Research Unit Summaries on Bioenergy
Bioenergy Stakeholders Workshop, September 18-20, 2007

Quality Assessment and Safety Research Unit, Athens, Georgia
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Current research projects and objectives:
The main research project is entitled: **Flax Fiber for Value-Added, Bio-Based Products**
The primary objective of the project is enhancement of the value of fiber commodities through microbial and enzymatic activities. Recently, research has focused on lignocellulosic materials and co-products related to biofuels. Source of materials have been expanded to include flax waste streams, grasses (e.g., corn stover), and corn fiber as particular materials of interest.
Approaches include: 1) chemical and structural assessment of fibers and lignocellulosic materials, 2) use of microorganisms and enzymes to enhance value through new processing methods, products, and co-products, and 3) rapid and non-destructive assessment during processing and of end products.

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Key accomplishments:
1. **Determined constituents in waste flax shive and developed processes for value-added coproducts**
The chemistry and structure of shive, which is an extensive waste product from processing flax fiber, was determined with the goal of developing co-products. Methods for delignifying flax shive, identifying aromatic compounds as coproducts, and subsequently fermenting residual cellulose to ethanol are under development. The inner, woody core tissue called shive makes up about 75% of the flax stem and is a large disposal problem in processing for fiber. Currently, shive sells for about 25$/ton for burning or animal bedding. A vast profile of aromatic compounds was extracted from shive and offers the potential for myriad value-added co-products, notably antioxidants, antimicrobials, and resins. The residue after extraction of aromatics is mostly cellulose. This residual cellulose was saccharified with cellulase and fermented to ethanol with an efficiency as high as commercially pure celluloses. Impact: from an already collected waste product at the processing plant, hundreds of tons of lignocellulose could provide aromatic co-products and sugars for ethanol.
2. **Developed environmentally sensitive pretreatment of lignocellulose biomass for enhanced sugars and co-products**
Ferulic acid esterase is potentially a non-corrosive, environmentally-friendly method to replace chemical (e.g., dilute sulfuric acid) pretreatment of grass lignocellulose to ethanol. The method takes advantage of particular aromatic-carbohydrate linkages in grasses, specifically phenolic acid esterification to sugars. In laboratory studies, this enzymatic treatment before saccharification with cellulase shows a significant

enhancement in release of glucose and xylose sugars for fermentation over those released by cellulase alone. Further, ferulic acid is released in significantly higher concentrations. A variety of materials responded favorably with esterase pretreatment, including bermudagrasses, corn stover, and corn fiber. Ferulic acid is a particularly important compound that can be used as a substrate for vanillin (a food flavoring ingredient), antioxidant in foods, anti-ageing and ultraviolet absorbent ingredient in creams and ointments, and an antimicrobial agent. Corn fiber gave the highest increases in fermentable sugars and ferulic acid with esterase pretreatment. Esterase pretreatment of corn fiber could significantly extend ethanol production from corn and provide a value-added co-product with identified uses already in the market place. Impact: ferulic acid esterase pretreatment could be new environmentally friendly biological pretreatment for increased levels of fermentable sugars and value-added aromatic co-products that reduce costs of lignocellulose to ethanol.

Other scientific expertise or capabilities already available in the RU applicable to bioenergy

1. David Himmelsbach, research chemist: lignocellulose investigations using NMR spectrometry, mid infrared and Raman microspectroscopy, ultraviolet absorption spectroscopy.
2. Ronald Holser, chemical engineer: technologies for separation and purification of aromatic and other value-added co-products.