Integration of first and second generation biofuels: Fermentative hydrogen production from wheat grain and straw

I.A. Panagiotopoulos a,b,⇑, R.R. Bakker a, T. de Vrije a, P.A.M. Claassen a, E.G. Koukios b

a Wageningen UR Food & Biobased Research, P.O. Box 17, 6700 AA Wageningen, The Netherlands
b Bioresource Technology Unit, School of Chemical Engineering, National Technical University of Athens, Zografou Campus, Athens GR-15700, Greece

HIGHLIGHTS

The feasibility of integrating lignocellulose- and starch-rich biomass-based hydrogen production was investigated with the extreme thermophilic bacterium *Caldicellulosiruptor saccharolyticus*.

Wheat grain hydrolysate showed limited fermentability whereas wheat straw hydrolysate showed relatively good fermentability.

The mixed hydrolysate showed good fermentability at the highest tested sugar concentration.

1. Introduction

One of the major challenges in the utilization of hydrogen gas as a biofuel is the need for inexpensive production methods from renewable resources. A significant amount of research work has already been done on fermentative hydrogen production from various types of biomass. Sugary biomass such as sugar beet (Hussy et al., 2005; Panagiotopoulos et al., 2010a) and sweet sorghum (Claassen et al., 2004; Panagiotopoulos and I.A., 2008; Antonopoulou et al., 2010) and starch-containing biomass such as sweet potato residues (Yokoi et al., 2002), potato industry coproducts (Mars et al., 2010), wheat flour industry coproducts (Hawkes et al., 2008) and corn and barley grains (Panagiotopoulos et al., 2009) have been investigated. However, the utilization of lignocellulosic biomass would be preferable as it is cheap, abundant and does not directly compete with food production. Therefore, wheat and barley straw (Eriksen et al., 2011; Panagiotopoulos et al., 2011a), *Miscanthus* (de Vrije et al., 2009), corn stover (Datar et al., 2007; Panagiotopoulos et al., 2011a), sweet sorghum bagasse (Panagiotopoulos et al., 2011b), olive pulp (Koutrouli et al., 2009) and carrot pulp (de Vrije et al., 2010) have been used for biological hydrogen production. The strategy of the present work was the integration of lignocellulose- and starch-rich biomass-based hydrogen production in a biorefinery.

In the current work, the extreme thermophilic bacterium *Caldicellulosiruptor saccharolyticus* (Raine et al., 1994; Jones, 2008; Blumer-Schuette et al., 2008) was used. *C. saccharolyticus* is a cellulolytic bacterium of the order Clostridiales and grows at an optimum temperature of 70 °C. It is advantageous over other microorganisms because it leads to high hydrogen yields (van Niel 2012 Elsevier Ltd. All rights reserved.)