The potential use of bark residues from commercial eucalyptus plantations as a source of sugars for bioethanol and biopolymers production

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Abstract

Eucalyptus is a fast growing tree which allows harvesting every 7 years, and on average, the total biomass production is around 150-160 tons ha^{-1}, with bark residues representing 10-15% of the dry weight (DW). Therefore, the total bark production at the end of 7 years cultivation is around 15-24 tons ha^{-1}, which are left in the field after harvesting, for nutrient recycling. In order to evaluate the potential use of bark residues as source of sugars for biofuel and biopolymer production, we quantified the carbohydrate composition of barks from two commercial clones, of Eucalyptus grandis (EG) and the hybrid E. grandis x E. urophylla (HGU). Soluble sugars (sucrose, glucose and fructose) were extracted from eucalyptus bark by immersing the chopped bark pieces (8 cm long) in hot water (80ºC) for 1h. The total amount of soluble sugars released were quantified and expressed on a DW basis, varied between 10-20%. The molasses produced from each eucalyptus clone were concentrated to a final concentration of 14% (w/v) of sugars and fermented with Saccharomyces cerevisiae. The efficiency of the fermentation of two eucalyptus molasses was compared with the fermentation of a sugarcane molasse under the same conditions. Considering the average production of 14-20 tons of bark residues per hectare, we estimate that the ethanol production can vary between 800-1000 L ha^{-1} (first generation ethanol). After the extraction of soluble sugars, the residual biomass of barks were pretreated with different concentrations of NaOH in a factorial design, and the highest enzymatic efficiency of glucose conversion was around 60% after 24 hours of incubation. Considering that around 25% of the bark biomass is represented by soluble sugars and extractives, we estimate that the amount of residues produced following the soluble sugars removal is around 10-15 tons per ha^{-1}. Therefore, the amount of ethanol produced by the enzymatic hydrolysis is around 1000-1800 L ha^{-1}. Overall, considering a continuous process of removal of soluble sugars followed by enzymatic hydrolysis and the production of a molasse with a prevailing concentration of C6 carbons, the potential ethanol production from eucalyptus bark is in the range of 1800-3000 L ha^{-1}.