



## Effect of different steam explosion conditions on methane potential and enzymatic saccharification of birch

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### HIGHLIGHTS

- ▶ Steam-explosion pretreatment of birch allows efficient enzymatic saccharification.
- ▶ Anaerobic digestion of steam-exploded birch yield high methane yields.
- ▶ Accumulation of lignin indicates pseudo-lignin formation during steam explosion.

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### ABSTRACT

Birch (*Betula pubescens*) was steam exploded at 13 different conditions with temperatures ranging from 170 to 230 °C and residence times ranging from 5 to 15 min. Increasing severity in the pretreatment led to degradation of xylan and formation of pseudo-lignin. The effect of the pretreatments was evaluated by running enzymatic saccharification and anaerobic digestion followed by analysis of sugar and methane yields, respectively. Enzymatically released glucose increased with pretreatment severity up to 220 °C for 10 min and levels of solubilized glucose reached 97% of the theoretical maximum. The highest methane yield (369 mL gVS<sup>-1</sup>) was obtained at a severity factor of 4.5 and this yield was 1.8 times higher than the yield from untreated birch. Enzymatic glucose yields and methane yields were generally correlated. The results indicate that steam-exploded birch can be effectively converted to either glucose or methane.

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### 1. Introduction

Our global economic system is dependent on the use of fossil energy sources for the production of fuels and chemicals. However, fossil fuels are limited resources and its depletion is inevitable. Indeed, global production of conventional oil may already have past its peak level (Aleklett et al., 2010). Plant biomass represents an alternative feedstock for production of chemicals and energy, and is likely to be increasingly used as replacement for fossil feedstocks in the emerging bioeconomy. In this regard, efficient and sustainable biomass production systems as well as methods for biomass conversion will be key technologies.

Biochemical processing of biomass involves the use of enzymes and/or microorganisms to convert feedstock to useful chemicals or fuels. The main bulk product of biochemical conversion today is bioethanol, mainly produced from sugarcane or corn by fermentation (Walker, 2011). However, both these feedstocks are also a

potential source of food, and huge efforts take place to develop conversion technologies that enable utilization of non-food feedstocks such as lignocellulose.

Lignocellulosic biomass is recalcitrant and despite recent improvements in enzyme technology (Horn et al., 2012; Quinlan et al., 2011; Vaaje-Kolstad et al., 2010) its processing usually requires some physical-chemical pretreatment (Ramos, 2003) before efficient biochemical conversion can take place. Steam explosion (SE) is known as one of the most efficient pretreatment methods for lignocellulosic biomass (Ramos, 2003). This process involves high temperature steam treatment followed by mechanical disruption of the biomass fibers by a rapid pressure drop (explosion). SE pretreatment works well on hardwood (Horn and Eijsink, 2010; Sassner et al., 2005). For *Salix* it has been shown that the pretreatment not only improves enzymatic saccharification but also biogas production through anaerobic digestion (Horn et al., 2011a).

Birch is a widespread and readily available biomass throughout Northern Europe and the potential use of this biomass for biofuel production is of major interest. Its presence all over the Nordic countryside makes it an interesting substrate, e.g. in local biogas

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