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Influence of alkaline pre-treatment conditions on structural features and methane production from ensiled sorghum forage

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HIGHLIGHTS

- ▶ NaOH pre-treatment reduced the content of lignin and hemicelluloses of sorghum.
- ▶ NaOH pre-treatment enhanced TOC and proteins solubilisation of sorghum.
- ▶ The methane yield was not affected by NaOH dosage, temperature and contact time.
- ▶ Digestion kinetics increased with NaOH dosage, temperature and contact time.

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ABSTRACT

Alkaline pre-treatment has been widely applied to lignocellulosic biomass but the tested conditions are quite variable in literature. Results are also quite scattered even when similar substrates are compared. Therefore the aim of this study was to test different alkaline dosages (4% and 10% gNaOH/gTS), temperatures (40 °C and 55 °C), and contact times (12 h and 24 h) in order to investigate the influence of the pre-treatment conditions on the structural features and methane production from ensiled sorghum forage. This study confirms the positive effect of NaOH pre-treatment on fibre reduction, total organic carbon and proteins solubilisation, and thereafter the anaerobic degradability of ensiled sorghum forage. An increase in methane yield, with respect to untreated sample (from 8% to 19%), was observed at all pre-treatment conditions tested. Nevertheless, no significant differences on methane yield were observed by varying NaOH dosage, temperature, and contact time. The increase of sodium hydroxide dosage led to an increase of the soluble total organic carbon (TOC) (from 12% to 29%) and proteins (from 56% to 72%), at each temperature and contact time tested. By increasing the NaOH dosage, a reduction of hemicelluloses (from 37% to 70%) and lignin contents (from 26% to 70%), and an increase of the anaerobic digestion kinetics (with a maximum increase of 43% for samples treated at 55 °C for 24 h), were also observed. Finally, the anaerobic digestion kinetics were improved with the increase of contact time (up to 13%) and temperature (up to 20%).

1. Introduction

Nowadays some 80% of the world's overall energy supply is derived from fossil fuels [1]. The Renewable Energy Directive adopted in 2009 focuses on achieving a 20% share of renewable energies in the EU's energy mix by 2020. Among the renewable energy resources, biomass contributes by some 3–13% to the total world energy supplies of the industrialised countries. In developing countries this proportion is much higher [1].

Biomasses, both residual (such as agro-industrial wastes and crop residues) and specifically grown energy crops offer a huge potential for the production of renewable energy, as heat and electricity. Their use could be beneficial to reduce pollution and greenhouse gas emissions and to reduce the dependence on oil and gas.

Anaerobic digestion is considered to be a sustainable way to combine renewable energy generation with sustainable waste

Abbreviations: ADF, acid detergent fibre; ADL, acid detergent lignin; BMP, Biochemical Methane Potential; COD, chemical oxygen demand; NDF, neutral detergent fibre; SMA, specific methane activity; TKN, total kjeldahl nitrogen; TOC, total organic carbon; TS, total solids; VS, volatile solids.

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