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Ionic liquid stable cellulase from *Bacillus Subtilis* G_2 having application potential for biomass saccharification under one pot consolidated bioprocess

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Ionic liquid (IL) based pretreatment of lignocellulosic biomass for facilitating efficient enzymatic saccharification has emerged as an environmentally benign approach that offers several advantages over conventional strategies. However, residues of ionic liquid left in the pretreated biomass may cause inactivation of saccharifying enzymes thus, necessitating the want of ionic liquid-stable enzymes. Cost-effective production of industrial enzymes is always desired. Current study reports IL-stable cellulase production from a newly isolated bacterium *B. subtilis* G_2. Design of experiment (DoE) based on response surface methodology was used in sequential manner for optimizing cultural and environmental variables to enhance cellulase production by 2.66-fold. IL-stable cellulase was used for saccharification of IL-pretreated pine needle biomass (PNB) with 1-ethyl-3-methylimidazolium methanesulfonate in a consolidated single pot process i.e. one pot consolidated bioprocess (OPCB). The saccharification efficiency of 23.57% was observed under OPCB. The hydrolsate obtained was fermented by dual culture of yeast i.e. *Saccharomyces cereviasie* NCIM 3078 and *Pichia stipitis* NCIM 3497, and a yield of 0.092 g ethanol/g of PNB was obtained with fermentation efficiency of 25.62%. This study is first ever where-in IL-stable cellulase production is accomplished using agroindustrial residues by employing DoE, and assessment of its application potential under OPCB for saccharification of IL-pretreated PNB. IL-stable cellulases would not only preclude expensive washing step following IL-pretreatment of biomass, but their application in a consolidated single pot process (OPCB) offers numerous technoeconomic advantages over conventional multi pot processes.

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Geothermal, biomass and fuel cell

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This is an important study on the transition to 100% renewable energy especially biomass, fuel cells and geothermal energy which likely shall take place in about a century because fossil fuels will become too rare and expensive to burn. This problem of lack of fossil fuel will give rise to demand of biomass, geothermal and especially fuel cell energy technology as hydrogen can easily be produced in diverse ways in its abundance, though hazardous and some transport issue but it can be effectively managed as its pros supersedes its cons. These energy sources are in abundance and less harmful, with less environmental pollution. The transition with next century suggests that fossil fuel energy usage will be replaced with these energy systems which are efficient and also more sustainable.

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