Fats, Oils and Animal Coproducts Research Unit
Fats & oils, biodiesel, biopolymers, surfactants, hides & leather, wool, rendered protein

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NP307 (213) BIOENERGY PLANNING AND COORDINATION MEETING
Beltsville, November 29th – December 1st, 2006
ERRC SY’s Who Work on Biodiesel

CWU 1935-41000-066
(bioenergy in part; CWU coded NP306)

Tom Foglia  
Mike Haas  
Bill Marmer  
Victor Wyatt

CWU 1935-41000-067
(coded NP306)

Dan Solaiman  
Rick Ashby

EASTERN REGIONAL RESEARCH CENTER
WYNDMOOR, PENNSYLVANIA
John P. Cherry, Center Director
Objective 4 (of 5), Biofuels and additives:

- Develop alternative processes for producing biodiesel from intact oils and fats and/or less expensive lipid feedstocks.

- Develop methodologies for improving the quality and performance of biodiesel fuels.

Objective 5 (of 5), Glycerol utilization:

- Convert glycerol to prepolymer for prospective use in the synthesis of polyesters and polyamides or for use as polydispersants.

  - Hyperbranched and dendrimeric polymers
  - Reactive intermediates for production of adhesives, elastomers and foams
  - Linear condensation prepolymer (2-5 polyester/amide monomers)
Objective 1 (of 2): Develop fermentation-based bioconversion systems …that utilize…fats, oils and coproducts as feedstocks to produce value-added biobased products and materials with enhanced properties and minimal environmental footprints

Sub-objective 1.1: Broaden the application expanse of the feedstocks
- Explore their suitability for use in the fermentative or cell-based production of value-added bioproducts such as water-soluble biopolymers, biosurfactants, chemical intermediates, biolubricants, thickening agents, and bioemulsifiers

Sub-objective 1.2: Implement strain improvement…

Sub-objective 1.3: Explore the use of inexpensive feedstocks and of alternative fermentation techniques such as fed-batch culture
- produce new bio-based materials
- maximize the yields of existing technologies
Biodiesel Research
Research capabilities/instrumentation/facilities

test engine at ERRC

Benchtop fermentors

GC-MS and HPLC-MS

ERRC Pilot Plant: “SUPER” Group support
Biodiesel Research
Production from Alternative Feedstocks

Direct (in situ) production from

- soy flakes
- DDGS
- meat & bone meal
- veg. oil, animal fat, restaurant grease
- Soapstock
- trap grease

Before transesterification  Biodiesel product  After transesterification
Biodiesel Research

Production: Process simulation and cost engineering
ASPEN+ and SuperPro Designer Software

Cost modeling:
Alkali-Catalyzed Transesterification

Model for refined soy oil

Andy McAloon
Biodiesel Research: Assessment of Fuel Quality

**Total Glycerol by HPLC**

- SME
- DAG and Sterols
- MAG
- Glycerol

**Analysis of Biodiesel Blends**

- HPLC B5 Blend
- Diesel
- SME biodiesel
- Soy oil

- GC B20 Blend

**Analysis of Minor Constituents by HPLC**

- SME and Glycerides
- Steryl Glycosides
(1) Synthesis and characterization of oligomers:
   (a) with iminodiacetic acid
   (b) with dicarboxylic acids (succinic or azelaic)

(2) Conversion to hyperbranched polymers:
   Anticipated: some will be water-soluble
   Most will be soluble in polar organic solvents

Potential uses: adhesives, films, elastomers, surgical applications
Uses for Glycerol Coproduct Stream
Glycerol as a Fermentation Feedstock
(Rick Ashby, Dan Solaiman)

Glycerol
- Pure (99%)
- Semi-refined (80%)
- Crude (40%)

Microbial Screening
- Strain Improvement
- Fermentation Manipulation

Biopolymers
- Poly(hydroxyalkanoates)
- γ-Poly(glutamic acid)

Biosurfactants
- Sophorolipids
Activities planned for next couple of years

- **Feedstocks:**
  - *In situ* conversions: continuous processes, assessment of defatted meal as feed
  - Grease applications: improve conversion processes
    - Enzymatic and solid acid catalysis
- **Analytical:** Adoption of new methods for trace constituents
  - Partial glycerides, steryl glycosides, residual sulfur
  - Rapid determination of blend levels
  - Applications of methods to identify and eliminate the problems
- **Glycerol:**
  - Production, characterization and application of hyperbranched polymers
  - Synthesis of new reactive monomers
  - Fermentation products: effect of feedstock on yields and properties
    - Biosurfactants and biopolymers
- **Intact fats and oils:** use as heating fuel
Biodiesel and Related Biofuels: American Collaborations
(other than Pennsylvania)

- National Biodiesel Board
  Jefferson City, MO
- USDA
- Hagerman, ID
- Golden, CO
- USDA
- Minnesota
- Laughing Stock Farm
  Freeport, ME
  Ralph Turner
- Fats & Proteins Res. Found.
  Alexandria, VA
- P&G
  Procter & Gamble
  Cincinnati
- ADM
  Decatur, IL
- Runyon Industries
  Memphis, TN
- SRRC, New Orleans
- NCAUR, Peoria, IL
- USDA
- USDA
Biodiesel and Related Biofuels: Pennsylvania Collaborations

Pennsylvania Department of AGRICULTURE
Harrisburg
ERRC: Member, Biodiesel Feasibility Working Group
David Bingaman

Pennsylvania State University
Energy Institute
State College
Fuel Evaluation & Engine Testing
André Boehman, Joseph Perez

Pennsylvania Fry-o-Diesel, LLC
Philadelphia

Biodiesel from Trap Grease
Leola
Direct combustion of fats and oils

Leola
M. Rt. Ullman

Biodiesel Feasibility Study

Greater Philadelphia
Clean Cities Program
ERRC: Silver Member
Nathalie Shapiro

Philadelphia Fry-o-Diesel, LLC
Biodiesel from Trap Grease
Nadia Adawi

The Energy Cooperative
Greater Philadelphia
Clean Cities Program
ERRC: Sponsor
Russ Montgomery, Organizer

Regional Economic Development District Initiatives
Harrisburg, August 2005
Energy Symposium
ERRC: Sponsor
Russ Montgomery, Organizer

Changing World Technologies
Philadelphia
Renewable Fuels from Agricultural Co-Products
Brian Appel

Energy Symposia for Schools
Abington, 2003-2006
ERRC: Presenter
Organizer: Ellen Bard

AgCom
New Oxford
Soy Diesel Analysis
Dan Sharrer

PPG Industries
Pittsburgh
Coproduct
fermentation to industrial products
Biodiesel and Related Biofuels: Worldwide Collaborations

- **Eastern Regional Research Center, Wyndmoor, Pennsylvania**
  - Fats, Oils and Animal Coproducts Research Unit
  - William N. Marmer, Research Leader
    - wmarmer@arserrc.gov

- Karl-Franzens University, Graz, Austria
  - Martin Mittelbach

- Nigerian Institute for Oil Palm Research, Benin, Nigeria
  - Roland Abigor

- CIRAD
  - Montpellier, France
  - Pierre Villeneuve

- Universidad Federal de Paraná, Curitiba, Brazil
  - Prof. Paulo A. Z. Suarez

  - GosNIIOKhT
  - Moscow, Russia

- Int'l Congress on Biodiesel
  - Vienna, Nov. 2007
  - Mike Haas, General Chair

- ГосНИИОХТ

- Karl-Franzens University, Graz, Austria
  - Martin Mittelbach