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Plant Biomass from Grasses: An Underutilized Feedstock for Microbial Production of Chemicals and Biopolymers

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Abstract

Plant biomass from grasses is an underutilized feedstock for the microbial production of chemicals and biopolymers. Hydrolysates of this type of plant biomass provide sufficient levels of glucose or xylose to support specialty chemical and biopolymer production. Considering the availability of these grasses worldwide, additional studies are needed to determine whether the production of industrially important chemicals and biopolymers from grasses using microbial bioconversion is feasible.

Keywords: Grass; Specialty chemicals; Biopolymers; Microbial bioconversion

If biobased-related products are to replace petroleum-related products, new methodologies, where various types of lignocellulosic biomass undergo bioprocessing to commercially important products, must be devised [1]. A relatively low value lignocellulosic biomass that could be utilized to produce biobased-related coproducts is grass. Currently, many grasses are largely utilized for grazing by livestock or harvested as hay [2]. For example, many North American prairie grasses produce a high yield with minimal fertilizer input and they contain a very high fiber content indicating a high level of cellulose and hemicellulose [2]. A high concentration of cellulose and hemicellulose can be released by treatment of grass biomass [3]. Subsequent cellulase and xylanase treatment of the treated biomass has been found to release glucose and xylose [3,4]. The fermentable glucose released from the hydrolyzed cellulose following enzymatic treatment of the biomass can be converted to chemicals such as citric acid, fumaric acid, gluconic acid, itaconic acid, lactic acid, malic acid, oxalic acid, propionic acid and succinic acid as well as biopolymers such as polysaccharide gums by microbial strains. Citric acid, gluconic acid, itaconic acid, malic acid and oxalic acid can be produced from glucose by species of the fungus *Aspergillus* [5,6]. The bacterium *Propionibacterium acidipropionici* has been shown to produce propionic acid from glucose while species of *Lactobacillus* produce lactic acid from glucose [5]. A number of anaerobic bacteria are capable of producing succinic acid from glucose [5]. Fumaric acid can be synthesized from glucose by a fungus and a genetically engineered bacterial species [5]. The fermentable xylose released from the hydrolyzed biomass can be converted to xylitol by yeast species [7]. Polysaccharide gums, such as pullulan or curdlan, can be synthesized from glucose by microorganisms [8,9] The literature examining microbial specialty chemical or biopolymer production from grass hydrolysates is extremely limited. It has been shown that hydrolysates of plant biomass can support fungal citric acid production by *Aspergillus niger* or fumaric acid production by *Rhizopus oryzae* using solid-state fermentation [10,11]. Also, a xylanase hydrolysate of the grass big bluestem supported the production of xylitol by *Candida* species [7]. The opportunity exists to use grass as a plant biomass feedstock for the production of chemicals and biopolymers to decrease reliance on petroleum- based feed stocks for their production. To exploit this opportunity, the feasibility of using microbial bioconversion to produce chemicals and polysaccharide gums from the fermentable sugars present in hydrolysates of various grass species will need to be more intensively investigated.

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