SEVIM ERHAN (D1120-1)

Soy-Based Hydrogel

Ready for Biomedical Exploration

Soy-based hydrogel mixed with water (left) and in powder form (right). The polymer has great potential as a drug-delivery agent.

Agricultural Research Service (ARS) scientists in Peoria, Illinois, have done it again.

They've added yet another invention to an already long list of oleochemical accomplishments that includes petroleum-free newspaper ink, industrial lubricants, hydraulic fluids, and aircraft deicers.

Their latest addition is a "hydrogel." Made from soybean oil, it's a squishy but durable polymer that expands and contracts in response to changes in temperature or acidity levels. These characteristics make it "suitable for use in the hair-care and drug-delivery areas," says ARS chemist Sevim Z. Erhan. Another potential use is in wound dressings.

Erhan and ARS chemist Zengshe Liu developed the hydrogel in studies at ARS's National Center for Agricultural Utilization Research in Peoria. Their invention dovetails with the center's mission of developing new, value-added uses for corn, soybeans, and other Midwest crops, which will benefit farmers, processors, and consumers. A key focus of the center is to explore options to reduce the myriad uses of petroleum, which include making fuel and polymers like plastic.

"Today's hydrogels are mainly made of synthetic polymers, like polyacrylic acid, polyacrylamide, and so on," notes Erhan, who leads the center's Food and Industrial Oil Research Unit. Soybean oil offers the advantage of being a home-grown polymer resource—one that need not be imported or mined from the Earth. Indeed, in 2006, U.S. farmers planted 76 million acres of soybeans, equal to about 38 percent of the world's total oilseed production.

There are environmental benefits, too. Vegetable-oil-based polymers like the soy hydrogels are biodegradable, notes Erhan. "The only disadvantage," she adds, "is that their water-absorbing capacity is lower than that of petroleum-based hydrogels."

One area where this may not pose a problem is drug delivery. In collaboration with Erhan and Liu, University of Toronto professor Xiao Yu Wu has formulated the new hydrogel into minuscule particles that effectively deliver controlled doses of the breast-cancer drug doxorubicin.

Wu's team encapsulated the doxorubicin in stearic acid, a waxy lipid that, together with the particles, releases the drug at prescribed temperatures and pH values.

In drug-release experiments Wu's team published in the *Journal of Pharmaceutical Research,* nanoparticle-delivered doxorubicin proved eight times more toxic to cancerous cell lines than when it was delivered in a lipid-water solution.

Erhan and Liu first developed the soy-based hydrogels in 1999. Their method uses a two-step process—ring-opening polymerization and hydrolysis—to create a crosslinked polymer backbone with carboxylic groups that gives the hydrogel its unique properties.

Soy proteins are known allergens. But Erhan doesn't anticipate this being an impediment to the hydrogel's potential use as a drug-delivery agent, because soybean oil's chemical structure is completely changed by the two-step manufacturing process.—By **Jan Suszkiw,** ARS.

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