National Program 306,
Quality and Utilization of Agricultural Products
FY 2016 Annual Report

Introduction

The USDA-ARS National Program for Quality and Utilization of Agricultural Products (NP 306) in 2016 completed the first year of their new 5-year research objectives for the various research Projects. Scientists in NP 306 continue to demonstrate impact in the numerous and diverse areas of research that enhance the marketability of agricultural products, increase the availability of healthful foods, develop value-added food/nonfood products, and enable commercially-preferred technologies for post-harvest processing.

National Program 306: Quality and Utilization of Agricultural Products Biorefining, Vision & Relevance can be found at:
http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=306 and includes: the ***FY2015-FY2020Action Plan*** for NP 306 which went into effect in the summer of 2015.

The overarching goal of NP 306 is to conduct research that develops knowledge and enables commercially-viable technologies to:
(1) Measure and maintain/enhance post-harvest product quality,
(2) Harvest and process agricultural materials, and
(3) Create new value-added products.

By developing commercially viable technologies that maintain/enhance postharvest product quality and create new products, ARS Quality and Utilization of Agricultural Products research increases the demand for agricultural products and, therefore, benefits both agricultural producers and rural communities.

During FY 2016, 161.1 full-time scientists and 13.5 vacancies working at 21 locations across the U.S. actively engaged in 59 ARS-base Projects and 217 ARS-led cooperative research projects in NP306.

Number of graduate students (147), postdoctoral students (43) and visiting scientist (4) hosted in NP306 labs.

The following scientists retired from the ranks of NP 306:

Dr. George Inglett, Peoria, IL; Dr. Kevin Baker, Mesilla Park, NM; Dr. Richard Offeman, Albany, CA; and Dr. Kevin Baker, Mesilla Park, NM

The following scientists were hired into the ranks of NP306:

Dr. Micah Lewis, Athens, GA; Dr. Bryan Penning, Wooster, OH; Dr. Anthony Bucci, Wyndmoor, PA; Dr. Jason Walling, Madison, WI; Dr. Donna Peralta, New Orleans, LA;

Dr. Loren Honaas, Wenatchee, WA; Dr. Majher Sarker, Wyndmoor, PA; Dr. Jose Luis Ramirez, Peoria, IL; Dr. Dan Brabec, Manhattan, KS; Dr. Michelle Rosado, Wyndmoor, PA; Dr. Ryan Marsico, Wyndmoor, PA; Dr. Christina Dorado, Ft. Pierce, FL

The following scientists in NP 306 received prominent awards in 2016:

Dr. Randy Cameron, received a HQ postdoc award.
Dr. Lin Shu Liu, Peggy Tomasula, received an ARS 1890's Faculty research Fellowship visiting scholar.
Dr. Yaguang Lou, Outstanding Volunteer Service Award, Institute of Food Technologist
Dr. Lisa Dean, received a USDA-ARS Innovation grant.
Dr. Floyd Dowell, Applied Energy Award, 2015 for a highly cited paper.
Dr. Craig Morris, awarded the John C. Halverson Memorial Lectureship**,** WA. St. Univ.
Drs. Brian Condon, Judson Edwards, Doug Hinchliffe, received the Federal Labs consortium technology transfer award.
Dr. Agnus Rimando, received the K. A. Spencer Award for outstanding achievement in Food and Ag. Chemistry.
Dr. Wally Yokoyama, awarded Fellow of the American Chemical Society.
Dr. Mendel Friedman, received the Tanner Award for the most cited publication in the Journal of Food Science.
Dr. Roberto Avena-Bustillos, received the 2016 Exemplary Sinaloans of the World Award from Mexico.
Dr. Tara McHugh, received the International Food Technologist Harold Macy Award, and a USDA-ARS Innovation Award.
Dr. Gregory Glenn, received a USDA-ARS Innovation Award.
Dr. Stuart Nelson, (retired) received the IEEE Instrumentation and Measurement 'Career Excellence Award'.
Dr. Atanu Biswas, was recognized by the Brazilian government for scientific achievements.
Dr. James Kenar, awarded Fellow of the American Oil Chemist Society.

The quality and impact of NP 306 research was further evidenced in 2016 by the following:

- **676** refereed journal articles published
- **11** new patent applications, and
- **7** new invention disclosures submitted
- **14** current cooperative research and development agreements with stakeholders
- **23** new material transfer agreements with stakeholders, and
- **16** new scientific technologies developed.

In 2016, NP 306 scientists participated in research collaborations with scientists in 38 different countries: Argentina (2), Australia (3), Austria, Bangladesh , Brazil (8), Canada (3), Central African Rep., Chile, China (18), Denmark, Egypt, Finland, France, Germany (2), Ghana, India (3), Ireland, Israel (3), Italy (3), Japan (5), Kazakhstan, Kenya, Korea (South) (8), Mexico, New Zealand, Nigeria, Pakistan, Philippines (2), Portugal, Russia, Saudi Arabia, Spain (2), Switzerland, Tajikistan, Tanzania, Thailand, Turkey, and United Kingdom (4). Note: the number next to the country indicates different agreements.

NP 306 Accomplishments for FY2016

This section summarizes significant and high impact research results that address specific components of the FY 2012 – 2015 Action Plan for NP 306. Each section summarizes accomplishments of individual research projects in NP 306. Many of the programs summarized for FY 2016 include significant domestic and international collaborations with both industry and academia. These collaborations provide extraordinary opportunities to leverage funding and scientific expertise for USDA - ARS research by rapidly disseminating technology, which enhances the impact of ARS research programs.

This National Program is organized into two component areas:

Foods

Problem areas of research are:
Define and measure quality
New bioactive ingredients and functional foods
New and Improved Food Processing Technologies

Non-Foods

Problem areas of research are:
Develop new post-harvest technologies
Enable technologies for (1) expanding market applications of existing biobased products, and (2) producing new marketable non-food biobased products derived from agricultural products and byproducts, and estimate the potential economic value of the new products.

Component 1: Foods

Beneficial soil microbe isolated. Phosphorous is an important crop nutrient that can become chemically fixed in the soil making it unavailable to plants. ARS scientists in Albany, California, isolated a strain of bacteria found naturally in soil that can release chemically bound phosphorous and make it available for plant growth. Greenhouse studies showed that plants inoculated with the bacteria had much better growth compared to other plants that were grown without the bacteria in soils containing fixed phosphorous. The use of beneficial soil microbes reduced the amount of phosphorous fertilizers needed for crops and reduced the problem of fertilizer runoff from fields into waterways.

Near infrared (NIR) based detection of pits in cherries. High speed sorting of cherries to remove pits that were missed by the pitting machine is a high priority research area for the industry. ARS researchers in Albany, California, have used NIR spectroscopy to identify pits in cherries with accuracy greater than 99%. Furthermore, data reduction to reduce the number of required wavelengths maintained the classification accuracy at greater than 95%. This provides the means to construct optical sorting devices based on reflection of light from a limited set of wavelengths that detects pits at high speed, and reduces the potential for injury to consumers and subsequent litigation.

Safety and healthful properties of potato skins. Potato skins, a byproduct of French fry production, are mainly used as feed. The skins are nutritious and contain 12-17% protein, 16-22% dietary fiber, and are low in fat. However, potato skins have a potential to contain toxic

alkaloids. ARS scientists in Albany, California, found that potato skins also contain significant amounts of the same polyphenols found in grapes, apples, cinnamon, and other foods with healthful properties. Polyphenols are useful in reducing the adverse metabolic effects of weight gain. Mice fed a diet containing potato skins had normal weight gain indicating that they are safe to eat. Potato skins may be a safe and useful dietary ingredient to improve health in overweight individuals.

Quinoa is a new and rapidly expanding grain for consumers and food processors. Knowledge of how salinity and fertilizer affect the grain quality of different quinoa varieties is lacking. ARS scientists in Pullman, Washington, in cooperation with Washington State University researchers, found that salinity had a minor effect on seed protein content compared to fertilizer and variety. Seed hardness varied mostly due to salinity and to variety. Also, the type of salinity had a bearing on seed quality traits. These results indicate that seed quality can be controlled to some extent by variety selection and that fertilizer can increase the nutritional quality of quinoa.

Apple fruit superficial scald risk can be objectively estimated long before symptom development. Apple fruit superficial scald results from chilling stress during the first month after harvest and results in dark, sunken peel tissue after 3-6 months of cold storage. Low oxygen controlled atmosphere (CA) storage can control superficial scald but is not always effective across orchard lots and production seasons. ARS scientists in Wenatchee, Washington, have identified natural compounds that accumulate in the peel of apples that can serve as early predictors of scald prior to symptom development. When elevated scald risk has been detected based on biomarker accumulation, storage room oxygen levels can be reduced or fruit can be marketed prior to symptom development. This research provides new tools for apple producers to avoid superficial scald throughout the supply chain.

'Honeycrisp' apple bitter pit is reduced by 1-MCP and controlled atmosphere (CA) storage. The apple physiological disorder bitter pit is an unsightly cosmetic defect on the fruit surface and results from several factors existing in orchards prior to harvest. Bitter pit symptoms often do not arise until fruit have been harvested and stored for 1 to 2 months. Bitter pit prevention typically relies on application of calcium sprays and crop load management prior to harvest. ARS scientists in Wenatchee, Washington, conducted studies to evaluate postharvest technologies as an additional means to reduce bitter pit development. Apples were exposed to the ripening inhibitor 1-methylcyclopropene (1-MCP) and/or stored in a controlled atmosphere with low oxygen and high carbon dioxide content relative to air. Both 1-MCP and CA reduced bitter pit in some orchard lots with the combination of 1-MCP then CA established rapidly after harvest providing the best bitter pit prevention. This postharvest prevention protocol can be readily adopted by commercial producers as all technology necessary is currently in place in most apple warehouses having controlled atmosphere storage rooms.

Near infrared spectroscopy used to discriminate gluten containing grains. U.S. Food and Drug Administration and Commission of European Communities requires that gluten-free oats or products can only be labeled as non-gluten if it contains less than 20 ppm gluten, the established safe consumption limit for people with celiac disease. The need for testing samples for gluten products is highly sought by industry to assure a gluten-free product can be delivered. In response to this need a near-infrared instrument, developed in-house, was compared with

commercial near-infrared instrument to classify grain types on a single seed basis. Both instruments could distinguish oats and groat kernels from other grains with excellent accuracy, 95% to 100%. The in-house instrument had somewhat better accuracy but the commercial instrument was a magnitude faster and thus provides an excellent method to evaluate commercial samples for gluten containing products.

Potato cultivars with reduced acrylamide content identified. Acrylamide is an unwanted and potentially toxic by-product produced when carbohydrate-rich foods are processed at high temperatures. As part of the $7.8 million Specialty Crops Research Initiative Acrylamide Reduction project and in cooperation with publically funded plant breeders and the potato industry, the postharvest storage and processing qualities of 56 advanced clones grown in Washington, Idaho, North Dakota, Wisconsin, and Maine have been evaluated for process quality, asparagine content and acrylamide levels using the standardized storage, processing, and evaluation procedures developed by the East Grand Forks Potato Research Worksite. Several clones exhibiting excellent processing characteristics and very low acrylamide levels have been identified. These clones will be evaluated in more detailed trials and may be candidates to replace currently used varieties in the commercial production of processed potato products. Eventual adoption of these clones and consequent reduction in the acrylamide content of potato products will benefit both producers and consumers.

A new polysaccharide similar to gum arabic from a North American frost grape species. A new polysaccharide was isolated from the North American frost grape species, Vitis riperia, a wild grape that is typically found in woodland across the United States, and grows up to 50 feet in length. Because it is resistant to the phylloxera pathogenic aphid, the frost grape is used agriculturally as a root stock for grafting of commercial edible grapes. Agricultural Research Service researchers in Peoria, Illinois, have found that the cut stems of frost grape produce large amounts of a viscous, transparent polysaccharide gum, similar in structure to gum arabic, which is a commercial food emulsifying agent. Like gum arabic, the Frost Grape polysaccharide forms viscous solutions and gels, is also an excellent non-oily emulsifier of various food-grade oils. We anticipate that this research will be of interest to the U.S. food and beverage industries as it provides a possible local source of a product similar to gum Arabic.
http://www.pjstar.com/article/20160130/NEWS/160139973.

Biochar to improve golf-greens. The current United States Golf Association (USGA) specifications recommend that golf green root zones consist of a minimum of 90% sand to provide sufficient drainage and reduce compaction. Biochar is the carbon-rich residual product created under anaerobic conditions by the pyrolysis of phytobiomass. ARS researchers in Peoria, Illinois, have determined the addition of biochar to greens can greatly increase water and nutrient retention, especially in sandy soils. An additional advantage of using biochar instead of other organic amendments is its resistance to microbial decomposition and hence longevity in golf greens. In all but one of the biochar treatments, root lengths were significantly greater with the roots of one treatment approximately three times the length of the control. The addition of certain biochars would improve water retention, and increase overall plant growth in golf green root zones.

Paper treated with starch complexes to impart water resistance. Current approaches for manufacturing paper with water resistance generally require chemical treatments and polymer coatings. ARS researchers in Peoria, Illinois, discovered that treatment of paper with corn starch complexed with a vegetable oil derivative renders the paper hydrophobic as measured by the contact angle with applied water droplets, which do not soak in. The amount of starch complex added is so small that it cannot be seen as a residue on the paper fibers viewed by scanning electron microscopy. The starch complexes can be easily made on a commercial scale with commonly available steam jet cooking equipment. This technology allows the use of a biobased and biodegradable material in place of synthetic, non-biodegradable plastic film coatings. A patent application has been filed and interest has been shown by paper manufacturing companies.

Egg yolk quality improved by dried distillers grains in feed. Dried distillers grains (DDGS) are a co-product from ethanol production from corn that are typically used as a feed component for cattle and pigs. ARS scientists in Peoria, Illinois, in collaboration with scientists at the National Corn to Ethanol Research Center, Edwardsville, Illinois, University of Georgia, Athens, Georgia, and Tufts University, Medford, Massachusetts, demonstrated that both regular and low-fat distillers grains could be incorporated into layer hen diets at levels up to 20% with no detrimental impacts on hen weight gain or on egg production. In addition, egg yolks from hens fed DDGS were more red and yellow in color, and contained higher levels of carotenoids and tocopherols. This research indicates that both regular and low-fat DDGS can safely be incorporated into laying hen diets and that these feed components actually improve the color and content of bioactive lipids in egg yolks.

Development of apple harvest and automatic infield sorting technology for commercial use. Harvest and postharvest storage and packing are major operations in apple production and handling. Currently, commercial harvest aid machines are available for improving harvest efficiency and the working condition for workers, but they do not have the capability for automatic sorting and grading of fruit in the orchard. Researchers at the ARS East Lansing, Michigan location, in collaboration with a commercial horticultural equipment company, have developed a first self-propelled prototype machine with an automatic fruit sorting and grading system and a fully-integrated harvest aid function, for commercial use. The new machine has several novel, cost-effective design features in fruit sorting and grading, and fruit and bin handling in the orchard. Economic analysis showed that adoption of the machine can help U.S. fresh apple growers achieve significant cost savings, ranging between $3,000 and $55,000 annually per unit machine, and processing apple growers could achieve even more cost savings. Moreover, the machine also provides detailed information about the quality of harvested fruit, thus further enhancing product traceability and postharvest inventory management.

Volatile organic compound (VOC) profile of soft winter wheat grain. Wheat grain VOCs determine the odor and often modified by extrinsic factors such as fungal infestation and post-harvest weathering. Accordingly, the grain VOCs contributed solely by the intrinsic components, once profiled, can serve as an indicator of grain soundness. ARS scientists in Wooster, Ohio, profiled major VOCs in eastern soft wheats, demonstrating that four alcohols and one aldehyde vary in grain during maturation. These results demonstrate the inherent VOC profile of wheat grain can be used to develop accurate and rapid methods for assessing grain soundness, fungal infection levels and post-harvest spoilage.

A sensory and chemical flavor analysis of tomato genotypes grown in Florida during multiple seasons. Many years of breeding tomatoes for disease resistance, yield, and size has resulted in fruit that lack flavor. A collaborative study with the University of Florida tomato breeding program was conducted and evaluated 38 tomato genotypes over 7 years with 2-3 seasons per year, to understand tomato flavor. Genotypes and harvest seasons significantly influenced sensory perception and chemical profiles and one cultivar, 'Tasti-Lee', now readily available in supermarkets, was released from that study. When comparing Florida 47, the Florida industry standard, with 'Tasti-Lee', 8 out of 29 aroma compounds were higher in 'Tasti-Lee' (including those contributing to fruity and floral aromas) and 4 were higher in Florida 47 (those compounds giving green aromas). This provides a useful chemical model for two genotypes that differ in flavor quality that can be exploited by breeders seeking to improve flavor. Consumers will benefit from having tastier tomatoes on the market.

Development of antimicrobial packaging system for raw poultry meat products. The microbiological shelf-life of fresh poultry meat is typically less than 7 days at refrigerated temperatures. This short shelf-life results in millions of pounds of food waste annually. ARS scientists in Athens, Georgia, have developed a novel antimicrobial packaging system for extending shelf-life in fresh poultry meat. Their work has shown that post-packaging ozone treatments can significantly reduce spoilage microbial populations and extend product shelf-life as well as decrease foodborne pathogens on raw chicken breast meat.

Use of natural functional ingredients to enhance quality and sensory attributes of chicken breast meat. Consumers are increasingly looking for healthier food attributes and clean labels during food purchase. ARS scientists in Athens, Georgia, found that the natural ingredients in tapioca and potato (starch) can be used to enhance chicken breast meat water-holding capacity, tenderness, and sensory quality. These findings demonstrate that natural ingredients can be used to replace salt and phosphate in poultry meat products which will make cleaner labels and healthier products.

Development of rice-blueberry prebiotics to promote health. Rice bran (outer layer of brown rice containing antioxidants) and flour combined with blueberry phenolics (antioxidants) produce unique food ingredients that function as prebiotics (food that promotes growth of beneficial gut bacteria). Each year tons of rice bran and fruit pomace (leftover pulp after juice production) are generated as waste material with low value. Development of rice bran+blueberry prebiotics and rice products+blueberry food ingredients have been completed. Rice bran and flour with blueberry pomace extracts have been combined to form value-added prebiotics with the potential to promote healthy blood sugar levels. ARS scientists from the Food Processing and Sensory Quality Unit of the Southern Regional Research Center in New Orleans, Louisiana, in cooperation with Microbiome Therapeutics have complexed rice bran and flour with blueberry phenolics (anthocyanins) to produce value-added food products for prediabetics. Data collected indicate beneficial anthocyanins and phenolics are retained by rice bran and flour. Recent data demonstrate extended phenolic and color stability after several months of storage. Additionally, methods used to produce rice prebiotics reduce arsenic levels in rice bran samples.

Algal-produced allergens promoted tolerance to peanut upon ingestion. ARS scientists at the Food Processing and Sensory Quality Research Unit, New Orleans, Louisiana, are developing novel, non-invasive ways to improve tolerance of a population to food allergy are highly desirable. A core region of a major peanut allergen deoxy ribonucleic acid (DNA) was isolated and the protein produced in food-grade algae and was shown to suppress peanut allergic reaction in allergic mice. This is one of few on-going novel exploratory methods that may be effective in protecting the susceptible population against developing peanut allergy.

Sensing food contamination by hyperspectral imaging. USDA-ARS scientists in Beltsville, Maryland, developed non-destructive spectral imaging methods to examine sources of contamination in food, be it by nature (e.g., mold in cereal grains) or by deliberate, nefarious adulteration (e.g., melamine in milk powder). Analytical laboratories traditionally rely on highly technical methods for detecting contaminant levels; however, these methods require levels of operator skill and analysis time that make them ill-suited for industrial food processing facilities. Near infrared hyperspectral imaging is a simpler technique that utilizes light wavelengths just beyond the visible light region to analyze food products. This work benefits manufacturers of food powder by offering a method that is readily adaptable to industrial processing operations.

Component 2: Non-Food

Vegetable oil was changed into building blocks for making plastic. Transforming plant oil into a usable replacement for petroleum is a complicated, yet worthwhile process. One of the problems with natural materials is that they contain too many oxygen atoms in their structures to be used in plastics that Americans use every day. These oxygen atoms must be removed in order for the correct reactions to take place and to form strong, durable, and useful plastic products. To make these materials from natural oils, there are a couple of different approaches, but some only work at extreme temperatures and other methods require expensive chemicals. These reactions can also produce undesirable side products, such as the poisonous carbon monoxide, or large amounts of sulfur-containing byproducts. ARS scientists in Peoria, Illinois, have developed a new technology which uses a very small amount of catalyst, and the only by-product is carbon dioxide. A patent application covering this technology has been filed, and the result will enable major polymer industrial partners to replace their currently used petroleum.

Commercialization/development of estolides as a bio-based engine oil. Current commercial bio-based vegetable engine oils fail to meet the rigorous requirements (thermal oxidative stability and poor low-temperature properties) demanded by the American Petroleum Institute (API). New bio-based fluids from vegetable oil sources called estolides have been commercialized as a bio-based engine oil. Estolides were developed and patented by ARS scientists in Peoria, Illinois. Estolides have excellent physical properties (traits that make them excellent lubricants), such as cold temperature and outstanding oxidative stability properties with limited additive packages and these performances exceeded other commercially available bio-based oils. As a result, estolides were developed on the commercial stage and, to date, two different motor oil formulations (5W-20 and 5W-30) that contain estolides made from high-oleic soybean oil have received certification from the API. The API certification allows automobile owners to still receive their engine warranty coverage for using this new bio-based material. A new type of carbonated estolide was developed as an extension of the original estolide material. The

carbonated estolide has higher viscosities than previously developed estolides and will extend the estolide technology platform.

Modified production of antimicrobial compounds. The yeast Aureobasidium pullulans is able to convert agricultural sugars to a family of related compounds called liamocins that have significant promise as selective antibacterial agents against certain organisms that are important in veterinary and clinical medicine. However, the yeast often produces multiple chemical forms of liamocin, which have varying degrees of antimicrobial activity. ARS scientists in Peoria, Illinois, developed genetic methods to control the type of liamocin that is produced depending on the sugar that is used to grow the strain. This technology allows for the production of novel liamocin structures for applications that require specific antibacterial properties and will benefit veterinary care with non-antibiotic treatment options.

Personal care ingredients from vegetable oils. To establish a bio-economy that can displace petroleum-based products, new processes and materials must be developed to convert sustainable, agricultural commodities to new, higher value materials with useful properties. ARS scientists in Peoria, Illinois, have expanded upon their patented enzymatic process to convert vegetable oils into higher-value, skin care ingredients. Commercial partners are manufacturing coconut oil-based compounds modified with a component of lignin to be sold as a high-value skin care active ingredient with antioxidant and broad ultra violet absorbing properties. This work directly contributes to ARS' efforts to create new and expanded markets for agricultural commodities and to combat climate change by reducing our dependence on petroleum for the manufacture of industrial chemicals.

Improved protein adhesive formulations. ARS scientists in New Orleans, Louisiana, have found that by including additives in cottonseed based protein adhesives, improved adhesive performance can be obtained. Both adhesive strength and water resistance have been improved by the addition of small amounts of organic acids or phosphorous containing compounds. Improved water resistance is of particular interest, as most protein based adhesives exhibit poor water resistance.

Less expensive protein adhesives. ARS scientists at New Orleans, Louisiana, have found that by blending cottonseed proteins with other components in adhesive formulations, improved adhesive formulations can be obtained. Blending some cottonseed protein with soybean protein allowed for improved performance over soybean protein alone. Additionally, cottonseed-based protein adhesives retain much of their properties when blended with relatively cheap fibrous fillers. These blends may provide an opportunity to decrease the amount of protein used in adhesive formulations, thereby reducing cost.

Determination of the mechanisms by which brown cotton fibers exhibit enhanced flame retardant characteristics. The link of the flame resistance of brown cotton to its color was confirmed by identifying the presence of condensed tannins using CP/MAS 13C NMR. The tannins enhanced the thermal properties of brown cotton by its capability to bind metal ions as well as its intrinsic thermal resistance. Among inorganic components, the important role of sodium was also identified. Sodium catalyzed the low temperature thermal reaction of cellulose, showing a significant negative correlation with the heat release capacity of cotton fiber. The inorganic

components, predominantly sodium, and tannins interplayed to induce the self-extinguishing property of brown cotton in which the fabric no longer supports an open flame once the ignition source is removed.

Bioprocessing. The use of proteins catalysts (enzymes) that remove unwanted constituents in cotton textiles is viewed as a viable alternative to traditional scouring approaches that utilize harsh caustic substances consuming large amounts of water and generating large volumes of waste. ARS scientists developed combinations of various enzymes that work synergistically in bio-preparation and bio-finishing of cotton textiles by using ultrasound energy to enhance the conditions. Statistical software analysis of bio-processing experiments determined that ultrasound can be safely applied to enzyme-based scouring of fabrics when used in an industrial setting, and without the need for expensive sound-attenuating enclosures for the equipment or hearing protection for the textile workers. This advance represents significant cost savings and alleviates health concerns associated with implementing this technology in the textile industry.

Rapid cotton fiber moisture content measurements by microwave technology. The moisture content of cotton fiber is an important fiber property, but it is often measured by a laborious, time-consuming laboratory oven drying method. ARS scientists in New Orleans, Louisiana, developed a laboratory microwave moisture measurement, using a microwave instrument, to perform rapid, precise and accurate fiber moisture measurements. The method agreements between the microwave instrument and two oven drying reference methods were very good, and the precision of the microwave moisture content measurements was very high. The impact of sample fiber weight was minor, and long-term stability was excellent. The microwave fiber moisture method was shown to be viable and applicable for daily quality control use. An extensive, multi-month on-site trial of the instrument was performed by the USDA-Agricultural Marketing Service, with favorable results. In addition, international interest has been expressed in potential applications of the Aqualab technique.

Potent pytotoxins from toothpickweed identified. Plants constitute a rich source of novel and structurally diverse phytotoxic compounds to be explored in searching for effective and environmentally safe herbicides. ARS scientists at USDA-ARS-Natural Products Utilization Research Unit (NPURU), Peoria, Illinois, selected toothpickweed (Ammi visnaga) for further study from screening nearly 2400 plant extracts extract. Phytotoxicity-guided fractionation of the extract yielded two compounds: khellin and visnagin, whose herbicidal activity had not been described before. In laboratory assays, khellin and visnagin inhibited the growth of lettuce and duckweed. Also, both compounds reduced the growth and germination of weeds: ryegrass, morningglory, foxtail and millet. The inhibitory activities of these compounds were similar to those of the commercial herbicides acetochlor and glyphosate in the lab bioassays. During greenhouse studies visnagin was more active, with significant contact post-emergence herbicidal activity on velvetleaf and crabgrass 2 kg ai ha-1. Moreover, its effect on velvetleaf, crabgrass and barnyardgrass (Echinochloa crus-galli) at 4 kg ai ha-1 was comparable to the bioherbicide pelargonic acid at the same rate. These results support the potential of visnagin, and possibly khellin, as bioherbicides or lead molecules for the development of new herbicides

Novel sweet-tasting and bitter-masking property of biosurfactants. Sophorolipids (SLs) are biosurfactants produced by yeast and have been used in niche-market commercial products for

dish washing and surface cleaning. There is a need to make SLs commercially more attractive and valuable by identifying any new value-added property associated with it. ARS researchers in Wyndmoor, Pennsylvania, and others in the past had shown the valuable antimicrobial activity of SLs against many bacteria important to various industries. Recently, in collaboration with an industrial partner, we have initiated new research to determine the taste-sensory properties of SLs. The results led to the novel discovery that SLs are an excellent stimulant to the receptors of the cultured sweet-taste cells (from human tongue) and can thus be used as a sweetener and/or bitter-masking agent. We have filed a provisional patent application on this novel discovery, and expect it to have a great impact for expanding the use of SLs into oral-hygienic cares and foods industries in which SLs' surfactant/emulsifier, antimicrobial, and taste-sensory properties could all be simultaneously and fully employed.

Modification of hemoglobin improves its water clarification properties. Hemoglobin can be used as a bio-based substitute for certain water treatment chemicals. The performance of hemoglobin in this application is very good, but the water to be treated must be slightly acidic. ARS researchers in Wyndmoor, Pennsylvania, modified hemoglobin through a simple chemical reaction which attaches alcohol molecules to specific sites on hemoglobin. The modified hemoglobin was much more potent in water clarification and had significantly reduced need for acidity. The modified hemoglobin produced in this research should be substantially more attractive as a bio-based water treatment chemical,

Biobased sponges derived from collagenous tannery waste. Due to fierce competition in global markets, the American leather and hide industries need to implement new technology for producing novel products using either raw hides or recycled tannery waste. ARS researchers in Wyndmoor, Pennsylvania, addressed these challenges by developing novel products such as biobased, collagen sponges from hides and tannery waste. Collagen sponges have many unique properties that are desirable in medical applications. They are being widely used to stop bleeding in surgery and as scaffolds in tissue engineering. This research focused on preparations of collagen sponges from un-tanned hides, including limed hides and delimed-bated hides, which correspond with their actual tannery waste of limed splits and their trimmings. These research results are instrumental to help hides and leather industry to produce biobased sponges, which have many medical applications.