Center for Corn-oil Based Polymers
Crops Utilization Research

Dr. Richard Larock (Chemistry) and Dr. Valerie Sheares (Chemistry) are developing a remarkable range of exciting new rubber, adhesive, elastomeric and plastic materials that are made by polymerizing soy and corn oils with a number of readily available, commercial plastic monomers, or completely replacing petroleum-based plastics with bioplastics made exclusively from corn and soy oils.

These materials are useful new bioplastics from inexpensive, renewable corn oils, and are economical and environmentally friendly. The materials are likely to produce new rubbers, elastomers and plastics that more readily biodegrade in landfills than the present, virtually indestructible, petroleum-based plastics. Additionally, the new materials will provide thermal, mechanical and physical properties not presently available in commercial plastics. The research is being commercialized with several industry partners.

The newest materials are made by the copolymerization of soybean oil with styrene and various amounts of divinylbenzene. A typical elastomeric material is highly elastic, has good tensile and good thermal stability. In addition to thermophysical and mechanical properties comparable to petroleum-based polymers, these new soybean oil-containing materials possess even more valuable properties, such as good vibration damping and shape memory properties. Damping materials are capable of reducing unwanted noise and preventing vibration fatigue failure. Good shape memory materials can be formed into desired, persistent shapes simply by altering the temperature of the material.

With the tremendous commercial importance of the plastics industry, it is obvious that the replacement of petroleum-based plastics with useful new bioplastics from inexpensive, renewable agricultural materials, like soybean and corn oils, will have tremendous economic, environmental and energy-impacts. For this reason, this research is supported by grants from the Iowa Soybean Promotion Board, Des Moines, IA; Iowa Energy Center, Ames, IA; Consortium of Plant Biotechnology Research; the Center for Advanced Technology Development, ISU, Ames, IA; and the Center for Crops Utilization Research, ISU, Ames, IA.

For more information, consult the Center for Crops Utilization Research web page at www.ag.iastate.edu/centers/ccur
Innovative Chemistry for New Value-added Products from Corn and Soy

Dr. John Verkade, Chemistry, his graduate students and cooperating colleagues are developing several new technologies that promise to enhance corn oil and biomass utilization. One technology aims to polymerize lactide from corn into specialty plastics. The second is a light-driven process for modifying fatty acids found in corn and soy oils to produce a drying oil that can be used in inks and alkyd resins. The third technology is a soy oil to soy methylester conversion process using a new catalyst system. Another new chemical-conversion process could result in the economical pre-treatment of wood biomass prior to bio-reactor conversion into industrial raw materials.

The polymerization of lactide from corn into specialty plastics is seen as a means to produce many specialty plastics and industrial chemicals from corn, instead of non-renewable petroleum feedstocks. Dr. Verkade’s research team developed an economical new catalysis technique to achieve this goal. The new technology may foster the adoption of a new family of polylactide plastics for use in a variety of diverse applications from medical implants to specialty packaging plastics.

Another process under investigation is a method to conjugate soy and corn oils so that they can be used as drying oils in inks and hard surface coatings. The process takes place very quickly at temperatures somewhat above room temperature in a cheap industrial solvent and in the presence of an inexpensive non-metallic catalyst. The catalyst is then easily removed by using charcoal filtration with the solvent being distilled and recycled. A preliminary cost analysis indicates that this industrial process will be economical and efficient. Dr. Rich Larock, Chemistry, and Dr. Valerie Sheares, Chemistry, are testing these new monomers for use in highly elastic and other plastics.

Other recent research discovered an invaluable process for use in bioreactors, the new digestive chemical engineering technology that enables crop wastes and other cellulosic materials to be broken down and turned into valuable industrial raw materials. This new process uses water and several commercially available organic compounds to completely dissolve plant materials such as raw uncrushed corn stalks and wood under mild conditions. Preliminary evidence indicates that the chemistry accompanying this process is unprecedented for biomass pretreatment. This chemistry is especially important with respect to the potential development of an economical process for corn fiber pretreatment for the purpose of obtaining sugars that can then be converted to ethanol.

An ongoing area of investigation is the conversion of soy oil to methyl soyate (soy methylster) using a new catalysis system. This could result in more cost-effective bio-diesel fuel and lubricant production. Also, this process produces a glycerol co-product that could have immediate application in aviation de-icing products.

For more information, contact Dr. John Verkade, Department of Chemistry, Iowa State University (ISU); or the Center for Crops Utilization Research (CCUR), ISU (515) 294-0160; the CCUR web page at www.ag.iastate.edu/centers/ccur
**National Survey of Soybean Quality**

Of the nearly 3 billion bushels of soybeans produced in the United States each year, more than a third is exported. More than 70 percent of the buyers of exported soybeans request information on protein and oil content.

Iowa State University is collecting and analyzing soybean samples from around the country for the 16th annual U.S. Soybean Quality Survey. More than 4,200 American Soybean Association (ASA) producer members were randomly selected to participate in the national survey. They are asked to send one-pound samples of their crop in pre-paid mailers to Iowa State's Grain Quality Laboratory.

Scientists analyze the samples using near-infrared spectroscopy (NIR), a technology that allows the analysis of thousands of samples in a short time. Samples are analyzed for protein and oil content. Participating producers will receive results of tests run on their samples.

"The survey has been successful mainly because of the participation and cooperation of ASA producer members," said Tom Brumm, ISU coordinator of the survey. "They send in samples of their crop from all over the country so we can analyze them and summarize results for our customers."

"The quality survey provides information that is crucial to strengthening our marketing efforts overseas," said Criss Davis, a soybean producer from Shullsburg, WI, and chair of the United Soybean Board's Trade Analysis Committee. "Our customers depend on this information. Because of this survey, we've been able to meet customers' needs and prevent problems."

Survey data are used by ASA's annual Quality Trade Mission to the Far East, where ASA professionals and industry experts interact with foreign buyers, answering their questions about the quality of the recently harvested crop and trends in the U.S. soybean industry. This year's mission leaves on Nov. 30 for Korea, Japan, China and Taiwan - all important purchasers of U.S. soybeans.

The survey is sponsored by the ASA, funded by the United Soybean Board and conducted by the Grain Quality Laboratory and the Department of Agricultural and Biosystems Engineering at Iowa State.

Special thanks to Brian Meyer, Agriculture Communications, (515) 294-0706 for this contribution that first appeared in ISU College of Agriculture's Inside Update 19 September 2002.

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**CCUR Staff Depleted by State of Iowa Budget Cuts**

The 2001 and 2002 State of Iowa fiscal shortfalls have affected all state departments and institutions. Iowa State University has been especially hard hit. Due to the fact that the CCUR is a support and research entity, and does not have a primary teaching function, this has resulted in the change-of-status or elimination of several key staff positions.

The total impact has been a reduction of 3 of 7 positions, or a 43% reduction in staff. CCUR's Sensory Test Kitchen Manager position was reverted after the staff person left to take an off-campus job. The Pilot-plant Equipment Specialist position was eliminated and that individual has taken an off-campus job. The Communications Specialist position is now split between CCUR and another research group, and a full-time secretary has been replaced by a graduate student.

These reductions in staff have left the center without staff to undertake a variety of service and operational duties. Community outreach activities, on-campus tours and workshops also will be significantly limited or curtailed. Although some of the center's services are now restructured or impaired, CCUR remains committed to assisting ISU faculty and off-campus clients with their research and product-development needs.

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**Turkish Oilseed Conference**


For more information, visit the U.S. Soybean Quality Survey website: http://www.abe.iastate.edu/soysurvey, or contact: Tom Brumm, Agricultural and Biosystems Engineering, (515) 294-5145
Biorenewables Consortium

CCUR is pleased to be an active participant in Iowa State University’s Biorenewable Resources Consortium (BRC) coordinated by Ames Laboratory. The BRC is dedicated to the development and utilization of agriculturally derived alternatives to petrochemicals and other nonrenewable fossil resources. It is hoped that the BRC will help redress the problem of our national dependence on nonrenewable resources as a primary source for energy.

The BRC is funded in part through a $2M appropriation through the Energy and Water Appropriations bill for fiscal year 2002 and will come through the Office of Industrial Technologies in the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy Network. This program is a prime example of a project that fits the Memorandum of Understanding between the U.S. Department of Energy and the U.S. Department of Agriculture. Federal funds have been acquired to implement the memorandum. The Office of Industrial Technology, in the U.S. D.O.E.’s Energy Efficiency and Renewable Energy Network administers the BRC’s funds. However, funds remain limited. Sufficient resources must be secured to sustain the vital research projects of today and to build for the future.

The BRC is dedicated to developing connections with industry, commodity groups, cooperatives and groups engaged in rural revitalization. In addition to the ISU partners that include the U.S. Department of Energy Ames Laboratory, the Iowa Agriculture and Home Economics Experiment Station, and ISU’s Plant Sciences Institute, the BRC has recently developed connections with the National Corn Growers Association, the Iowa Corn Growers Association and the Iowa Industries of the Future program.

The program builds on the fact that the ISU’s research community is a recognized leader in agriculture, the physical sciences, and engineering; and has an impressive faculty of world-renowned scientists and young researchers. This combination of basic science, applied development and outreach resources is unique among American universities. It provides an unprecedented opportunity to access and develop biorenewable alternatives in an integrated and systematic way.

The interdisciplinary initiative will develop and follow a state technology development roadmap intended to reduce our national dependency on foreign oil; improve the quality of the environment; result in the development of new products, new industrial processes, and new companies, which will, in turn, revitalize rural economies.

This national investment in biorenewables promises a huge payoff to the U.S. taxpayer. It will improve the international competitiveness of the U.S., form new industries, increase farmers’ profitability, enhance the sustainability, viability, and economic development in rural communities, reduce net carbon dioxide emission and thus improve our environment.

The BRC will also expand its working relationship with the newly formed Midwest Bio-based Materials and Energy Consortium. This is a regional consortium with goals similar to the BRC, but with a Midwestern regional mandate. It includes DOE’s Argonne National Laboratory, the USDA’s Peoria Laboratory, the University of Illinois, Michigan State University and Purdue University, in addition to Ames Laboratory and ISU.

For more information, contact Dr. George Kraus, Department of Chemistry, Iowa State University (ISU); (515) 294-7794; or visit the BRC web page at www.ameslab.gov/BRChomefinal.html

ISU Extension: Iowa Industries of the Future

In the coming Bioeconomy, the basic building blocks for producing industrial and consumer goods, chemicals, fuels and bioenergy will come from crops, plants and animal waste. ISU Extension is supporting the development of the coming bioeconomy by conducting a project called Iowa Industries of the Future (IIOF) for the state’s agricultural industry. Funding for this project comes from the U.S. Department of Energy and the Iowa Energy Center. IIOF agricultural project staff facilitated eight regional workshops in Iowa from March through July 2002. More than 250 Iowa farmers, industry leaders, economic development professionals, environmental advocates and public officials participated in the process to develop a vision statement, planning roadmap, and identification of directional targets intended to grow Iowa’s bioeconomy.

The vision and roadmap were presented at a Bioeconomy symposium at Iowa State Sept. 4. More than 350 people from 15 states attended. Speakers included Denise Swink from the United States Department of Energy, leaders in biobased research and emerging industries, and Iowa Gov. Tom Vilsack. In the coming months, IIOF will share the vision and roadmap more widely around the state, focusing on the analysis and identification of several business opportunities for Iowa investors and communities to target for development. CCUR and the ISU Biocomposites Research Group participated as display-session presenters.

For more information, visit the IIOF Web site, http://www.ciras.iastate.edu/iof/. Thanks to ISU College of Agriculture Communications and ISU Online for this contribution
Protein Isolation and Purification

The research group of Dr. Patricia Murphy (FSHN) is working on several problems associated with protein purification and isolation. Much of this work involves a collaboration between CCUR and the Center for Designing Foods to Improve Nutrition (CDFIN).

Purified soy proteins are of particular importance in many food and industrial products. Specialty proteins that have been modified through traditional chemical engineering or biotechnology are industrial materials that can have applications in many high-value products.

One project is attempting to optimize what is known as the Wu method for the water extraction of soy flakes. The new procedure relies on an additional protocol to further separate a relatively pure glycinin fraction via manipulation of the pH of the extractable solution. The researchers believe that this procedure may be valuable for the recovery of other protein fractions, as well as novel modified proteins.

A related project is looking into the use of ethanol for phytochemical separation and recovery. Phytochemicals are the extensive array of chemicals: hydroquinones, alkaloids, proteins, etc., produced within plants. Presently, many potentially valuable phytochemicals are discarded in waste streams when grain is processed by conventional wet milling. Techniques for recovering these phytochemicals or phytochemical constituents would be a boon for grain processors, allowing them to enter into renewable bio-based chemical production, as well as diversify their product output and enter new markets.

Another investigation is focusing on saponins. These are ethanol-soluble, soap-like compounds found in soy that may have cholesterol-lowering properties. An important question in nutritional research is whether or not the cholesterol-lowering properties of soy are the result of the isoflavone, the saponin, or an interaction of both compounds. One member of the research team is examining saponin metabolism in human subjects to attempt to track how saponins are metabolized and what effect their different fractions have on fat metabolism or how they interact with other soy compounds.

Another metabolism-related project is examining isoflavone. This project is attempting to reveal the attributes of how gut microbes breakdown isoflavone within the body and how those products interact and affect human metabolism.

Collaborative research within CCUR is taking the form of providing expertise and enzymes for several projects. One research project with Lawrence Johnson’s research group is investigating the resolubilization of expeller-extruder-produced soy proteins. Research with that group is providing protease enzymes and testing to examine more cost-effective resolubilization of soy protein by using this commonly available industrial enzyme. Work with Deland Myers’ wood adhesive project is providing protease enzymes for use in novel adhesive blends.
Production and Processing Experience for Food Science Students

Deland Myers, Food Science and Human Nutrition (FSHN), and Ken Prusa, FSHN, are the professors who direct FSHN 412, Product Development. This course regularly uses the CCUR Crop Products Pilot Plant for assembling and packaging of “products” developed in FSHN 412 as course projects.

This spring, the class of 23 students broke into three teams and used the pilot plants to develop "RaspSpray" a raspberry-vinagrette dressing in a spray-applicator bottle, a dry-mix pizza-crust formulation, and a pear-crisp dessert. Many of the ingredients used by the students in their products are donated by industry sponsors.

FSHN 412 is a “capstone” course in the FSHN curriculum. The course is for seniors and utilizes previous experience and knowledge gained from prior major and non-major course work. The instruction includes guest lecturers and practical exercises, and requires the student teams to get project approval and their final evaluation from a “Board of Directors.” This group is comprised of ISU faculty from a number of departments and off-campus industry representatives. In the past, the off-campus members have included individuals from Swift and Company (ConAgra), Cisco Systems, Pioneer/Dupont, and private consultants to the food industry.

On the Internet:

Center for Crops Utilization Research  www.ag.iastate.edu/centers/ccur
Crop Products Pilot Plant  www.ag.iastate.edu/centers/ccur/cropprodpiilotplant.html
Iowa Grain Quality Initiative  www.iowagrain.org
Plant Sciences Institute  www.plantsciences.iastate.edu
Biocomposites Research Group  www.public.iastate.edu/%7Ebiocom
ISU College of Agriculture  www.ag.iastate.edu
Agricultural Marketing Resource Center  www.agmrc.org
NASA Food Technology Commercial Space Center  www.ag.iastate.edu/centers/ftsc

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