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Saccharification and Bioethanol Production from Banana Pseudostem

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Abstract : Among the different forms of reuse and recovery of agro-residual waste is the production of biofuels. The production of second-generation ethanol has been evaluated and proposed as one of the technically viable alternatives for this purpose. This research work employed the banana pseudostem as biomass. Two different chemical pre-treatment methods (acid hydrolisis with H2SO4 2% w/w and alkaline hydrolysis with NaOH 3% w/w) of dry and milled biomass (70 g/L of dry matter, ms) were assessed, and the corresponding reducing sugars yield, AR, (YAR), after enzymatic saccharification, were determined. The effect on YAR by increasing the dry matter (ms) from 70 to 100 g/L, in dry and milled biomass and also fresh, were analyzed. Changes in cellulose crystallinity and in biomass surface morphology due to the different chemical pre-treatments were analyzed by X-ray diffraction and scanning electron microscopy. The acid pre-treatment resulted in higher YAR values, whether related to the cellulose content under saccharification (RAR = 79,48) or to the biomass concentration employed (YAR/ms = 32,8%). In a comparison between alkaline and acid pre-treatments, the latter led to an increase in the cellulose content of the reaction mixture from 52,8 to 59,8%; also, to a reduction of the cellulose crystallinity index from 51,19 to 33,34% and increases in RAR (43,1%) and YAR/ms (39,5%). The increase of dry matter (ms) bran from 70 to 100 g/L in the acid pre-treatment, resulted in a decrease of average yields in RAR (43,1%) and YAR/ms (18,2%). Using the pseudostem fresh with broth removed, whether for 70 g/L concentration or 100 g/L in dry matter (ms), similarly to the alkaline pre-treatment, has led to lower average values in RAR (67,2% and 42,2%) and in YAR/ms (28,4% e 17,8%), respectively. The acid pre-treated and saccharificated biomass broth was detoxificated with different activated carbon contents (1,2 and 4% w/v), concentrated up to AR = 100 g/L and fermented by Saccharomyces cerevisiae. The yield values (YP/AR) and productivity (QP) in ethanol were determined and compared to those values obtained from the fermentation of non-concentrated/non-detoxificated broth (AR = 18 g/L) and concentrated/non-detoxificated broth (AR = 100 g/L). The highest average value for YP/AR (0,46 g/g) was obtained from the fermentation of non-concentrated broth. This value did not present a significant difference ($p<0,05$) when compared to the YP/RS related to the broth concentrated and detoxificated by activated carbon 1% w/v (YP/AR = 0,41 g/g). However, a higher ethanol productivity (QP = 1,44 g/L.h) was achieved through broth detoxification. This value was 75% higher than the average QP determined using concentrated and non-detoxificated broth (QP = 0,82 g/L.h), and 22% higher than the QP found in the non-concentrated broth (QP = 1,18 g/L.h).

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