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Sustainability of cereal straws for the fermentative production of second generation biofuels: A review of the efficiency and economics of biochemical pretreatment processes

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HIGHLIGHTS

- Cereal straws are potential lignocellulosic feedstocks for second generation biofuels.
- Biochemical processes are efficient pretreatment options for cereal straws.
- Biochemical pretreatment employs several ligninolytic strains of fungi and bacteria.
- Microbial consortia perform better lignocellulose degradation than mono-cultures.
- Biochemical pretreatments are economically sustainable.

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ABSTRACT

Straws of cereal grains represent the major fraction of lignocellulosic agricultural wastes generated worldwide. Cereal straws (CSs) hold great potential for implementation as candidate feedstocks for fermentative production of second generation (2G) biofuels. Among the different varieties of CSs, rice and wheat straw are clearly the best available options for development of a reliable feedstock base from all aspects. Feasible alternatives of costly, energy intensive and non-ecofriendly physical and chemical pretreatments are needed to facilitate full scale utilization of the CSs in the 2G biofuel platforms. Biochemical pretreatments of CSs using potential lignocellulolytic microorganisms can become the alternative technology upon proper exploration and exploitation. In the present review article, efficiency of the microorganism mediated biochemical processes has been assessed as promising pretreatment methods for CSs. Ligninolytic action of different fungi, bacteria and microbial consortia on different CSs (mostly wheat and rice straw) has been evaluated on the basis of extent of lignin degradation, selectivity of degradation and sugar recovery from pretreated CSs. Utilization of microbial consortia has been recommended as better pretreatment agents in comparison to their mono-culture counterparts. The review also attempts to predict the economic viability of biochemical pretreatments on the basis of associated cost factor correlation with the physical and chemical processes. Construction of synergistically operating lignocellulolytic microbial consortia for application in biochemical pretreatments of CSs has been demonstrated in the article and advocated as a promising process amelioration strategy. Overall, the review affirms the biochemical processes as the most suitable pretreatment technique from techno-economic and environmental aspects.

1. Introduction

Implementation of environmentally benign and energy efficient alternatives of emission prone fossil fuels to tackle down the escalating problem of global warming, environmental degradation and energy insecurity is a global goal of the moment [1]. The "Bio-based" fuels, more commonly known as biofuels, are the most favorable options available as potential "green energy" alternatives [2]. Bioethanol, biobutanol, biogas/biomethane, biohydrogen and biodiesel are the most popular genre of biofuels and are currently being accentuated through rigorous research and development worldwide [2–6]. Except biodiesel, all of these biofuels are

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