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Project title: Supercritical CO_2 as effective wheat straw pretreatment for subsequent mild fractionation strategies

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Abstract (approx. 200 words)**:**

The efficient utilization of lignocellulosic biomass in biorefineries is pivotal for the transition to a carbon-neutral society, emphasizing the need for environmentally friendly fractionation techniques. While the extensive use of chemicals in biorefinery operations can yield favorable quantities of specific biomass components, adopting less chemically intense conditions is crucial for holistic methodologies that preserve the inherent potential of all biomass constituents. This study therefore comprehensively investigated the use of supercritical carbon dioxide (sc-CO_2) as a green pretreatment to improve subsequent mild fractionation of wheat straw. Sc-CO_2 was found to have minimal impact on the chemical composition and the lignin structure, while there were significant morphological changes in heightened surface area and reduced density. Apart from increasing enzymatic saccharification efficiency the treatment notably enhanced subsequent mild delignification through alkaline or inflow organosolv extractions, improving the lignin solubilization yields from 49 to 79% and 74 to 91%, while retaining a high β-O-4 conservation of 49 and 59 linkages per 100 aromatic units, respectively. Additionally, the combined use of sc-CO_2 with mild dilute acid pretreatment improved xylose solubilization from 59 to 76% and enzymatic saccharification from 53 to 90%, albeit with increased lignin condensation. In summary, this study demonstrates the potential of sc-CO_2 pretreatment as a versatile tool for biomass valorization within the evolving bioeconomy, by combining enhanced extraction yields with minimal lignin structural impact. Our work thereby highlights the promise of the use of sc-CO_2 for contributing to the overall economic potential of biorefinery processes.

Key words: scCO_2, enzymatic saccharification, lignocellulose, organosolv, lignin