Landfill to Car Fuel: Using Surfactants to Increase Cellulosic Ethanol Production from Waste Paper

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The purpose of my project was to optimize enzymatic hydrolysis of waste paper to make fermentable sugars for biofuel production. I focused on adding surfactants to the paper to improve cellulose conversion into sugar. I hypothesized that non-ionic surfactants would improve sugar production by aiding in enzyme desorption from cellulose fibers. Also that sugar production would peak at the critical micelle concentration of the surfactants. I used a 75-25 blend of two enzymes (Cellulase and Cellobiase) in combination with different surfactants to hydrolyze waste paper. I calculated the amount of sugar formed in each experiment using a DNS reagent test since DNS reacts with reducing sugars, darkening in color proportional to the concentration of sugar in the sample. Light absorption of the sample was measured using a 96-well plate reader. Two different surfactant variables were tested: surfactant type and surfactant concentration. Overall, 20 combinations were analyzed, and each experiment was repeated 5 times totaling 100 experiments. My results indicated that the addition of a non-ionic surfactant to paper improved cellulose conversion by up to 50%, while ionic surfactants (cationic, anionic, and zwitterionic) had negative impact on the reaction probably because ionic compounds deactivated the enzymes. In addition, increasing the non-ionic surfactant concentration resulted in a maximum sugar production at twice the critical micelle concentration of the surfactant, and a reduction in sugar production when the surfactant concentration was further increased. This observation was explained by the enzymes getting trapped in micelles formed by excess surfactant in the sample.

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