



Optimization of Bioethanol Production from *Oryza sativa* L.

Biomass: Process Parameters and Efficiency

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Abstract

The increasing demand for renewable and sustainable energy sources has encouraged research into the conversion of agricultural biomass into biofuels. This study focuses on the optimization of bioethanol production from *Oryza sativa* L. (rice) biomass, an abundant agricultural residue with considerable potential as a lignocellulosic feedstock. The production process involves pretreatment, enzymatic hydrolysis, fermentation, and ethanol recovery, with each stage significantly influencing the overall yield and efficiency. The study investigates the effects of important process parameters, including pretreatment conditions, substrate concentration, pH, temperature, enzyme concentration, fermentation period, and yeast inoculum size, on bioethanol production. Optimization of these parameters is essential for improving the release of fermentable sugars and enhancing their subsequent conversion into ethanol. Appropriate pretreatment facilitates the breakdown of complex lignocellulosic structures and increases the accessibility of cellulose and hemicellulose to hydrolytic enzymes. Fermentation efficiency is further influenced by environmental conditions and microbial activity. The optimized process is expected to improve ethanol yield while reducing energy consumption, processing time, and production costs. Utilization of rice biomass for bioethanol production also offers an environmentally sustainable approach to agricultural waste management by reducing open-field residue burning and greenhouse gas emissions. The study demonstrates the potential of *Oryza sativa* biomass as a promising renewable feedstock for bioethanol production and emphasizes the importance of process optimization for developing economically viable and environmentally responsible biofuel technologies.

Keywords: Bioethanol, *Oryza sativa* L., Rice Biomass, Lignocellulosic Biomass, Pretreatment, Enzymatic Hydrolysis, Fermentation, Process Optimization, Ethanol Yield, Renewable Energy.