Utilization of Switchgrass As A Biofuel Feedstock

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A complete characterization of switchgrass is essential so that the grass can be used as a resource for fuel, energy, and chemicals. This thesis research focused on biomass characterization and the hydrothermal pretreatment of switchgrass for bioethanol production.

In the first part of the thesis, chemical analyses were conducted for four populations of switchgrass, SW1-SW8. Each population consisted of 69% leaves, 27% internodes, and 4% nodes. The variations in carbohydrates, lignin, extractives content, Higher Heating Value (HHV), and syringyl:guaiacyl (S:G) ratio were determined among the populations and the morphological portions. The experimental results suggest that each population of switchgrass has a similar chemical profile, while the profiles of the morphological portions differ. The leaf portions have the highest arabinose, galactose, ash, and lignin contents and the lowest S:G ratio, while the internode portions have the highest values of these variables. The internode portions have the highest glucose content (44.3%).

In the second part of the thesis, the leaf and internode portions of switchgrass SW9 were analyzed to determine their chemical compositions and structures. The results indicate that leaves and internodes have different inorganic and organic chemical compositions. These differences include minerals, extractives, carbohydrates, and lignin content. The structure of cellulose is the same in both portions. The structure of lignin is different in terms of S:G ratio and molecular weight. The lignin S:G ratio is 0.69 and 0.74 for the leaf and internode portions, respectively. The molecular weight of acetylated lignin is 5919.7 when obtained from the leaf portion and 4375.6 g/mol when obtained from the internode portion.

In the third part of the thesis, four populations of switchgrass, SW1-SW8, were used to study the chemistry of hydrothermal pretreatment and the ensuing effect on the digestibility of pretreated materials. The results indicate that hydrothermal pretreatment chemically modifies leaves and internodes so that they have similar chemical compositions and structures. The accessibility of switchgrass is improved by hydrothermal pretreatment as measured by Simons' Staining technique. The results also suggest that the accessibility of pretreated leaves is greater than the pretreated internodes. However, the degree of polymerization of pretreated cellulose is 23.4% greater in the internode portions than in the leaf portions. The cellulose to glucose yield is 77.4% and 44.9% for the pretreated leaf and internode portions, respectively. The lower DPw of pretreated cellulose and greater accessibility of pretreated leaves is contributed to be a factor for the enhanced digestibility in comparison with the pretreated internodes.

In the fourth part of the thesis, hydrothermal pretreatment was performed on the extracted leaf and internode portions of switchgrass SW9 to enhance their susceptibility to cellulase. The results demonstrate that hydrothermal pretreatment increases the crystallinity of cellulose and the percentage of cellulose I□+□, but reduces cellulose I□ for both the leaf and internode portions. After hydrothermal pretreatment, the leaves and internodes have similar chemical profiles and a similar structure of cellulose. However, the DP of pretreated cellulose in the internodes is 30.5% greater than that in the leaves. Pretreated leaves have a 60.5% cellulose-to-glucose conversion yield, which is 33.8% greater than that of the pretreated internodes. The results of the enzymatic hydrolysis studies of cellulose

suggest that the reduced DP of cellulose of pretreated switchgrass was an important factor influencing the enhanced digestibility of pretreated switchgrass.