009, 2010) and their performances as papermaking raw materials was shown to be excellent with respect to opacity and smoothness of the handsheet paper. In the process of pulp generation, extracts containing agar are produced, which can be used as a sub-

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strate for ethanol production after saccharification, purification, and fermentation (Keating et al., 2004; Dhaliwal et al., 2011). Water-soluble extracts from *Gelidium elegance* contained mostly galactan, and 3,6-anhydrogalactose and D-galactose amounted to over 95% of the dry weight of the extracts (Do et al., 1997). *Gracilaria verrucosa* extracts contained 80–85% of galactan by weight (Do et al., 1997). The authors also determined that total soluble carbohydrates in the extracts from *G. elegance* and *G. verrucosa* amounted to 30–42% of the total algal dry weight.

To produce high-quality pulp more effectively, it is necessary to remove organic compounds (mostly galactan) from the algae effectively during the extraction process so that excessive use of