Potential Use of Wheat Straw in Biorefinery Based on Hot Water Extraction

A. Murphy, D. Corbett, C. Gong, Dr. B Bujanovic
Paper & Bioprocess Department, SUNY-ESF Syracuse, NY

Introduction

- The price of corn-based ethanol will continue to increase in the near future, making lignocellulosics a very viable candidate as a renewable source of ethanol production.
- Wheat Straw is grown in over 115 nations, with 300 million tons being produced annually in Europe and North America.1
- The Biorefinery proposed at SUNY ESF is based on the first environmentally friendly step of hot-water extraction (HWE) as a pretreatment which removes easily accessible hemicelluloses.
- Most of the studies on HWEs (2 hr, 160°C) have been performed on different hardwoods (e.g. sugar maple).
- The effect of the HWE on Wheat Straw was determined by how much lignin and hemicelluloses were removed.
- It was confirmed that the loss of hemicelluloses during HWE results in an increased heating value of the extracted Wheat Straw, which is a beneficial feature for use of hot-water extracted Wheat Straw as pellets for Combined Heat & Power (CHP) use.

Materials and methods

Tests Performed
Chemical Composition of Wheat Straw
- 1% NaOH Solubility (T 212)2
- Ash (T 211)
- Cellulose, Kurschner-Hoffer Method3
- Cold Water Solubility (T 207)
- Modified Klasson/Acid-Soluble Lignin (T 222/UM50)
- Moisture Content (T 412)
- Soxhlet Extraction (T 204) (Ethanol:Toluene (1:2)/Acetone/water (9:1));

Determining Effect of Hot Water Extraction
- Determination of Heating Value using Bomb Calorimetry (T 684)
- Modified Extraction with Dichloromethane
- Modified Klasson/Acid Soluble Lignin

All labs were performed in 413, 411 & 102 Walters.

Literature cited

Conclusion

The HWE determined that the amount of recoverable solids and the degree of delignification of wheat straw is very similar to other monocotyledons (e.g. corn cobs). Sugar maple had 4% more recovered solids than Wheat Straw, however the degree of delignification of Wheat Straw was double that of sugar maple1, indicating the wheat straw has a more open structure which led to the increased dissolution of the more accessible lignin.

The effect of the HWE was negligible according to Near Infrared Spectroscopy, leading to the conclusion that the NIR method requires an appropriate data base for use for Wheat Straw.

Further Research
- Do more experimentation to determine a more comprehensive chemical composition of the HWE Wheat Straw.
- Determine how much of the lignin and hemicelluloses are recoverable from the HWE extract.
- Test the Anti-oxidizing Activity of the three samples of extractsives (Ethanol/Toluene, Acetone/Water, HWE)
- Perform experimentation to determine type of lignin in Wheat Straw.