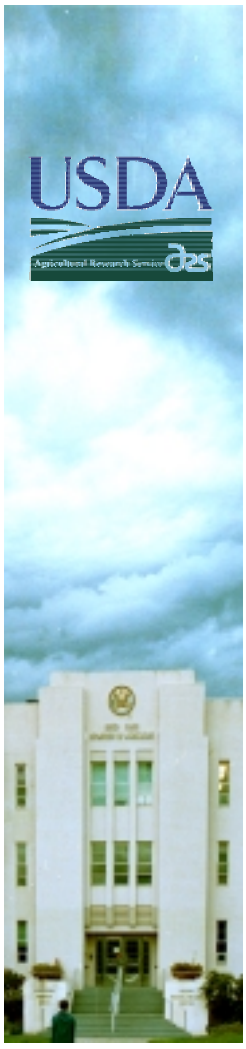


Western Regional Research Center

Spring 2002

Bio-Based Products, Bio-Fuels, and Bio-Refining

FY2002: New Biofuels Research

The FY2002 Federal budget includes $1.6 M in new funds for expanded Biofuels research at the Center. This helps to meet critical research needs not previously addressed by ARS and capitalizes on the genetic, enzyme modification, and separation science capabilities of the Center. The biofuels initiative research includes

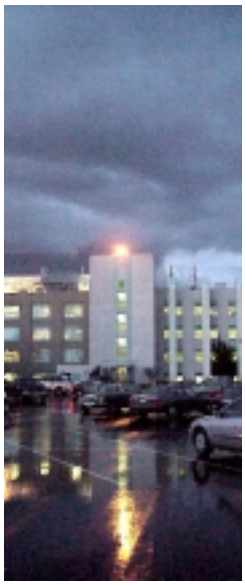
(1) new emphasis on modifying non-grain components of cereals and grasses to enhance the ability of the plant to make and store biofuel substrate and to enhance the ability to process these substrates efficiently;

(2) new efforts to tailor enzymes by directed evolution for hemicellulose hydrolysis as a pretreatment to cellulose hydrolysis;

(3) new efforts to research thermo-physical separation methods to solubilize and fractionate biomass residues to biofuel/bioproduct feedstocks; and

(4) new materials research to identify, efficient barrier/membranes for ethanol/water separations.

Five new research scientists and a research associate are being recruited to assist in these research projects.



Biobased Product - Biofuels Research Now and the Future

Continuing WRRC research with exciting potential for increased emphasis also includes starch and protein polymers composited with crop-derived micro and nano fibers, wheat grain refining technologies, new rubber-producing crops (guayule) for hypoallergenic rubber, and improved toxin-free castor oil varieties for oil-based industrial products.

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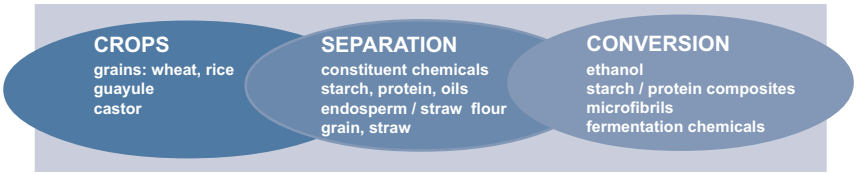
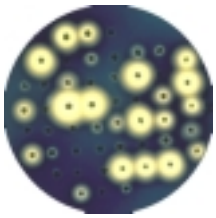
The Biorefining Framework: Separation and Conversion to Product Platforms.
Increasingly WRRC research embodies the biorefining concept. Moreover, WRRC brings a uniquely broad approach that now includes the crop and its modification within the biorefining "umbrella" along with separation and dissasembly, formulation and conversion, and separation and refining of the end products. WRRC biorefining researches



separation and disassembly of the crop to a variety of component platforms; and, through conversion and secondary separation, to a variety of derived-product platforms. For instance, WRRC is researching separation technology for the creation of new starch and protein platforms, the disassembly of polymers in the starch platform to create a sugar platform for fermentation ethanol and chemicals, the conversion of starch and protein into a variety of pure and composite structures, etc. Ultimately the advantages of the biorefining concept include the creation of stable industries producing a variety of products and stable demand for crop resources.

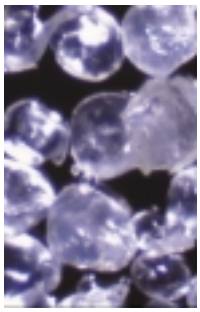
The Agricultural Research Service has research underway that addresses nearly every technical problem in the biofuels arena. These research activities are coordinated through National Program 307, Biofuels and Energy Alternatives and NP306, Quality and Utilization of Agricultural Products. Biofuels and bio-based product research includes efforts at all of ARS regional research centers

Separation: Grain-to-starch and protein platforms by cold ethanol displacement
The separation of wheat into starch and protein platforms is now a costly, technology. This separation precedes all refining options for wheat grain. WRRC has developed the cold-ethanol separation method that improves on both the separation and the subsequent drying technology. The cold ethanol method is capable of producing a gluten (shown at left) that meets or exceeds the properties of freeze-dried gluten, a conventional standard of gluten vitality, by enabling low temperature drying. This lab-scale technology is now being adapted for scaleup. New support would lead to evaluation of gluten subfractionation to new protein platforms. Dr. George Robertson.

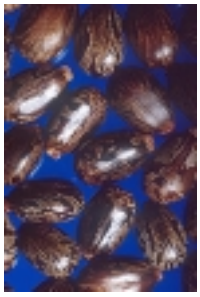


Separation / Disassembly: Starch-to-sugar platform by enzyme evolution/ cold hydrolysis: Processes for the conversion of crops or crop components into useful fuel or chemical products are limited by inefficient conversion processes and high energy use. WRRC is utilizing molecular evolution to create enzymes to overcome these limitations. In one example a process called cold hydrolysis could reduce energy and capital needs for grain to ethanol conversions. Enzymes with enhanced properties for this purpose have already have been produced at WRRC and plans are underway to begin evaluation at larger scale. Shown in the color example is a small fraction of amylase enzyme variants created in the lab. Dr. Dominic Wong and Dr. George Robertson.

Conversion from Starch Platform: Bio-Based Disposable Packaging from Wheat Starch Composites: Disposable “clamshell” fast food containers using potato starch, cellulose fiber, and limestone are currently being test-marketed at large fast food restaurant chains. Research employing wheat starch (at left) to reduce brittleness, processing losses, and cost of materials is underway. Containers from wheat starch are opaque, low-density foams exhibiting excellent thermal insulating properties, high tensile strength and improved flexibility. Dr. William Orts and Dr. Gregory Glenn.

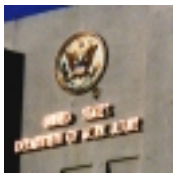


Conversion from Starch Platform: Lightweight Concrete Composites with Wheat Starch Gels: Small, rubbery gels of wheat starch can be made by swelling a starch aggregate in water. Starch-based lightweight concrete is then made by mixing the starch gel with cement. The mixture is poured into place and allowed to harden. During the curing and subsequent drying process, water migrates out of the gels causing them to shrink and form void spaces within the concrete product. These void spaces make the concrete lightweight. Lightweight concrete has many commercial uses such as in floors, walls, roofing tile and other products that need to be durable, lightweight and provide sound and thermal insulation. Dr. Gregory Glenn.



New Crop Resources: Toxin-Free Castor as an Oilseed resource New Crop Resources: Non-toxic source of castor oil. WRRC research is leading to a domestic crop that produces castor oil, a key industrial oil that is all imported because the castor plant is hazardous to grow. The castor seed produces a unique oil with up to 90% ricinoleate (12-hydroxyoleate). The oil is used to produce lubricants, coatings and plastics. Albany researchers have invented the means to transform the castor plant, Ricinus communis, the source of castor oil, providing the means to genetically eliminate the toxin ricin and allergens from castor. This research could lead to the re-introduction of castor as an energy and chemical crop for bio-based products, without the concomitant hazard.
Dr. Thomas McKeon.

New Crop Resources: Domestic *Guayule* for Hypoallergenic Rubber: Natural rubber is a vital raw material, and enormous quantities are used every year in commercial, defense, transportation and medical industries. The United States is wholly dependent imports from the tropics for natural rubber and is faced with shortages and high cost due to declining production and increasing global demand,. Continuity of the supply also is endangered by changing political climes and crop disease. Widespread occurrence of life-threatening "latex allergy" to *H. brasiliensis* rubber products makes development of an alternative, safe source imperative. WRRC is developing alternative rubber-producing domestic crops . The research has led to an exclusive patent license for commercial production of the perennial *guayule*, as a source of high-value, hypoallergenic latex. Expanded research will lead to higher-yielding guayule lines as well as to production of non-gyuayule annual rubber-producing crops. Dr. Katrina Cornish.



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The mission of the Western Regional Research Center is to enhance utilization of agricultural products, through development of pre-harvest and post-harvest technologies.

Located on the Pacific Rim in Albany, California, WRRC is the largest ARS lab west of the Mississippi. It is the first of the USDA/ARS Centers to modernize its base laboratories. These laboratories are the core resource supporting innovative, long-range, federally-appropriate research leading to stakeholder-useful solutions. Current facility upgrades include replacement of windows (see in-progress photo below).

The Center includes a 40,000 ft^2 Research and Development Facility for pilot-scale research up to commercial scale. This facility is currently being renovated to enhance its utility to both staff and cooperators.

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