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Lime pretreatment to improve methane production of smooth cordgrass (*Spartina alterniflora*)

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HIGHLIGHTS

- ▸ Lime pretreatment increased 122–180% methane yield for pretreated samples vs. raw sample.
- ▸ The highest methane yield (218.4 mL/g TS) was obtained under 0.12 g lime/g, 28 d and 45 °C.
- ▸ Of all three factors, lime loading had the greatest influence on methane yield.
- ▸ The condition of high lime loading, low temperature and short time was a preferential selection.

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ABSTRACT

Anaerobic conversion of smooth cordgrass (SC; *Spartina alterniflora*) to methane for energy production presents a viable option for effective management. The effect of lime pretreatment of SC on methane production was investigated in this study. The effect of three selected independent variables (lime loading (0.02–0.12 g $Ca(OH)_2$/g SC), pretreatment time (7–28 days) and temperature (25–55 °C)) on material composition and methane production was explored. Lime pretreatment resulted in significant changes in SC composition: 5.7–60.5% hemicellulose and 10.2–36.2% lignin reductions, and 91–98.7% cellulose remaining in the solid residues after lime pretreatment. Lime pretreatment increased methane yield by between 122% and 180% and the methane production rate constant in the range of 56–212%. The highest methane yield was 218.4 mL/g total solids from pretreatment conditions of lime loading 0.12 g $Ca(OH)_2$/g SC, for 28 days at 45 °C. These results were based on a 30-day biochemical methane potential assay. Lime loading had the greatest influence on methane yield of the three pretreatment factors. Considering the energy balance, the optimization of pretreatment experiment was carried out under the condition of 0.10 g $Ca(OH)_2$/g SC dry mass, at 25 °C for 14 days. Based on this study, the pretreatment condition of high lime loading, low temperature and short pretreatment time was a preferential consideration for lime pretreatment.

1. Introduction

There have been significant researches on renewable sources of liquid fuels to replace fossil fuels to improve energy security and reduce greenhouse emissions. Lignocellulosic biomass, including crops specifically grown for energy, agricultural residues and the organic fraction of municipal solid waste, are all promising renewable resources, being widely available and convertible into various forms of fuel and chemical raw materials [1]. In China, since 2003, smooth cordgrass (SC; *Spartina alterniflora*) has been identified as one of 16 invasive species by the China Environmental Protection Agency [2], because this plant has a rapid growth velocity and overwhelms the native ecosystems, resulting in clogging up rivers and even obstructing navigation in waterways [3]. The net primary production of SC varies from 110.9 to 601.8 g dry mass m^{-2} $year^{-1}$, and by 2002 it was distributed over an area of at least 1120 km^2 in China [3]. Anaerobic conversion of SC to methane as a clean fuel for energy production presents a viable option for effective management of SC. SC has been used as a potential and abundant biomass resource for producing biogas rich in CH_4 by anaerobic digestion [2,4,5].

The lignocellulosic structure of SC is resistant to biodegradation and unitization for biofuels [1]. The crystallinity of cellulose, degree of polymerization, available surface area and shielding effect

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