NATIONAL CENTER FOR AGRICULTURAL UTILIZATION RESEARCH

FOOD & INDUSTRIAL OIL RESEARCH

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Research

Research in my lab is focused on the synthesis of value added industrial products from soybean oil or other vegetable oils. Chemical modification of the soybean oil, or the fatty alkyl esters of soybean oil allows the synthesis of products with enhanced properties for potential applications as surfactants, lubricants, polymers, and adhesives. A higher focus is on developing relatively green syntheses which are industrially applicable.

One of the main focuses of my research is to gain understanding in order to control the factors which determine the products of a particular synthesis. An example of this is shown by our ability to synthesize either a branched oleochemical with potential to be a lubricant additive, or an acid degradable ketal with possible use in protein extraction, both from the same starting materials. In another example, the synthesis of four oleochemical cyclic carbonates, using readily available vegetable oil based materials were improved by the use of supercritical carbon dioxide. Using this route, the material can be produced in only 1/3 of the time reported in the literature.

My research also has an applied side, where various materials are made, with a focus on what the industry needs in the near term. Interesting materials, such as a powerful friction reducing lubricant additive, an environmentally friendly detergent builder, or a glycerol containing surfactant have all been made.

These are just a couple of examples of show how our research unit is helping to improve the way we utilize soybean oil and soybean oil derived products. These steps will help ensure the place of renewable agricultural resources in the United States, and decrease our dependence on non-renewable petroleum.

Selected Publications

Doll, K. M. A Convenient Low Resolution NMR Method for the Determination of the Molecular Weight of Soybean Oil Based Polymers. J. Assoc. Lab. Auto. (Article in Press).

Suarez, P. A. Z., Pereira, M. S. C., **Doll, K. M.,** Sharma, B. K., Erhan, S, Z. Epoxidation of Methyl Oleate Using Hetergeneous Catalyst. Ind. Eng. Chem. Res. (Article in Press)

Doll, K. M., Erhan, S. Z. Polyol anbd Amin Acid-Based Biosurfactants, Builders, and Hydrogels. Book Chapter in "Bio-Based Surfactants and Detergents" AOCS Press. (Book in Press)

Shogren, R. L., Willett, J. L., Westmoreland, D., Gonzalez, S. O., **Doll, K. M.**, Swift, G. Properties of Copolymers of Aspartic Acid and Aliphatic Dicarboxylic Acids Prepared by Reactive Extrusion. J. App. Poly. Sci. 110:3348-3354. 2008.

Doll, K. M. and Erhan, S. Z. Synthesis of Cyclic Acetals (Ketals) from Oleochemicals using a Solvent Free Method. Green Chem. 10:712-717. 2008.

Doll, K. M., Sharma, B. K., Suarez, P. A. Z. and Erhan, S. Z. Comparing Biofuels Obtained from Pyrolysis, of Soybean Oil or Soapstock, with Traditional Soybean Biodiesel: Density, Kinematic Viscosity, and Surface Tensions. Energy and Fuels 22:2061-2066. 2008.

Doll, K. M., Moser, B. R. and Erhan, S. Z. Surface tension studies of methyl esters and epoxidized methyl esters relevant to oleochemical based fuel additives. Energy and Fuels 21:3044-3048. 2007.

Doll, K. M., Sharma, B. K. and Erhan, S. Z. Synthesis of branched methyl hydroxy oleates including an ester from bio-based levulinic acid. Ind. and Eng. Chem. Res. 46:3513-3519. 2007.

Moser, B. R., Sharma, B. K., **Doll, K. M.** and Erhan, S. Z. Diesters from oleic acid: synthesis, low temperature properties, and oxidation stability. J. Amer. Oil Chem. Soc. 84:675-680. 2007.

Sharma, B. K., **Doll, K. M.** and Erhan, S. Z. Oxidation, friction reducing, and low temperature properties of epoxy fatty acid methyl esters. Green Chem. 9(5):469-474. 2007.

Doll, K. M. and Erhan, S. Z. Synthesis and performance of surfactants based on epoxidized methyl oleate and glycerol. J. Surf. Deterg. 9(4):377-383. 2006.

Doll, K. M., Moser, B. R., Sharma, B. K. and Erhan, S. Z. Current uses of vegetable oil in the surfactant, fuel, and lubrication industries. Chem. Today / Chimica Oggi. 24(6):41-44. 2006.

Doll, K. M., Shogren, R. L, Willett, J. L. and Swift, G. Solvent free polymerization of citric acid with D-sorbitol. J. App. Poly. A 44:4259-4267. 2006.

Holser, R. A., **Doll, K. M.** and Erhan, S. Z. Metathesis of methyl soyate with ruthenium catalysts. Fuel 85:393-395. 2006.

Doll, K. M. and Erhan, S. Z. The improved synthesis of carbonated soybean oil using supercritical carbon dioxide at reduced reaction time. Green Chem. 7:849-854. 2005.

Doll, K. M. and Erhan, S. Z. Synthesis of carbonated fatty methyl esters using supercritical carbon dioxide. J. Agric. Food Chem. 53(24):9608-9614. 2005.

Doll, **K. M.,** Shogren, R. L., Holser, R. A., Willett, J. L. and Swift, G. Polymerization of L-aspartic acid to polysuccinimide and copoly(succinimide-aspartate) in supercritical carbon dioxide. Lett. Organic Chem. 2:687-689. 2005.

Patents

Doll, K. M., Sharma, B. K. and Erhan, S. Z. Method of making fatty acid ester derivatives, U.S. Patent Application 11/717524. (Patent Application: March 2007).

Swift, G., Westmoreland, D. G., Willett, J. L., Shogren, R. L. and **Doll, K. M.** Methods of synthesis of polymers and copolymers from natural products. U.S. 7256251. 2007.

Swift, G., **Doll, K. M.**, Shogren, R. L., Holser, R. A. and Willett, J. L. Synthesis of polysuccinimide and copoly(succinimide-aspartate) in a supercritical fluid. U.S. Patent 6887971. 2005. *(Updated 03-02-09)*