Renewable Energy 155 (2020) 1347–1354

Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

Sustainable approach of high-pressure agave bagasse pretreatment for ethanol production

Arelí Aguirre-Fierro [a, b], Héctor A. Ruiz [b, *], Miguel A. Cerqueira [c], Rodolfo Ramos-González [d], Rosa M. Rodríguez-Jasso [b], Susana Marques [a], Rafal M. Lukasik [a, **]

[a] National Laboratory for Energy and Geology (LNEG, I. P.), Unit of Bioenergy and Biorefineries, Estrada do Paço do Lumiar 22, 1649-038, Lisbon, Portugal
[b] Biorefinery Group, Food Research Department, Faculty of Chemistry Sciences, Autonomous University of Coahuila, 25280, Saltillo, Coahuila, Mexico
[c] INL-International Iberian Nanotechnology Laboratory, Av. Mestre José Veiga, 4715-330, Braga, Portugal
[d] CONACYT – Autonomous University of Coahuila, 25280, Saltillo, Coahuila, Mexico

ARTICLE INFO

Article history:
Received 3 July 2019
Received in revised form
21 March 2020
Accepted 9 April 2020
Available online 15 April 2020

Keywords:
Supercritical CO_2
Enzymatic hydrolysis
Biomass
Biofuels
Severity factor

ABSTRACT

Agave bagasse is one of the most abundant lignocellulosic residues readily available for valorization. The agave bagasse was pretreated by applying high-pressure CO_2–H_2O mixture at temperatures ranging from 150 to 190 °C for a residence time varying from 10 to 50 min. Subsequently, solid phase obtained from pretreatment was subject to enzymatic hydrolysis at high solid loadings. Under optimal conditions, the process integrating pretreatment followed by enzymatic hydrolysis yielded 75.8 mol% of the polysaccharides present in the biomass converted into oligo- or monosaccharides, providing 110.5 g/L of reducing sugars. The monosaccharides present in the obtained hydrolysate were successfully fermented into ethanol, demonstrating the feasibility of performing its biological conversion to commercial biofuels or biochemicals. Thereby, the present study has demonstrated the proof of concept of use of more sustainable high-pressure CO_2–H_2O pretreatment in the context of lignocellulosic residual biomass valorization based on the biochemical sugar platform.

1. Introduction

Biorefineries can be compared to the traditional refineries, where bulky low-cost energy-like products and low volume but higher value commodities are produced by processes capable of valorizing each fraction of the total crude [1]. Consequently, biorefineries should generate either high volumes and low cost products such as biofuels (bioethanol, biogas, biodiesel) or low volumes but high value commodities, e.g. chemicals, fertilizers, materials, cosmetics, nutrients and others [2].

Being one of the most abundant residue worldwide, lignocellulosic biomass (LCB) can be considered as the primary source of renewable carbon able to replace different sources of energy as well as diverse commodities [3]. There are a great variety of lignocellulosic resources, which can be valorized, hence the selection of the right biomass plays an important role to make the process economically viable [4]. One of them is *agave tequilana* bagasse, which is an agroindustrial residue generated along the production of alcoholic beverages e.g. tequila, mezcal and pulque in Mexico [5]. In addition, agave leaves are also generated as residues available for potential valorization. According to the tequila regulatory council, the annual generation of *agave tequilana* bagasse achieved closed to 1 million tons in 2017. Therefore, the use of *agave tequilana* bagasse has become a great opportunity for the exploitation in biorefineries. Considering the Mexican panorama, agave bagasse has already attracted a significant attention as an alternative renewable energy source [6] or as a potential source of high-value chemicals [4]. However, the recalcitrance of LCB cell wall caused by the complex inter- and intra-connections of the cellulose, hemicellulose and lignin fractions, as well as chemical products which are formed during the pretreatment step [7], prevents effective use and fractionation of LCB. Therefore, to fully exploit the potential of LCB, the development of efficient pretreatment technologies able to break down the complex structure is needed [3]. Up to now, dozens of pretreatments, including physical, chemical, physicochemical

* Corresponding author.
** Corresponding author.
E-mail addresses: hector_ruiz_leza@uadec.edu.mx (H.A. Ruiz), rafal.lukasik@lneg.pt (R.M. Lukasik).

https://doi.org/10.1016/j.renene.2020.04.055
0960-1481/