Biopolymers and biocomposites workshop a success

Ed Adcock, Agriculture and Life Sciences Communication

Getting researchers of biopolymers and biocomposites and those who design products using them into the same room was an educational experience for those participating in the Midwest Biopolymers and Biocomposites Workshop May 11 at Iowa State University.

“The great amount of interaction between industrial participants and academia made the workshop a great success. We had meetings that ran into the evening after the workshop and have had many follow-up inquiries,” said David Grewell, Iowa State professor of agricultural and biosystems engineering and workshop coordinator.

The 94 participants were nearly equally divided between those from industry and academia. Speakers from commercial groups alternated with those from the research laboratory.

Anil Netravali of Cornell University started things off with an overview of the status and future of green composites. He said research in his lab has produced biocomposites that are stronger than existing materials, for example soy composites that can replace two by four lumber used in structures with one by one composite boards.

Craig Shore, founder of Creative Composites Ltd., spoke of his company’s acoustic door that incorporates such natural products as kenaf, hemp and flax. Applying the latest research to find possible new products motivated him to participate in the workshop.

“One of the exciting things with the workshop is to see what research is going on and what potential next steps there could be,” he said. “We’re always looking for products that we could move into more biobased. If we know where the research is going now, that might help us identify more opportunities.”

Products made from composites are expanding

Keynote speaker Anil Netravali discusses the future of green composites.

Iowa State receives $200,000 grant to develop biomass crops in southern Iowa

Tyler Teske, Agronomy Communications

Iowa State University has been awarded a $200,000 grant to develop perennial cash crops for southern Iowa.

“The grant was awarded by the Sun Grant Initiative to fund biomass crop production research. The grant forms a partnership with the U.S. Department of Agriculture Natural Resources Conservation Service and Agricultural Research Service. The funds will be used for research at Iowa State, Southwestern Community College and on-farm research.

“Perennial warm-season grasses may be a much more appropriate crop for farmers in the southern part of the state,” said Emily Heaton, an Iowa State University agronomy professor and BioCentury Research Farm affiliate. “Because the soils are more erodible and less productive for corn, perennials have the potential to be an economical alternative.”

Iowa State research will focus on crop selection
College of Agriculture and Life Sciences presents awards to faculty

The College of Agriculture and Life Sciences at Iowa State University presented annual awards to faculty and staff at its spring semester convocation. Center for Crops Utilization Research affiliates receiving awards include:

- Thomas Brumm, associate professor in agricultural biosystems and engineering, received the Learning Community Coordinator Award. Brumm has been an innovative leader in making the Technology Learning Community a success and helping students develop peer networks and enhance their learning experience.
- David Grewell, assistant professor in agricultural and biosystems engineering, received the Early Achievement in Research Award. His techniques to improve biofuel and bioplastics production are being explored by Iowa-based companies.
- Jacek Koziel, associate professor in agricultural and biosystems engineering, received the Mid-Career Achievement in Research Award. Koziel has established himself as a leading international expert in the chemical analysis of agricultural odors. He also is researching innovative techniques using ultraviolet light to break down odors, which could have tremendous impacts on swine production.

Ginder retires from Iowa State University

Iowa State University professor, extension economist, and Center for Crops Utilization Research affiliate Roger Ginder retired in January after 31 years of service. Ginder led the Iowa Alliance for Cooperative Business Development, a USDA Rural Development cooperative center at Iowa State, since its inception in 2003.

Ginder worked closely with the Iowa Institute for Cooperatives, Nebraska Cooperative Council, University of Nebraska, and CoBank to develop and deliver strategic and financial planning and management programs. Ginder also developed and conducted workshops for boards of directors of local and regional grain elevator and farm supply, rural telephone, credit union, and insurance cooperatives.

Widely regarded as one of the leading experts in cooperative financial and strategic management, Ginder worked with Congress and state and national cooperative organizations when the farm debt crisis, hedge-to-arrive contracts, and StarLink corn threatened grain elevator and farm supply cooperatives.

Ginder served as outside advisory member for the Land O’Lakes cooperative board of directors from 1996 to 2002. He currently serves as outside director on the board of West Central Cooperative.

500-liter fermenter installed at BioCentury Research Farm

A new 500-liter fermenter was purchased from Applikon and installed at the BioCentury Research Farm in April. The purchase was made possible by a special Congressional grant through the U.S. Department of Agriculture. The top-drive unit will handle a wide range of material viscosities and suspended particles.
New research shows hail damage linked to increased corn ear rots and mycotoxins

New research on hail-damaged corn shows that hail damage during grain fill increases the risk of ear rot diseases and mycotoxin contamination. This may impact the use of hail-damaged corn for livestock feed.

“Hail damages crops somewhere in Iowa every year. But until recently, there was little data to quantify effects of hail damage on grain quality,” said Iowa State University plant pathologist Alison Robertson.

Robertson studied the issue with Center for Crops Utilization Research affiliates Charles Hurburgh, professor-in-charge of the Iowa Grain Quality Initiative and professor of agricultural and biosystems engineering, and Gary Munkvold, Seed Science Endowed Chair and plant pathologist, as well as Steve Ensley, clinician with the Veterinary Diagnostic Laboratory.

The team found that as hail damage to kernels increased, so did severity of ear rots – and with the ear rots, the presence of certain mycotoxins. Fusarium, Gibberella and Cladosporium were the main molds found in the study. Fusarium ear rot can contaminate grain with toxins called fumonisins. The toxins deoxynivalenol (commonly known as vomitoxin) and zearalenone are produced by the fungus that causes Gibberella ear rot.

“Swine are very sensitive to vomitoxin,” Robertson said. “And zearalenone is an estrogen-type mycotoxin that can affect breeding pigs.” Vomitoxin causes visible signs of sickness such as poor weight gain.

“Cladosporium does not produce toxin but does create black mottling on kernels,” Hurburgh said. “This classifies as ‘total damage’ in the official U.S. grades, creating marketing issues.”

The mycotoxins may enter livestock feed through feeding corn or distillers dry grains with solubles (DDGS), a by-product of the ethanol industry.

“When damaged grain is used to make ethanol, any mycotoxins present concentrate up to three times in the resulting DDGS,” Robertson said.

Pre-harvest scouting of fields is an effective way to cut risks of mycotoxin contamination. “Our research showed there was a positive correlation between visually damaged samples and detectable levels of toxins,” she said. “So, it’s very important for producers to scout their fields to see how much ear rot they have.

“Our management recommendation is to harvest this damaged grain as early as possible, and dry and cool the grain immediately to reduce growth of molds and minimize further development of these mycotoxins.”

Hendrich named University Professor

Suzanne Hendrich has been named University Professor of food science and human nutrition. She has introduced new concepts about teaching and learning to Iowa State University. Hendrich led development of outcomes assessment, co-created the first residential learning community and played a key role in starting the Academy for Leadership and Learning. She also created and led new interdisciplinary and multi-institutional graduate programs while building a strong research program of her own. Hendrich participated in national programs to define nutrient requirements that impact all U.S. citizens and served in key roles in professional organizations. A strong advocate for diversity, Hendrich has taught and mentored multicultural students at all levels and in all colleges. Hendrich is also Lura M. Lovell Fellow in the department of food science and human nutrition.
Johnson honored for research in cereals and oilseeds

An Iowa State University scientist has been honored for outstanding achievements in cereals and oilseed research.

Larry Johnson, a professor of food science and human nutrition, received the 2010 Andersons Cereals and Oilseeds Award of Excellence at the annual meeting of the NC-213 Multistate Research Program in Marketing and Delivery of Quality Grains and Bioprocess Coproducts in Kansas City.

The award recognizes individuals or teams that have made superior contributions to science or education related to cereals and oilseeds. The NC-213 program involves engineers, scientists and economists from leading land-grant universities and government research centers. It conducts research to create and disseminate technical knowledge needed to manage quality, food safety and biosecurity efficiently in world grain markets.

Johnson was selected for his significant contributions in research, outreach and technology transfer, as well as leadership and professional service related to cereals and oilseeds. He is internationally recognized for research and technology development of new value-added products from corn and soybeans. For more than 20 years, he has led Iowa State’s Center for Crops Utilization Research, which develops or improves commercial and industrial uses for corn and soybeans. He also is director of Iowa State’s BioCentury Research Farm, the first fully integrated biomass production farm and processing facility located west of Ames.

The Andersons Cereals and Oilseeds Award of Excellence is funded by The Andersons, Inc.

BioCentury Research Farm update

A new concrete pad and covered structure has been erected at the BioCentury Research Farm (BCRF) to house the biomass grinding equipment donated by Vermeer Corporation. A complete integrated biomass grinding and drying line is being assembled.

Portable offices donated by the University of Northern Iowa National Ag-Based Lubricants Center will be installed this summer in the Harvest, Transportation, and Storage Facility. The offices will provide a professional workspace for scientists and students working on large-scale experiments.

Many equipment and facility installations and customizations are in progress. A few examples are the electrical power installation in the Biomass Preparation and Equipment Buildings, the Thermochemical Train control room installation, the

Biomass grinding facility

Thermochemical Train control room
Kessler’s CAREER award combines quests for self-healing, biorenewable polymers

Eric Dieterle, Iowa State University College of Engineering

The successful pursuit of polymer research along two separate lines brought Michael Kessler, associate professor in materials science and engineering and CCUR affiliate, to a simple yet unexpected confluence of ideas that raised a straightforward question: Why not combine them?

His proposal to do so has earned the materials science and engineering researcher a $400,000 National Science Foundation (NSF) CAREER award for a project titled “Multifunctional Biorenewable Polymers.” Funding for the work will begin in July.

In the area of biorenewable polymers, Kessler and chemistry department collaborator Distinguished Professor Richard Larock made substantial progress in demonstrating how polymers derived from vegetable oils were “excellent alternatives to petroleum-based resins for both environmental and economic reasons,” as Kessler wrote in his NSF proposal. In separate research on self-healing materials, Kessler had shown that polymers possessed “great potential” for solving problems of microcracking and hidden damage—key considerations for the lightweight composites used in aerospace structures.

“The proposal is to take these two separate ideas and merge them into a single material,” Kessler said, “and investigate if this self-healing functionality that we’ve demonstrated in synthetic materials can be applied to renewable materials.”

Kessler said the idea arose from an offhand comment made by a visiting seminar speaker, with whom Kessler had been discussing his two lines of research. During a subsequent brainstorming session with graduate students about potential proposal topics, Kessler simply noted the idea on a white board. It quickly rose to the top.

“I thought it was important to have some preliminary data to put into the proposal,” Kessler said, “and we had lots of preliminary data, references we had done, and papers we had written.”

Still, the idea of developing self-healing biorenewable polymers is yet to be demonstrated. The uniqueness is an opportunity and a challenge.

“There’s a handful of people doing work in self-healing polymers and a good number of people doing work in biorenewable polymers, but not together,” Kessler said. “I thought it was fairly straightforward to see how the two could merge, but I didn’t go into the lab and try to do it.”

Not yet. But when he does, the biggest leap will be to chemically bridge the gap between self-healing and vegetable oil-based polymers while introducing a new twist: using biorenewable healing agents; i.e., oils that can be encapsulated.

“All the work that we’ve done has been in an epoxy matrix,” Kessler said, noting that epoxy composites are commonly used in airplanes and...
beyond building applications, according to presenters at the workshop.

Grewell presented the results of work with plastics made from blends of zein, a corn protein, and soybean protein. His team developed products such as wrapping for large bales of hay, lubrication sticks for use on train locomotives and pots for transplanting plants that would biodegrade in the soil and provide nutrients for the growing plant.

Ken Laverdure, a research engineer with PepsiCo, described the challenges of developing a compostable bag for its Frito-Lay unit’s SunChips product. Iowa State’s Biopolymers and Biocomposites Research Team helped develop and test the bags, which were introduced earlier this year.

The bags were made from plant-based polylactic acid produced by NatureWorks, another presenter at the workshop.

When marketing biobased products, manufacturers should be careful not to oversell the environmental benefits of the products, according to Ramani Narayan, professor of chemical engineering and materials science at Michigan State University. He advised using biodegradability information based in science and generally accepted standards to counter misleading or deceptive claims.

A variety of biobased plastics, rubbers, composites and coatings are being studied by Richard Larock, distinguished professor of chemistry at Iowa State. He said that bioplastics from natural oils have been improved by adding fillers, some from agricultural commodities, that reinforce the mechanical properties and increase thermal stability.

The many potential products and uses helped build the industry presence at the workshop, according to Grewell.

“The level of interest in bioplastics by industries reflects the fact that these materials are no longer a dream but are now reality,” he added.

The workshop was sponsored by the Center for Crops Utilization Research, Bioeconomy Institute, Center for Industrial Research and Service, Iowa Department of Economic Development, and Institute for Physical Research and Technology.
and improvement. Faculty and students at Southwestern Community College will identify methods to grow and use biomass crops as an energy source.

Heaton says farmers in northern Missouri and southern Iowa are already producing biomass from grasses for a Missouri cooperative. The harvested biomass is processed into clean-burning pellets that are mixed with coal for electric companies. Biomass production is a response to Missouri’s carbon mandates, which limit emissions from coal-fired power plants.

Mark DePoy, Natural Resource and Conservation Service regional coordinator for the Southern Iowa Research Conservation and Development district, thinks the cooperative model would be a good fit for southern Iowa.

“This could be a business that is profitable in southern Iowa,” said DePoy. “This part of the state is similar in natural resources and soils to northern Missouri. Acreage dedicated to grass crops would produce cleaner water, improve soil quality and provide ample habitat for wildlife while creating good paying jobs.”

The federal government also offers incentives through the Biomass Crop Assistance Program. The program matches each dollar up to $45 a ton that farmers spend to deliver biomass crops.

“The goal of our grant project is to create viable systems that protect the land and create a profitable crop for farmers,” said Heaton. “If we aren’t helping the farmers make money and protect the soil, we aren’t doing our job.”

Biomass Crops
From page 1

CCUR affiliates receive awards and recognitions

Juliana Maria Leite Nobrega de Moura, and Lawrence A. Johnson received the ADM Protein and Co-Products Division Award in the engineering/technology category for the Journal of the American Oil Chemists’ Society article Two-Stage Countercurrent Enzyme-Assisted Aqueous Extraction Processing of Oil and Protein from Soybeans (JAOCS vol. 86(3):283–289). The award recognizes outstanding papers published each year in AOCS Press publications on the topics of engineering/technology and chemistry/nutrition of protein and co-products.

Hongxin Jiang has been selected a finalist in the American Association of Cereal Chemists, International, Best Student Research Paper Competition for his presentation Starch-granule development in highamylose maize. Jiang will compete again on October 26 at the annual meeting in Savannah, Georgia. Jiang is a student with CCUR affiliate Jay-lin Jane.

Debjani Mitra has been selected to receive a 2010 Graduate and Professional Student Senate Research Award.

Debjani Mitra has been awarded the Dean Klecker Global Agriculture Graduate Scholarship.

Lawrence A. Johnson received the Alton E. Bailey Award at the American Oil Chemists’ Society in May. Johnson gave the award address, The Bioeconomy–A Revolution in American Agriculture, at the USA Section Luncheon. The Alton E. Bailey Award recognizes outstanding research and exceptional service in the field of lipids and associated products. The award commemorates Alton E. Bailey’s great contributions to the field of fats and oils as a researcher, an author of several standard books in the field, and a leader in the work of the Society. Archer Daniels Midland Company and Kraft North America co-sponsor the award.
biomass drying system installation, and construction of the slurry storage tank. The concrete receiving drives for the Biomass Processing Facility were completed.

In the Thermochemical Train, the pyrolysis unit was installed and is being tested prior to its use. One of the future users of the pyrolysis unit will be Avello Bioenergy, the first company to move into the BCRF business incubator space.

Corn, soybeans, and fast growing trees were planted in the Plant Zoo. The Plant Zoo is an area dedicated to growing small plots of bioenergy crops. Other crops including miscanthus and sorghum will be planted this summer and fall.

Contracts and Grants

Expanding the Near-Infrared Spectroscopic Capacity of the Official Inspection System, USDA-Grain Inspection-Packers and Stockyards Administration, $32,588, C. Hurburgh.

Iowa Grain Quality Initiative FY10, Center for Crops Utilization Research, Extension 21 Grants, $153,430, C. Hurburgh.

Select Yield and Quality, United Soybean Board, $35,000, C. Hurburgh.

Uniformity in Near-Infrared Measurements of Soybean Quality Traits. (VII), United Soybean Board, $64,555, C. Hurburgh.

2010 Midwest Biopolymers and Biocomposites Workshop, Iowa Department of Economic Development, $5,000, D. Jarboe and D. Grewell.

Student Travel Funds to Attend the Corn Utilization and Technology Conference, Iowa Corn Promotion Board, $5,000, D. Jarboe and L. Johnson.

Fiberglass Reinforced Polymers from Agricultural Oils, The Consortium for Plant Biotechnology Research, $205,000, M. Kessler and R. Larock.

CAREER: Multifunctional Biorenewable Polymers, National Science Foundation, $400,000, M. Kessler.

Growth Performance and Kinetics of Probiotic Microorganisms in Enzyme-modified Corn Distillers Dried Grains, Lallemand Animal Nutrition, $10,000, B. Lamsal.

The BCRF hosted many tours this spring including Coe College faculty and students, Deere & Company, Winterset High School students, and Virent Energy Systems, Inc.


Food Science and Industry Network, Iowa Department of Economic Development, $5,000, R. MacDonald.

Publish Motion of Matter: Of Disturbed Fundamentals, the Embrace of Strangeness and Indeterminate Dimensions, ISU Publication Subvention Grant, $14,500, M. Muecke and A. Petrov.


Pathogen Inactivation in Fresh Produce by Incorporation of Sanitizer into Existing Operations within the Produce Chain, The Ohio State University, $201,000, L. Wilson, B. Brehm-Stecher, and A. Mendonca.

Patent filed

Thomas Bobik and David S. Gogerty; Biochemistry, Biophysics and Molecular Biology; have engineered an enzyme for efficient biobased production of isobutene, which is used in the manufacture of fuel additives, adhesives, plastics and synthetic rubber.
sporting goods. So far, the self-healing functionality has been added to that base material. That approach needs to be resolved with the vegetable oil-based polymers developed by Kessler and Larock on a chemistry called ROMP (ring-opening metathesis polymerization). The science behind bringing those two together involves using residual reactive sites in the matrix to react with the healing agent, and then to apply cationic polymerizations to the healing agent to induce compatibility with the ROMP system.

“We’re looking at some fundamental questions that have broader applications to the field of self-healing materials and biorenewable materials,” Kessler said. “Can we use the residual reactivity in the matrix to improve adhesion? By answering that kind of question, hopefully we can make a contribution to understanding in that realm.”

For the project as a whole, Kessler is guarded about long-term implications, preferring caution to excessive optimism. But he acknowledges the potential.

“The system that we are proposing is a low-cost alternative to some of the high-cost self-healing that’s been developed over the last several years,” he said. Most of the cost reduction would come from relying much less on a widely used but extremely expensive ruthenium catalyst.

“The applications for self-healing using that system are really limited to high-cost systems where you have to be able to repair in situ, such as aerospace applications,” Kessler said. Whereas the biorenewable materials with a cationic healing agent, by using much less of the ruthenium catalyst, make the process economical. “I think there’s a real opportunity to extend self-healing technology to real-life applications where cost is a factor,” Kessler said. “I wouldn’t see the biorenewable materials being heavily used in aerospace composites, but composites are being used in a lot of other applications that are lower cost.”

Those other applications may have some real benefits in the realm of sustainability, something that motivates Kessler to pursue the research. As he points out, most technologies are limited by the materials they use.

“From a societal point of view, sustainable systems are key as the population grows,” he said. “We’ve got to find other alternatives to petroleum, not just for fuel but for materials, too. Most of the materials we use now that are plastics are derived from petroleum, so using biorenewable feedstock to make materials is a key driver in our quest for sustainability.”

“On the other side is multifunctional materials, with one of those functions being autonomic or self-healing. When you add multiple functions to a single material, you have big weight savings and materials that can push the envelope even more. In the automotive industry, lighter and stronger materials will go a long way toward improving fuel efficiency. Pursuing these kinds of questions about materials is really important to improving lives.”