Microwave Irradiation with Submerged Ultrasonication: A Novel Lignocellulosic Pretreatment Method

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Starch-derived biofuels from first-generation feedstocks, like Zea mays (corn) and Saccharum officinarum (sugarcane), dominate the bioenergy market. The competing applications of these conventional sources of bioethanol present a sustainability issue. As the most abundant bioresource on Earth, lignocellulosic biomass (LCB), including most crop residues and herbaceous biomass, would be a superior source if only its conversion to ethanol were as efficient as that of starch-based feedstock. The recalcitrant molecular structure of LCB thwarts its industrial potential by hindering its enzymatic breakdown and subsequent fermentation. To enhance the efficiency and sustainability of this conversion process, a novel pretreatment method was devised using the synergistic properties of microwave (MW) and ultrasonic (US) irradiation. Corrugated fibreboard was used as an experimental feedstock to test 36 combinations of selected values for these variables. Following hydrolysis and fermentation, the resulting bioethanol concentration of each sample was quantified using an electronic sensor. The combination of 440 W of MW power (2,450 MHz, 8 min) and 480 s of submerged US irradiation (42 kHz, 35.00 W) yielded an optimal recovery of 2.24 ± 0.05% v/v of ethanol. A thin-plate spline curve fitting of all the collected data revealed a theoretical peak concentration of 2.26 ± 0.05% v/v from 500 W of MW power and 462 s of submerged US irradiation. This optimal combination recovers an additional 0.53% v/v of bioethanol compared to untreated LCB and an additional 0.06% v/v compared to untreated starch derivatives which have historically prevailed by 0.50% v/v. This increase in bioethanol recovery affirms the potential of this novel pretreatment method as an enhanced form of biofuel production.

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Second Award of $2,000