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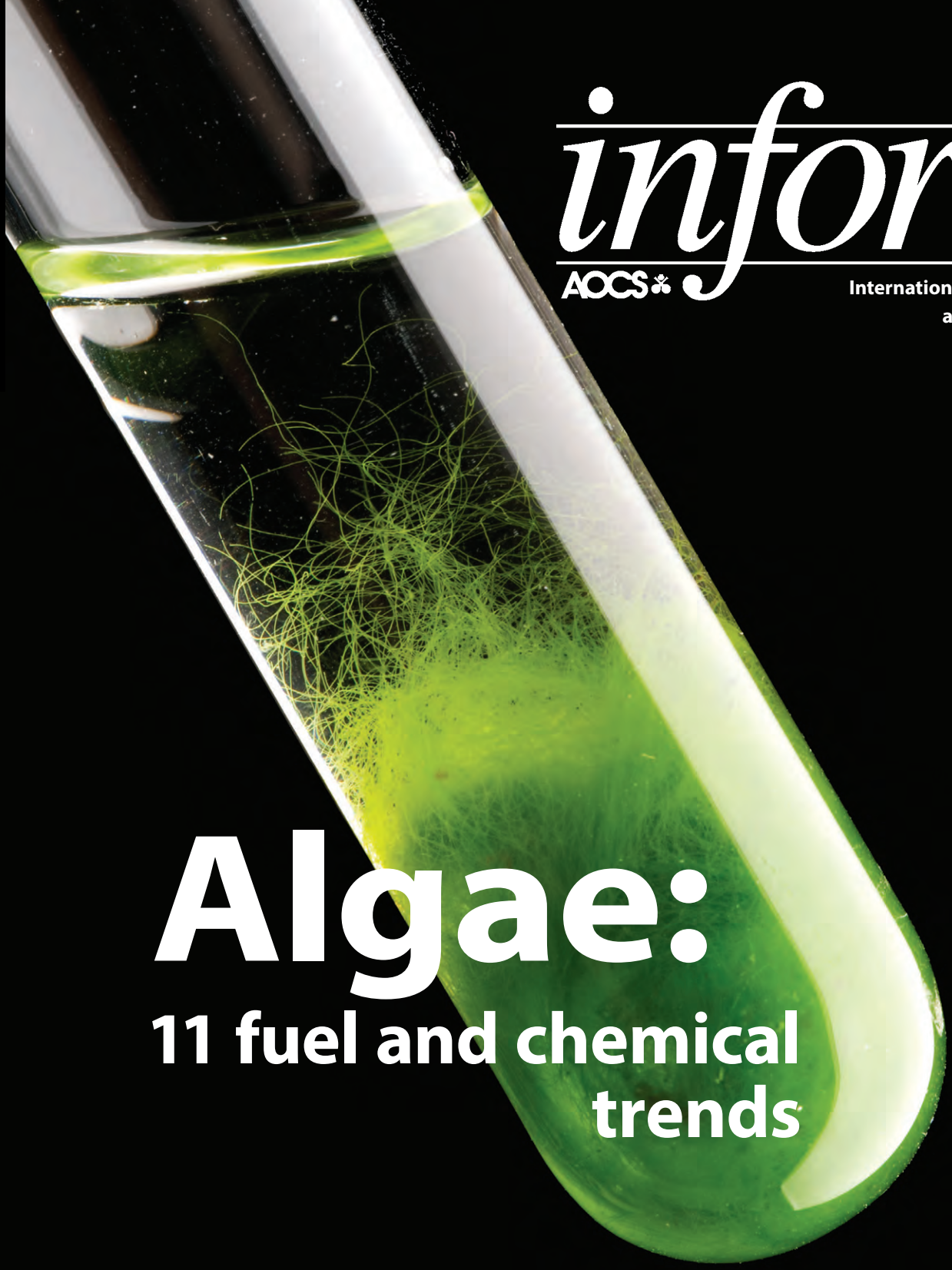

Algae:

11 fuel and chemical trends

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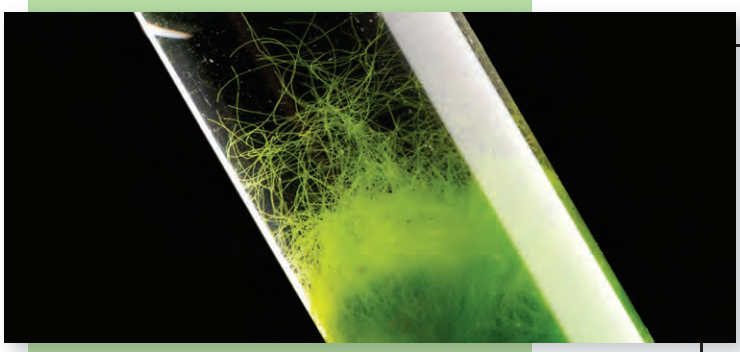
Fast pyrolysis

Degumming with enzymes

Avoiding the "next melamine"



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June 2011 Volume 22 (6) 321–380

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Calendar

bold type: *new listing*
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June

June 13–16, 2011. A Short Course in Agricultural Microscopy, sponsored by AOCS/Great Plains Institute of Food Safety, Northern Crops Institute, Fargo, North Dakota, USA. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.northern-crops.com/scourses/scmicroscopy/11microscopysc.html; www.aocs.org/Education/content.cfm?ItemNumber=16751.

June 15–16, 2011. European Biodiesel 2011, Rotterdam, the Netherlands. Information: Marisa Magtultol: Tel: +44 (0)20 7981 2503; email: mmagtultol@acieu.net; www.acius.net/aci/conferences/eu-eaf4.asp.

June 18, 2011. Sensory Evaluation of Olive Oil Short Course, Hilton Hotel, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-683-4821; fax: +1 217-693-4865; www.aocs.org/goto/Turkey2011.

June 18–21, 2011. International Oil Mill Superintendents Association 117th Annual Convention, Nashville Holiday Inn-Downtown, Nashville, Tennessee, USA. Information: www.iomsa.org.

June 18–19, 2011. Basics of Oilseed Processing Short Course, Hilton Hotel, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-683-4821; fax: +1 217-693-4865; www.aocs.org/goto/Turkey2011.

June 19, 2011. Edible Oil Refinery and Optimization and Maintenance Short Course, Hilton Hotel, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-683-4821; fax: +1 217-693-4865; www.aocs.org/goto/Turkey2011.

June 19–22, 2011. Nordic Lipid Forum Symposium, Ålesund, Norway. Information: www.lipidforum.info/index.php?p=53-53-53.

June 19–24, 2011. Atherosclerosis: Understanding the Pathophysiology and Identifying New Modes of Prevention, Gordon Research Conference, Salve Regina University, Newport, Rhode Island, USA. Information: www.grc.org/programs.aspx?year=2011&program=athero.

June 20–21, 2011. Oils and Fats World Market Update 2011, İzmir Hilton, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-683-4821; fax: +1 217-693-4865; www.aocs.org/goto/WorldMarket.

June 21–22, 2011. Enzymatic Processing and Modification, Het Pand, University of Ghent, Belgium. Information: phone: +44 (0)20 7598 1561; www.soci.org/General-Pages/Display-Event?EventCode=OF107.

June 21–23, 2011. World Conference on Oilseed Processing, Fats & Oils Processing, Biofuels & Applications, İzmir Hilton, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-683-4821; fax: +1 217-693-4865; www.aocs.org/goto/Turkey2011.

June 21–23, 2011. 15th Annual Green Chemistry and Engineering Conference/5th International Conference on Green and Sustainable Chemistry, Washington, DC, USA. Information: www.gcande.org.

June 23–24, 2011. Sustainable Foods Summit, Mövenpick Hotel Amsterdam City Center, Amsterdam, the Netherlands. Information: http://www.sustainablefoodssummit.com.

June 27–28, 2011. JatrophaWorld Asia 2011, Hainan, China. Information: www.futureenergyevents.com/jatropha/jatrophaworld-asia.

June 27–30, 2011. BIO [Biotechnology Industry Organization] International Convention, Walter E. Washington Convention Center, Washington, DC, USA. Information: http://convention.bio.org.

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AOCS Meeting Watch

June 13–16, 2011. A Short Course in Agricultural Microscopy, sponsored by AOCS/Great Plains Institute of Food Safety, Northern Crops Institute, Fargo, North Dakota, USA. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.northern-crops.com/scourses/scmicroscopy/11microscopysc.html; www.aocs.org/Education/content.cfm?ItemNumber=16751.

June 18, 2011. Sensory Evaluation of Olive Oil Short Course, Hilton Hotel, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/goto/Turkey2011.

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June 21–23, 2011. World Conference on Oilseed Processing, Fats & Oils Processing, Biofuels & Applications, İzmir Hilton, İzmir, Turkey. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/goto/Turkey2011.

September 16–18, 2011. 10th Phospholipid Congress of The International Lecithin and Phospholipid Society (ILPS): Phospholipids—Sources, Processing and Application, Congress Centre "De Doelen," Rotterdam, the Netherlands. Information: e-mail: ilps@lecipro.nl; www.ilps.org/10th%20Congress.htm.

October 17, 2011. Basics of Edible Oil Processing and Refining—AOCS Short Course, Hilton Cartagena, Cartagena, Colombia. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/LACongress.

October 17, 2011. Oilseed Processing and Solvent Extraction—AOCS Short Course, Hilton Cartagena, Cartagena, Colombia. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/LACongress.

October 18, 2011. Oils and Fats Modification—AOCS Short Course, Hilton Cartagena, Cartagena, Colombia. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/LACongress.

October 18, 2011. SODEOPEC: Soaps, Detergents, Oleochemicals, and Personal Care Products—AOCS Short Course, Hilton Cartagena, Cartagena, Colombia. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/LACongress.

October 19–21, 2011. 14th Latin American Congress on Fats and Oils, Hotel Cartagena, Cartagena, Colombia. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; www.aocs.org/LACongress.

For in-depth details on these and other upcoming meetings, visit www.aocs.org/meetings.

June 30–July 1, 2011. European Lab Automation, CCH-Congress Center Hamburg, Germany. Information: www.selectbiosciences.com/conferences/ELA2011.

July

July 10–13, 2011. 5th European Symposium on Plant Lipids, Gdansk, Poland. Information: www.eurofedlipid.org/meetings/gdansk2011.

July 10–15, 2011. Molecular Membrane Biology, Gordon Research Conference, Proctor Academy, Andover, New Hampshire, USA. Information: www.grc.org/programs.aspx?year=2011&program=molecmemb.

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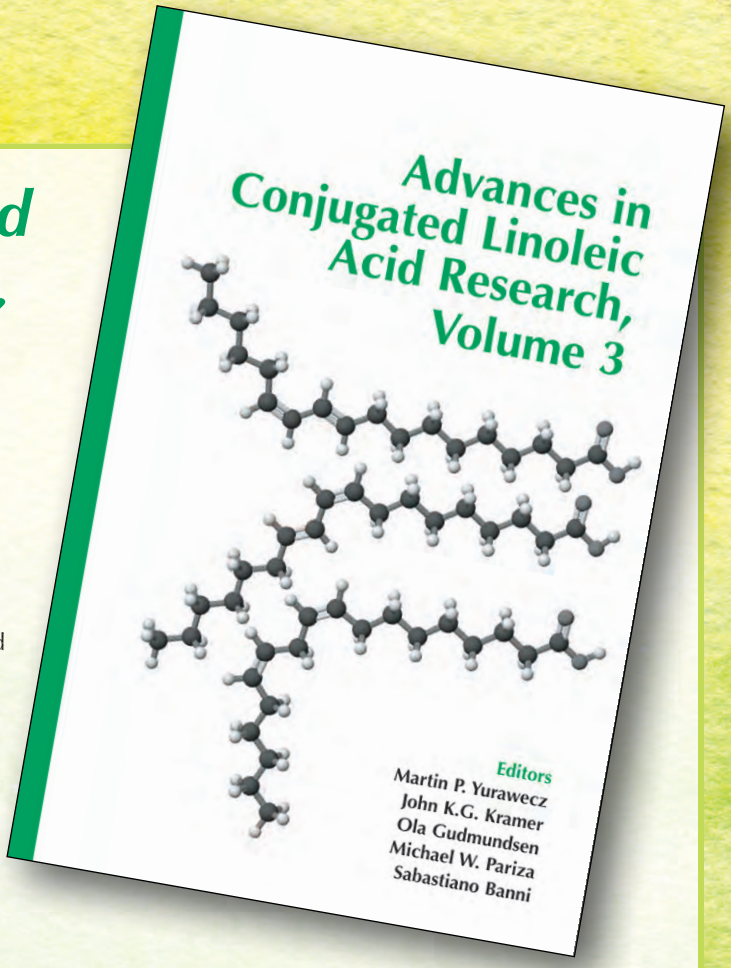

Advances in Conjugated Linoleic Acid Research, Volume 3

Martin P. Yurawecz, John K. G. Kramer, Ola Gudmundsen, Michael W. Pariza, and Sebastiano Banni, Editors
2006. Softbound. 280- pages. ISBN: 978-1--893997-87-5.
Product code 209

List: ~~$210~~ $185 • AOCS Member: ~~$175~~ $150

Interest in the chemistry and biological properties of conjugated linoleic acid, or CLA, continues to grow. The number of peer reviewed publications on CLA since the 2003 publication of *Advances in Conjugated Linoleic Acid Research,* Volume 2, has more than doubled. It is likely that CLA, as a model test object, will be used in the future in many more studies related to major maladies such as cancer, atherosclerosis, and diabetes.

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July 13–14, 2011. 2nd International Conference on Tocotrienols & Chronic Diseases, Wynn Las Vegas, Nevada, USA. Information: Malaysian Palm Oil Board, Washington, DC, USA: Rosidah Radzian: phone: +1-202-572-9719/9768; fax: +1-202-572-9783.

July 17–20, 2011. 1st International Conference on Algal Biomass, Biofuels and Bioproducts, Westin St. Louis, St. Louis, Illinois, USA. Information: www.algalbbb.com.

July 17–22, 2011. Molecular & Cellular Biology of Lipids, Gordon Research Conference, Waterville Valley Resort, Waterville, New Hampshire, USA. Information: www.grc.org/programs.aspx?year=2011&program=lipids.

July 19–22, 2011 CESSE [Council of Engineering and Scientific Society Executives] 2011 Annual Meeting, Hyatt Regency Vancouver, Vancouver, British Columbia, Canada. Information: http://community.cesse.org/CESSE/CONFERENCE .

July 30–August 5, 2011. 43rd IUPAC World Chemistry Congress, Puerto Rico Convention Center, San Juan, Puerto Rico. Information: www.iupac2011.org.

August

August 14–18, 2011. Practical Short Course, Trends in Margarine and Shortening Manufacture, Non-Trans Products, Food Protein Research & Development Center, Texas A&M University, College Station, Texas. Information: http://foodprotein.tamu.edu/fatsoils/scmargarine.php.

August 21–24, 2011. Delivery of Functionality in Complex Food Systems, Guelph, Ontario, Canada. Information: www.uoguelph.ca/foodscience/content/delivery-functionality-complex-food-systems.

August 21–26, 2011. 13th Annual Practical Short Course on Food Extrusion: Cereals, Protein & Other Ingredients (formerly, Texturized Vegetable Protein and Other Soy Products), Texas A&M University, College Station, Texas, USA. Information: email: mnriaz@tamu.edu; http://foodprotein.tamu.edu/extrusion/ShortCourses/tvp/sctvp.php.

August 28–September 1, 2011. 242nd ACS National Meeting & Exposition, Denver, Colorado, USA. Information: www.acs.org.

August 30–September 3, 2011. 52nd International Conference on the Bioscience of Lipids, Warsaw, Poland. Information: www.icbl.unibe.ch/index.php?id=81.

September

September 14–16, 2011. International Biorefining Conference and Trade Show, Hilton Americas–Houston, Houston, Texas, USA. Information: www.biorefiningconference.com.

September 16–18, 2011. 10th Phospholipid Congress of The International Lecithin and Phospholipid Society (ILPS): Phospholipids—Sources, Processing and Application, Congress Centre "De Doelen," Rotterdam, the Netherlands. Information: e-mail: ilps@lecipro.nl; www.ilps.org/10th%20Congress.htm.

September 18–21, 2011. 9th Euro Fed Lipid Congress, Rotterdam, the Netherlands. Information: email: amoneit@eurofedlipid.org; www.eurofedlipid.org/meetings/rotterdam.

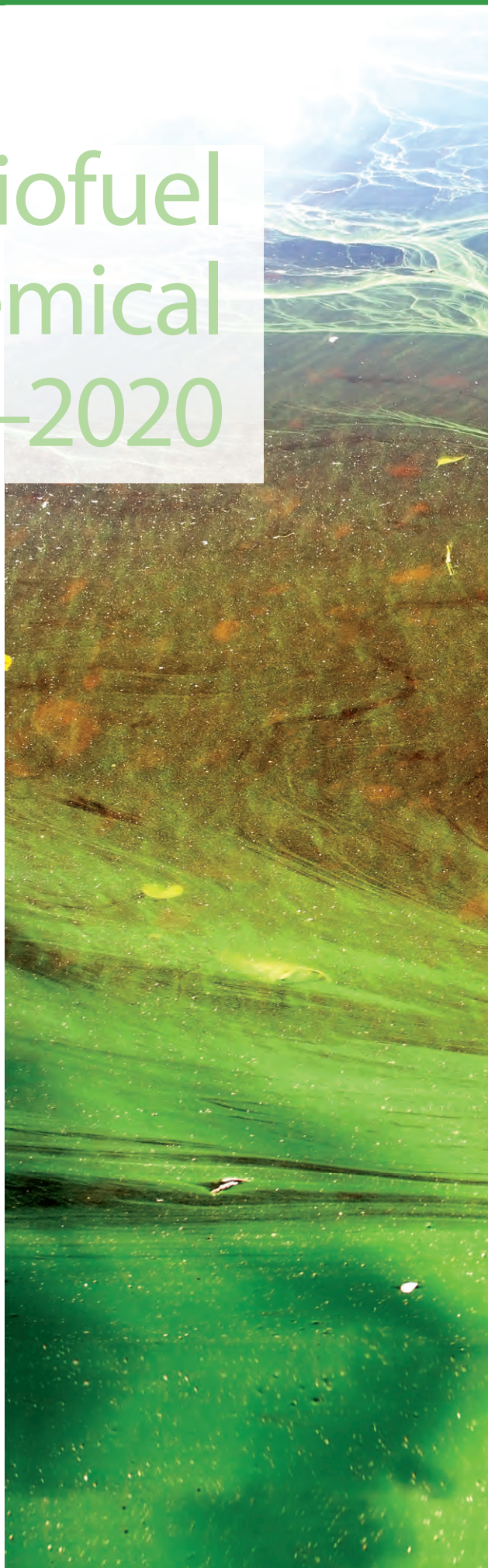
September 18–21, 2011. 12th International Conference on Bioactive Lipids in Cancer, Inflammation and Related Diseases, Westin Hotel, Seattle, Washington, USA. Information: http://bioactivelipidsconf.wayne.edu.

September 20–23, 2011. 7th International Congress of Food Technologists, Biotechnologists, and Nutritionists, Grand Hotel Adriatic, Opatija, Croatia. Information: www.pbncongress2011.hr.

September 21–23, 2011. 7th NIZO Dairy Conference: Flavour and Texture, Innovations in Dairy, Papendal Hotel and Conference Centre, near Arnhem, the Netherlands. Information: www.nizodairyconference.com.

September 22–23, 2011. Biofuels Hall of Fame 2011, Brussels, Belgium. Information: email: dm@greenworldconferences.com; www.greenworldconferences.com. ■

Top 11 algae biofuel and biochemical trends for 2011–2020



Will Thurmond

Editor's note: The following summary of 11 top algae biofuel and biochemical trends was excerpted from Thurmond's technology, investment, and market study entitled Algae 2020, Volume 2 *(2011 update), available at info@emerging-markets.com.*

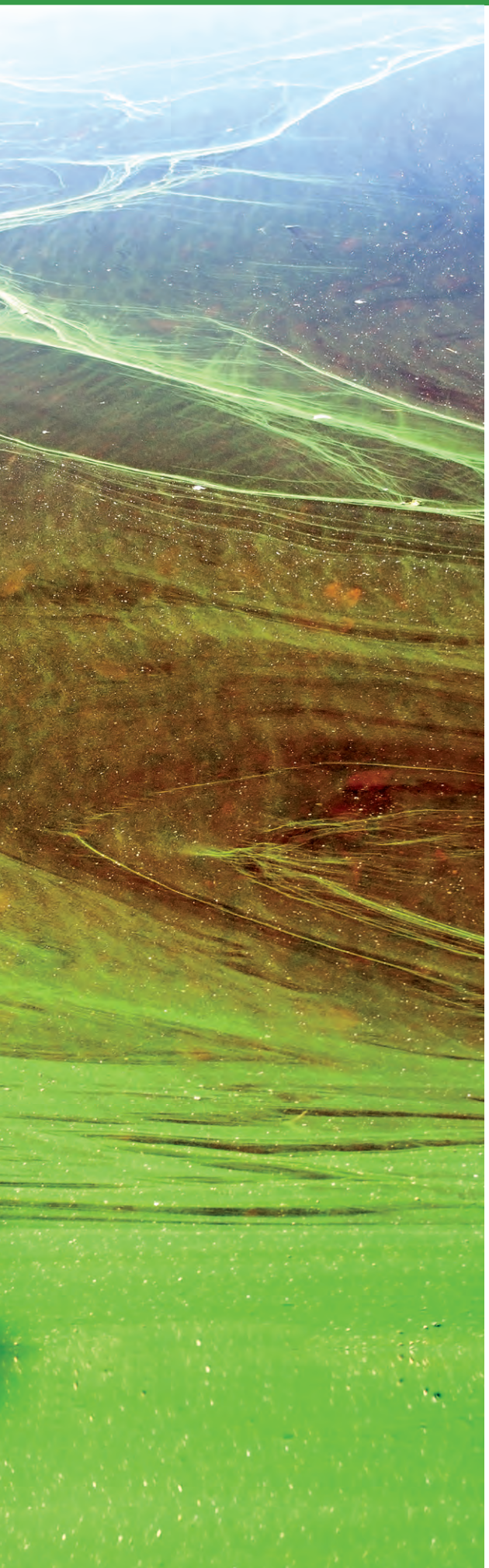
1. Renewable oils for biofuels and biochemicals

The "brewery" model in algal biofuels ventures is known for low-cost, high-tech production using standard industrial fermenters. Solazyme (South San Francisco, California, USA) is leading the charge in the algae-based brewery/fermentation model, followed by veteran algae producer Martek (Columbia, Maryland, USA) with support from BP. We expect to see companies similar to Solazyme emerging in the 2011–2012 time frame worldwide using the microbial brewery model to produce "renewable oils" via fermenting sugars as seen with Amyris (Emeryville, California; green crude and renewable diesel from yeast), Virent (Madison, Wisconsin, USA; green diesel), LS9 (South San Francisco, California; renewable diesel from bacteria), and others emerging in this space. Where there is cheap sugar, and cellulosic sugars from agricultural and industrial waste, these commercial ventures will find advantages. Where lower-cost, economically advantaged sugars are available in the United States, European Union (EU), China, and India, expect increasing military use for collaborative research and development (R&D) deployment tests.

2. biofuels and drop-in fuels

In the biggest markets in Europe, the United States, Brazil, China, and India, government mandates are requiring large oil and gas refiners to blend in biofuels to their existing infrastructure. Most oil and gas companies facing blending mandates, military suppliers, and auto manufacturers and transport companies considering fleetwide upgrades to higher biofuels blends wish to find fungible fuels that are compatible with existing engines, pipelines, storage systems, and petrol stations.

A common theme among algae leaders that have progressed into pilot and demonstration-scale projects is that in addition to biodiesel and ethanol, these organizations are able to produce drop-in replacement fuels from microalgae, from blue-green algae (also known as cyanobacteria), and from other microbes. Military, aviation, government, and petrochemical organizations all demand fungible, drop-in fuels and prefer to work with advantaged producers with scalable technologies for R&D and deployment.



3. Green chemicals and polymers

In the capital markets, investors have far more confidence in market demand as a measure of long-term opportunity in transport fuels and petrochemical derivatives. For this reason, the early leaders in advanced algal and microbial fuels are diversifying and targeting existing petrol, diesel, and aviation markets, as well as related biofuels markets for green chemicals, polymers, and power generation. The diversification of biofuels companies beyond one fuel—ethanol and biodiesel—to include a portfolio of advanced biofuels represents a wise long-term strategy to inspire investor confidence.

4. Oleochemical consumer products

Oleochemical consumer products are an emerging trend in commercial and privately funded algae projects. Increasingly, the focus among start-up and venture capital (VC)-backed algae ventures is on high-value products including: livestock and fish meal, omega-3 fatty acids, health products, and cosmetic and pharmaceutical uses. Most algae farmers seek these highest-value products for key addressable markets first, and then plan to scale up operations over time for commercial biofuels production. Many ventures will pursue these high-value, addressable markets to develop cash flow for operations, resources, and staff, and establish early brand identity. Such high-value, small-market focus is a short-term strategy on the pathway to the mid- to longer-term commercialization of biofuels. The longer-term strategy for producing algal biofuels closer to petroleum price parity improves significantly as algae producers reach larger economies of scale in industrial, deployment-stage algal biomass production systems.

5. Scalability

Why are some algae companies attracting capital and scaling up their enterprises while others continue to peer into the "valley of death" from the laboratory to the pilot phase? Of the 100+ companies involved in the algae space, fewer than 25 have moved from the laboratory to the pilot phase during the economic recession. Few have been able to convince investors to risk placing $10 million or more to make this necessary transition. If an algae venture is not (i) able to demonstrate and prove its technology works on a small scale or (ii) to produce more than 1,000 tons (900 metric tons) of algal biomass or at least 100 gallons (400 liters) of algal oil with its partners, it is unlikely investors will take serious notice. Notably, some companies have been able to attract investment based on initial proof of concept at the lab/bench scale via strategic partnerships, early-stage VC money, and government grants.

6. Seaweed

Seaweed has gained favor with petrochemical majors Statoil (Oslo, Norway), DuPont (Wilmington, Delaware, USA), and ENAP (Empresa Nacional del Petróleo; Santiago, Chile) because it grows faster than terrestrial crops, has a high sugar content for conversion to ethanol and advanced biofuels, absorbs more airborne carbon than land-based plants, has no lignin, can be easily harvested compared to microalgae, requires no pretreatment for ethanol production, and can be harvested up to six times a year in warm climates. Seaweed biofuels include ethanol, methanol, and biobutanol. BP-Dupont's Butamax will collaborate with BAL (Bio Architecture Lab; Berkeley, California) to produce biobutanol for drop-in fuels and chemicals.

7. Emerging markets growth

US- and EU-based algae producers and licensors of technology are increasingly looking to the emerging markets in Latin America, Asia, Africa, and the

Middle East for faster economic growth, increasing market demand, and more supportive government and regulatory climates for accelerated commercial growth. This follows a key trend by Shell and BP, investing $12 billion and $8 billion, respectively, in sugar-based conglomerates in Brazil to produce ethanol, biobutanol, drop-in fuels, and biobased chemical products.

8. Government R&D

Governments in the United States, EU, Brazil, China, India, Canada, and worldwide are funding algae R&D collaboratives at universities and laboratories, public-private partnerships, precommercial demonstration stage enterprises, pilot- and prototype-stage endeavors. Most funded or awarded ventures bring together clusters of industry, government, academia, clean technology investors, and producers to share and collaborate on key challenges and opportunities. Some government algae R&D ventures are now phasing into precommercial, deployment-stage algae ventures using pond, photobioreactor, and fermentation-based production systems. Government R&D, deployment, and commercialization support continues to expand into new countries and territories worldwide.

9. Capital light, global exports

Many precommercial, VC- and angel-backed ventures are increasingly pursuing a two-pronged strategy. The first strategy seeks to license technology to partners with capital to develop and scale up the precommercial enterprise to commercial levels. This is also known as the capital light strategy. The second strategy is for producers to export technology to local partners in global geographies with advantaged environments for sunlight, operating expenses, market growth, and government support.

10. Strategic R&D partnerships

Suppliers and buyers are forming early-stage R&D relationships in the algae space. Some algae producers now have collaborative R&D partners with big industry players, such as the ExxonMobil-Synthetic Genomics $600 million collaborative for green crude development, the Algenol-Dow for bioproducts, BP-Martek for algae fermentation, Shell-HR Biopetroleum for hybrid photobioreactor-pond development, Chevron-Solazyme for green crude and drop-in fuels, and DuPont-BAL for biobutanol from seaweed.

11. Global deployment partnerships

Current economic and regulatory trade winds in the northern parts of the United States and EU are shifting algae technology exports southward and east to Central and South America, Africa, and Asia. An increasing number of partnerships are forming and leveraging advantages in technologies, economies, and geographies. Long-term trade winds favor large-scale production supplies of algae from the Americas, the Middle East, and Asia with increasing demands for algal biofuels, products, and technologies from China and India.

Will Thurmond is a market trends columnist for Biofuels Digest *and* Biofuels International. *He is the chief executive officer of the market research fi m Emerging Markets Online and the author of the studies entitled* Algae 2020 Volume *2 (February 2011) and* Biodiesel 2020. *He can be contacted at info@emerging-markets.com.*

Fast pyrolysis: next generation biomass gasoline and diesel production

Mark Wright

The United States has established an aggressive target of producing 16 billion gallons (60 billion liters) of advanced cellulosic biofuels by 2022, as mandated by the 2010 Renewable Fuel Standard (RFS2). This has encouraged the exploration of diverse pathways including both biochemical processes, which use enzymes and microorganisms, and thermochemical processes, which involve heat and catalysts. Among thermochemical processes, fast pyrolysis is an especially promising technology.

According to Paul Grabowski, technology manager of thermochemical conversion at the US Department of Energy (DOE), the US government is "quite interested in fast pyrolysis to gasoline diesel jet fuel, and is actively seeking and funding projects in that area."

The direct feedstock to fuel pathway was recently highlighted in a design report prepared by researchers at Iowa State University (Ames, USA) in collaboration with ConocoPhillips Co. (Houston, Texas, USA) and the National Renewable Energy Laboratory (Golden, Colorado, USA). The report may be downloaded at www.nrel.gov/docs/fy11osti/46586.pdf.

FIG. 1. *Bio-oil contains more than 300 diffe ent compounds including aldehydes, carboxylic acids, anhydrosugars, and lignin-derived oligomers. New research at Iowa State University has shown that the lignin is present as oligomers and not pyrolytic lignin, as industry calls it.*

Fast pyrolysis is a liquefaction process that takes place at mild temperatures (~500°C) and atmospheric pressure. This thermal process employs fast heating rates with residence times of a few seconds. During fast pyrolysis, biomass is fed into an oxygen-free environment to encourage formation of liquids rather than gaseous products. Fast pyrolysis converts up to 70% of biomass feedstock into a liquid mixture known as bio-oil (Fig. 1). The remaining fraction is split between noncondensable gas (NCG) and solids (biochar). NCG is a low-heating-value natural gas replacement consisting mostly of carbon dioxide, carbon monoxide, hydrogen, and other light gases. Biochar contains 20–65% carbon and most of the minerals from the original feedstock. These minerals remain in a form that is accessible to crops. Therefore, biochar could serve the dual role of a carbon sequestration agent and soil amendment material. NCG and biochar yields range between 10% and 30% by weight depending on process conditions. NCG yields tend to increase with temperature whereas biochar yields decrease.

FIG. 2. *Andrew Friend changes out a bio-oil collection bottle on a 1/4 short ton per day pilot scale pyrolysis unit that converts biomass such as corn stover or switchgrass into bio-oil. The bio-oil can be upgraded to gasoline-range fuel molecules and other biobased products.*

Bio-oil contains more than 300 different compounds including aldehydes, carboxylic acids, anhydrosugars, and pyrolytic lignin. This combustible mixture is a suitable fuel oil replacement for furnaces and boilers. Bio-oil requires upgrading before use in vehicle engines. Research laboratories are developing processes that convert bio-oil compounds into hydrocarbons indistinguishable from those

TAbl E 1. Summary of fast pyrolysis and bio-oil upgrading techno-economic analysis results

	Hydrogen production	Hydrogen purchase
Capital cost (millions $)	$287	$200
Annual operating cost (millions $)	$109	$123
Fuel yield (million liters/year)	134	220
Product value ($/gallon gasoline equivalent)	$3.09 ($0.80/L)	$2.11 ($0.55/L)
Pioneer plant capital cost (million $)	$911	$585
Pioneer product value ($/gallon gasoline equivalent)	$6.55 ($1.73/L)	$3.41 ($0.90/L)

found in crude oil-derived gasoline and diesel. Some researchers envision upgrading bio-oil with conventional hydroprocessing technologies found in oil refineries. The challenge is to develop catalysts and equipment that can convert bio-oil while tolerating the properties that make it problematic for existing refineries. Typical bio-oil is corrosive, contains solid particles, and is unstable at room temperature.

At this time no commercial plants have been built that convert bio-oil into transportation fuels. In the absence of commercial operating experience, Iowa State University researchers and their collaborators estimated the cost of biofuels via pyrolysis from engineering process models. They modeled a 2,000 metric ton per day (MTPD) biorefinery that converts corn stover into 134 and 220 million liters of naphtha-range (gasoline blend stock) and diesel-range (diesel blend stock) products per year (Fig. 2). Bio-oil upgrading requires hydrogen to remove contaminants such as oxygen, sulfur, nitrogen, and metals from the fuel. The study considers two scenarios for sourcing hydrogen: production from steam reforming of bio-oil, and purchase from an external supplier.

The hydrogen production scenario uses a fraction of the available bio-oil to generate hydrogen. Steam reforming generates hydrogen from fuels such as natural gas or biomass-derived synthetic gas. This scenario estimates that 38% of bio-oil needs to undergo steam reforming to provide enough hydrogen for the remaining oil. This scenario represents a stand-alone refinery with minimal use of external energy sources. Process heat for this biorefinery derives from pyrolysis NCG and a fraction of biochar resulting in reduced reliance on fossil fuels.

Biorefineries based on the hydrogen purchase scenario would require an external supply of hydrogen. Potential sources include hydrogen from crude oil refineries, natural gas reforming, or electrolysis of water using wind- and solar-based electricity. This alternative results in a higher yield of transportation fuels from a given amount of biomass than the hydrogen production scenario.

Key assumptions include plant capacity (2,000 MTPD), feedstock cost ($75 per short ton, or $68 per metric ton), and profitability analysis method (discounted cash flow rate of return). This study seeks to estimate the biofuel product value (PV), defined as the value of the product that produces a net value of zero with a 10% internal rate of return over a 20-year depreciation period. Results include estimates for

mature and pioneer, or first-of-a-kind, biorefineries producing biofuels via fast pyrolysis and upgrading.

Capital costs for such biorefineries were estimated at $287 and $200 million for the hydrogen production and purchase scenarios, respectively. These cost estimates include quotations for a 2,000 MTPD biorefinery with equipment for biomass handling, biomass conversion, pyrolysis gas cleaning, oil collection and storage, heat recovery and steam generation, and bio-oil hydroprocessing.

Results indicate that corn stover biorefineries could produce naphtha and diesel range stock fuel at PVs of $2.11/gal ($0.56/liter) and $3.09/gal ($0.82/liter) for the hydrogen purchase and production scenarios, respectively. These estimates are based on the assumption that major technological breakthroughs have been achieved and the process has reached maturity. The PV of fuels from a pioneer fast pyrolysis biorefinery is estimated at $3.41/gal ($0.92/liter) and $6.55/gal ($1.73/liter) for the given scenarios.

Process and economic assumptions have significant impacts on the estimated PVs. A 5% decrease in bio-oil upgrading yield results in $0.80/gal ($0.21/liter) higher PVs for the hydrogen production scenario, and $0.27/gal ($0.07/liter) for the hydrogen purchase scenario. Biomass costs of $50 and $100 per short ton correspond to PVs of $2.57 and $3.62/gal ($0.68 and $0.96/liter) in the hydrogen production scenario. These results are summarized in Table 1.

Companion studies based on similar assumptions of analysis were performed on the cost of biofuels via enzymatic hydrolysis and gasification (see accompanying references). In comparing these studies it appears that fast pyrolysis has the best prospects for cost-competitive biofuels in the near term.

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Has degumming with enzymes come of age?

Flavio Galhardo and Tim Hitchman

The use of enzymes for degumming vegetable oils is hardly new. Such enzymes were first introduced to the industry in the early 1980s. Since then, a steady stream of technical publications has demonstrated that degumming using enzymes is feasible and can be applied to deliver oil that exceeds standard quality specifications. In recent years, the economic benefits of enzyme degumming have also been quantified by several oilseed processors. Although there is a growing body of evidence in favor of enzyme use, many in the industry have hesitated to use the technology. Nevertheless, those processors who have taken the lead in adopting the technology for degumming of crude soybean oil are documenting yield gains of up to 2%. These data allow the industry to establish benchmarks for overall economics of investment for future implementations.

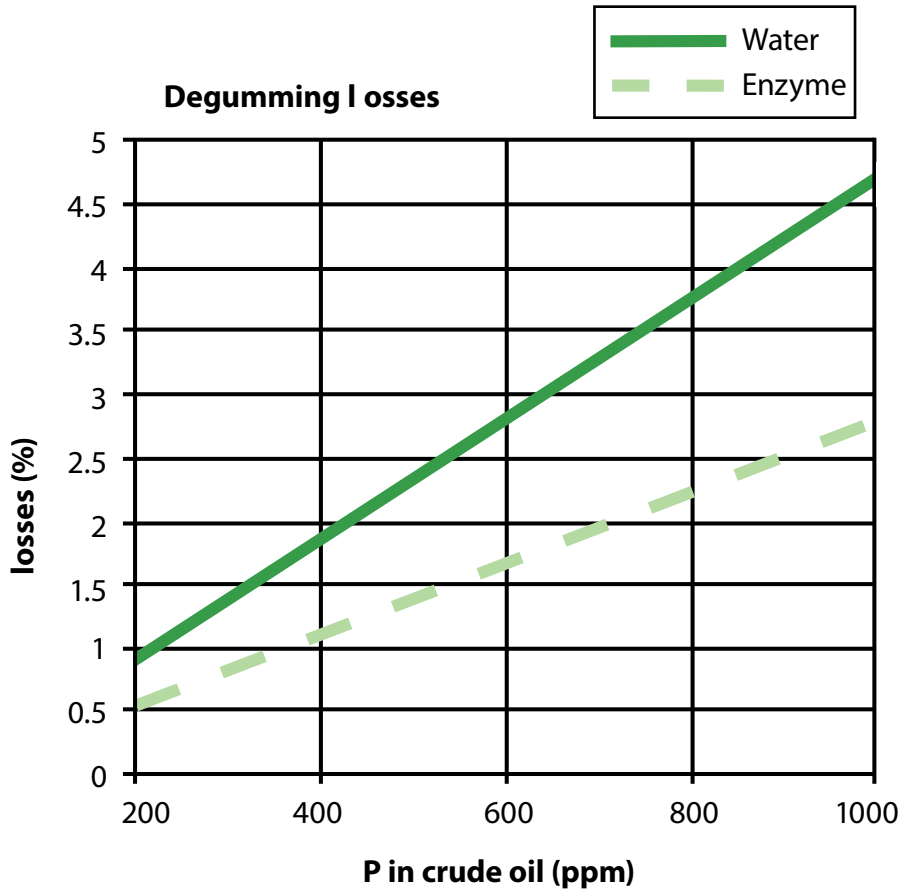

FIG. 1. *Predicted losses of fatty matter from water degumming and enzyme-assisted degumming of crude oils relative to phosphorus content of the oil.*

What exactly do degumming enzymes do?

Let's start with the basics of how enzymes can be used in oil processing.

Degumming is the removal of phospholipid impurities from the oil. This step results in the majority of yield losses associated with purification of crude soybean and canola oils. The reason for the yield loss is that phospholipids are emulsifiers, which "drag" oil with them as they are removed (Fig. 1).

Unlike industrial chemical catalysts, an enzyme is very specific in the reaction it causes. Enzymes used in degumming, called phospholipases, specifically act on the phospholipids without degrading the oil itself. Use of enzymes diminishes the emulsification properties of the phospholipids, allowing for the reduction of oil loss. This happens for two reasons: The total mass of emulsifier is reduced, and the new compounds formed in the reaction have little or no emulsification capability. In short, degumming enzymes cause a reaction of phospholipids and thereby enable a higher yield of oil. The different enzymes that are commercially available for oil degumming differ by the way they act on phospholipids, but all increase the yield of fatty matter recovered through the degumming and refining process.

When implemented correctly, an enzyme-based process is robust, versatile, and creates significant value. Degumming assisted by enzymes can be performed in two different ways: as a substitute for water degumming, leaving 50–200 ppm residual phosphorus in the degummed oil; or as a substitute for acid degumming, leaving just 0–15 ppm residual phosphorus in the oil. The latter process creates oil that can be used directly in physical refining processes and is therefore also a substitute for chemical refining. Let's be clear, however; degumming enzymes are not a panacea and will not solve all process problems. For instance, enzymes degrade

phospholipids and therefore may not be compatible with the production of lecithin.

In both enzyme-assisted degumming processes it is critical to establish and control the process conditions to ensure the maximal conversion of phospholipids by the enzyme. This entails installation of equipment to control enzyme dosage and oil temperature, to ensure adequate mixing of enzyme and water into the oil, and to provide sufficient residence time for the reaction to go to completion. In addition, it is likely that separator settings will need to be modified to account for the reduced volume and changed properties (lower viscosity, higher density) of the gums. Finally, a temperature-controlled storage facility is required to maintain enzyme quality. Without these modifications, suboptimal reaction performance will reduce or negate the economic benefits of using the enzyme. The only ways to be sure of process performance are to work with the enzyme suppliers to measure the reaction caused by the enzyme, and to carefully monitor oil yields in the plant.

Elements for a successful implementation

The industry today has become accustomed to engineering service and equipment providers offering performance guarantees for conventional processes that are based on simple analytical methods and controls. In the case of degumming assisted by enzymes, some new elements are necessary in order to elucidate plant performance and, therefore, the value of the technology:

■ *Measurement of performance of existing processes.* Unfortunately, baselines for conventional process losses in plants are often not clear. This is particularly true for water degumming, where very little attention is paid to the causes of oil losses. The yield gains generated by new processes based on enzymes are calculated relative to losses in conventional processes. Therefore, great care should be spent on evaluating (or modeling, in the case of plants proposed for construction on undeveloped land, i.e., greenfield plants) losses occurring while operating water degumming. The solution is to invest in yield-monitoring tools such as mass flow meters and custody transfer automation before converting to the new enzyme-based process. After the new process is implemented, the same measurements can then be used to confirm the improved performance of an enzyme-based process relative to the traditional process.

■ *Measurement of enzyme performance in plants.* Since the industry is accustomed to performance guarantees, there is an expectation that new processes will be implemented under similar terms. Obtaining the yield gain benefit from an enzyme-based process is based on the enzyme reacting well and on the capture of the extra oil through the equipment used in the process. The former is met by quality assurance guarantees provided by the enzyme manufacturer. Proving the quality and reaction performance requires advanced analytical methods not available in the plant, but can be achieved by regular and frequent transfer of process samples from enzyme customer to enzyme supplier for analysis. Ensuring capture of the yield gain means that equipment suppliers must also provide mechanical guarantees for the equipment used in the process, particularly components that impact enzyme reaction and separation of the reacted materials from the oil.

Ultimately, though, technical success of implementing a new process is not enough. The plant has to realize the benefits that were expected. These can only be accomplished if all stakeholders—processors, engineering companies, and enzyme suppliers—come to a common understanding of the language and metrics to describe the process.

Current market drivers for introducing enzyme-assisted degumming processes

Several recent changes in the oilseed processing industry are accelerating adoption of degumming assisted with enzymes. Some of the most important relate to the economic gains expected from these processes:

■ *High oil prices.* Current market conditions may allow the cost of plant modifications to be paid back through gains sooner than previously anticipated. However, return on capital investment depends on many factors, including the value of meal (if gums are sent back to the crushing operation) and the cost of enzymes.

■ *Growth (and consolidation) of the biodiesel industry.* Biodiesel production is growing rapidly, particularly in South America, so biodiesel producers integrated with crushing operations can take full advantage of the additional oil yield. There are now several examples of installation of enzyme-based oil pretreatment processes in biodiesel production. These are providing the whole

industry with robust examples that will reinforce the coordinated role of enzyme and equipment suppliers in enabling predictable return on investments.

■ *Increased automation and analytical capabilities in plants.* Practices common in petrochemical, oleochemical, and dairy industries are becoming more usual in oilseed plants. Tools more commonly used include advanced process controls, such as mass flow meters, and advanced analytical tools that give plant operators the confidence that they can reliably extract the full value created by the enzyme. The result is a great reduction in the perceived gap between normal practice and the required sophistication of enzyme processes.

Expectations of value created by degumming with the assistance of enzymes

It is impossible to provide a one-size-fits-all scenario for the value created by adopting processes using enzymes. This is partly because the impurity content and profile of the crude oil extracted from the seeds differ greatly from plant to plant (and over time in the same plant), and also because the nature of gums in crude oil depends on several factors such as source of beans or seeds, preparation and extraction techniques, and others. However, the 1–2% yield gains being reported from use of degumming enzymes are greater than any other recent process improvements have been able to provide. This magnitude of value addition is compelling to an industry challenged to continually improve oil yields. Furthermore the economics of investment are very attractive. In greenfield projects, the additional cost of implementing an enzyme-based process is small compared with the overall project cost, and the cost of modifying existing plants is quickly returned through the extra oil generated. All things considered, we are confident in saying, "Yes, degumming with enzymes has come of age."

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News & Noteworthy

Briefs

The Tanzania Daily News reported in March that the majority of sunflower processing factories in Tanzania had stopped production due to a sunflowerseed shortage. Sunflower oil prices in that market increased by 71%, and the managing director of one processing factory was quoted as saying that an unreliable market had discouraged farmers from growing sunflowers. However, sources within the edible oil industry said that the prices of oilseeds produced in the country had almost tripled since the government discontinued the Value Added Tax on manufacturers that used locally produced seeds in their processing and production of cooking oil.

■■■

Solae, LLC, was recognized by the Ethisphere Institute as one of the World's Most Ethical Companies for the second year in a row. Solae was the only food ingredients company among those named in 2011. The list of 110 companies included businesses in 38 industries—43 of which are headquartered outside the United States. Solae, which is based in St. Louis, Missouri, USA, manufactures soy-based food ingredients.

■■■

The global soy chemicals market is poised to reach $13 billion by the year 2017, according to a new report by Global Industry Analysts, Inc. of San Jose, California, USA. Growth will be spurred by high demand from the biodiesel market and growing adoption of alternative renewable sources of energy. Soy-derived chemicals such

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Starch-controlling gene fuels more protein in soybean plants

A newly discovered gene introduced into soybean plants increased the amount of protein in the plant's seeds by 30 to 60%.

The gene, found only in *Arabidopsis thaliana* plants, was placed into the soybean plants by Eve Wurtele, professor of genetics, development, and cell biology at Iowa State University (Ames, Iowa, USA) and Ling Li, an adjunct assistant professor and an associate scientist working in her laboratory. The results were a pleasant surprise as the function of the gene, known as QQS, was previously unclear because its sequence is very dissimilar from all other plant genes.

"Most genes contain clues in their DNA sequence as to their biological function," said Wurtele. "But this one has no sequence features that gave us any hint of what it's doing."

Arabidopsis is a small flowering plant in the mustard family that is often used in scientific research. When the researchers neutralized the gene in the plant, they discovered the gene was involved in regulating starch accumulation, called deposition.

"Based on the changes in activities of other genes that occurred when we altered QQS, we conjectured that it was not directly involved in starch synthesis, but rather it may be involved in altering [the plant's] composition in general," Wurtele explained. "We decided to test this concept by transferring the gene to an agronomically important plant species, soybean, which has a seed and is important as a source of vegetable protein and oil."

In addition to having a DNA sequence that is not similar to any other gene in that or any other plant, the gene also is unusual because it has only 59 amino acids. The median size of a gene in *Arabidopsis* plants is 346 amino acids. Wurtele hopes that the discovery may lead to a greater understanding of other genes that do not have recognizable functionalities based on their sequences.

EFSA reports exposure data on acrylamide

It is a case of good news/bad news as far as voluntary acrylamide mitigation efforts go in the European Union (EU).

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as soy-based foamed plastics, polyols, methyl soyate, fatty acids, and waxes were singled out as having tremendous potential. The report noted that petrochemical and crude oil price increases and rising environmental concerns generated several opportunities for sustainable/renewable raw materials that bode well for soybeans and chemicals made from sunflowers, corn, algae, and other renewable sources.

■■■

The Roundtable on Sustainable Palm Oil (RSPO) issued an announcement on April 5, 2011, regarding a local dispute over plantation land occupied by IOI Pelita Plantation Sdn. Bhd., a 70% subsidiary of IOI Corporation Bhd. (IOI; Kuala Lumpur, Malaysia) with a Sarawak state agency as the other shareholder. The RSPO stated that it had suspended IOI Group's green certification activities and gave IOI 28 days to develop an acceptable solution. IOI agreed to work closely with RSPO to develop a solution, explaining that the decision will not affect its sale of RSPO-certified palm oil to its existing customers. IOI is Malaysia's second-largest producer of palm and palm kernel oil.

■■■

Switzerland's Barry Callebaut, a manufacturer of cocoa and chocolate products, has opened a new research and development laboratory and pilot plant at its cocoa products factory in Eddystone, Pennsylvania, USA. The pilot plant will enable the company to produce cocoa liquor, cocoa powder, and cocoa butter from any cacao bean blend in small batches, as well as test new products and raw ingredients, prior to producing them on a mass scale. Previously, pilot-scale research and development work in the area of cocoa could only be done in the company's cocoa processing facility in Louviers, France. ■

That is, according to a report published in April 2011 by the European Food Safety Authority (EFSA) on acrylamide levels in food that includes an estimated exposure assessment for different age groups. The report is based on data submitted by Member States between 2007 and 2009 and will be used by the European Commission (EC) and EU Member States to help assess the effectiveness of voluntary measures taken by the food industry to reduce acrylamide levels.

When comparing data from 2007 with those from 2009, the report identified a trend toward lower acrylamide levels in only three out of 22 food groups (acrylamide levels decreased in crackers, infant biscuits, and gingerbread). Over the three-year monitoring period, acrylamide levels increased in crisp bread and instant coffee and remained unchanged in a number of other food groups. The highest average levels of acrylamide were found in such foods as potato crisps and coffee substitutes, which include coffee-like drinks derived from chicory or cereals such as barley.

That was the bad news. The good news is that exposure estimates for the different age groups were comparable with those previously reported for European countries.

Acrylamide typically forms in starchy food products during high-temperature cooking, including frying, baking, and roasting. An EFSA statement in 2005 noted that there is a potential health concern with acrylamide consumption because the compound is known to be both carcinogenic and genotoxic (that is, it can cause damage to the genetic material of cells). Following a recommendation by the EC in 2007, Member States have been asked to perform yearly monitoring of acrylamide levels and to submit the data to EFSA for assessment and compilation in an annual report.

This latest report also includes an estimate of acrylamide exposure in different age groups in Europe. The pooled monitoring results submitted by Member States were combined with individual dietary information from the EFSA Comprehensive European Food Consumption Database to establish exposure to acrylamide through food.

Fried potatoes (including French fries), roasted coffee, and soft bread were identified as the major contributors to acrylamide exposure in adults; fried potatoes, potato crisps (chips), biscuits, and soft bread were identified as the major contributors to exposure in adolescents and children. The exposure estimates for these different age groups in Europe were comparable to those previously reported in scientific literature and in risk assessments carried out by the Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives (JECFA). After its risk assessments, JECFA concluded that acrylamide consumption may be a human health concern and that efforts should be made to reduce exposure.

As in previous annual acrylamide reports, EFSA concluded in 2011 that the voluntary measures developed by industry to reduce acrylamide levels in foods—the so-called toolbox approach—have had only limited success. To lower overall exposure, levels must be reduced in food groups that contribute the most to acrylamide exposure, EFSA said. The agency also recommended that sampling in future years should be consistent by covering the same products and must contain "sufficient sample numbers in each food group to make interpretation of results easier and to establish clear statistical trends."

The full report is available at http://tinyurl.com/EFSAacrylamide.

Global oilseed production expected to reach 447 million metric tons

Global oilseed production for 2010/2011 is likely to reach a total of 447 million metric tons, according to a US Department of Agriculture's World Agriculture Supply and Demand Estimates (WASDE) report released on April 8, 2011.

The projection is based on expectations that higher soybean, sunflowerseed, and rapeseed production will more than offset lower cottonseed production. Global soybean production has already increased 2.6 million metric tons (MMT) to 261 MMT, and Brazil is expected to produce a record 72.0 MMT (2 MMT more than was last projected) due to ample moisture and favorable late-season weather in the southern states that improved yield prospects. Meanwhile, soybean production for Paraguay is projected at 8.1 MMT, up 0.6 MMT, also based on higher yields.

The forecast for global rapeseed production was raised 0.2 MMT to 58.6 MMT owing to increased output in Russia, whereas global sunflowerseed production was also projected to be higher as increased production in Argentina and Turkey more than offset reductions for India and Russia.

Other changes include reduced cottonseed production for Pakistan and Turkey, and higher cottonseed production for Brazil. Malaysian palm oil production is reduced 0.5 MMT to 17.5 MMT owing to lower than expected yields.

Meanwhile, a lower soybean crush led by Argentina and China is expected to be only partly offset by increased rapeseed crush, with the largest gains expected in Mexico, Pakistan, and United Arab Emirates. Global oilseed stocks were raised 2.5 MMT, with the largest gains for soybeans in Brazil and Argentina.

New UC Davis report replicates 2010 olive oil data

A second report from the University of California Davis Olive Center (USA) again found that almost three-quarters of a number of popular brands of imported extra virgin olive oil taken from California grocery shelves no longer fit the definition under international quality standards.

The report, entitled "Evaluation of Extra-Virgin Olive Oil Sold in California," was released in April 2011 and is available online at http://tinyurl.com/UCDavisOliveOil2. A full review of the report, as well as reaction from the International Olive Council and North American Olive Oil Association, will appear in the July/August issue of *inform*.

Drops in penguin numbers linked to shrinking availability of krill

Dramatic reductions in the availability of Antarctic krill have reduced the number of penguins living in the Antarctic Peninsula by more than 50%, according to a study published online April 11, 2011, in the *Proceedings of the National Academy of Sciences* (doi: 10.1073/pnas.1016560108).

The study, which was based on the long-term monitoring of krill and penguins in the South Shetland Islands and data from other sites throughout the Scotia Sea and the West Antarctic Peninsula, called into question a popular hypothesis that the world's populations of ice-loving penguins are decreasing with global warming and the consequent shrinking of winter ice, while species that avoid ice are on the rise. If that were correct, numbers of Adélie penguins, which winter on pack ice, would decline as temperatures warmed, while chinstrap penguins, which winter in the open water, would flourish.

On the contrary, the scientists from the National Oceanic and Atmospheric Administration (La Jolla, California, USA) and the Scripps Institution of Oceanography (La Jolla, California) observed that both species had declined dramatically in the past 30 years. They also noted a similar rapid decrease in the penguins' chief food source: krill. Local populations of these tiny shrimp-like creatures had declined by 40 to 80% during the same time period—primarily owing to rapidly warming temperatures in the area but also owing to increased pressure from larger predators that eat krill, such as whales and seals. (Populations of these animals have recovered since whaling and sealing shrank their numbers.) This led the researchers to propose that the shrinking supply of krill was responsible for the precipitous drop in penguin populations.

The finding will likely result in increased monitoring of penguins and krill and could prompt further evaluations into the sustainability of krill harvesting in the Antarctic. Krill are high in long-chain polyunsaturated omega-3 fatty acids, and the growing human demand for such oils has stepped up efforts to harvest the creatures for their oil and use as fish food. (See *inform 18*:588–593, 2007.)

Australians race to develop plant-based omega-3s

An Australian research alliance has joined the international race to break the world's reliance on fish stocks for its supply of the vital dietary nutrient, long-chain omega-3 fatty acids. On April 12, 2011, three Australian organizations announced a $50 million research collaboration that will use leading edge gene technology to develop and commercialize vegetable oil that will contain the same DHA (docosahexaenoic acid) long-chain omega-3 fatty acids that traditionally come from fatty cold-water fish.

The pioneering collaboration brings together Nuseed (a wholly owned subsidiary of Nufarm Ltd.), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and the Australian Grains Research and Development Corporation

(GRDC). As part of the project, CSIRO scientists have already made a significant breakthrough by enabling canola plants to generate DHA, something that up until now has only been found in beneficial quantities in ocean-based algae and the fish that eat them. Some land-based plants, such as flax, can produce seeds containing short-chain omega-3 oils, but are unable to produce the more beneficial long-chain omega-3 fatty acids containing DHA.

The three parties have signed two major agreements to develop and market plant-made DHA-rich oils through biotechnology. The first agreement is a multiyear collaborative research project to achieve a series of development milestones and complete a broad range of studies. The second agreement is a global exclusive commercial license to Nuseed for existing and co-developed long-chain omega-3 intellectual property.

DHA and EPA (eicosapentaenoic acid), another long-chain omega-3 fatty acid, have well-documented roles in heart and brain health, child and infant development, and the treatment of inflammation. The awareness of their health benefits and inclusion in diets—either as supplements or as fortification in processed foods—have grown exponentially over the last decade. The Global Organization for EPA/DHA (GOED; Salt Lake City, Utah, USA) currently values the total long-chain omega-3 market at $18.6 billion.

The CSIRO has long led the way in research aimed at developing plants, through the transfer of genes from one plant (microalgae) to another (canola), which can produce the omega-3 fatty acids typically found in fish oil. The first phase of the project is to assess milestones, obtain regulatory approval, and introduce a canola-based product in Australia. The new collaboration will test elite canola lines as early as 2013 and have seeds commercially available by 2016.

The GRDC provided financial support to assist in the development of the technology to make the production of the special canola possible, and Nuseed has joined to support the next stage of development, regulatory approval, and global commercialization.

GRDC Managing Director John Harvey said, "Plant-based omega-3 oil production is a sustainable, long-term solution to the growing demand for omega-3 oils. This alternative long-chain omega-3 canola oil will provide Australian growers with an exciting new variety for domestic and international grain markets."

Low fertilizer use drives deforestation in West Africa

Low-input farming of cacao, cassava, and oil palm has resulted in widespread deforestation and degradation of West Africa's tropical forest area, according to a new study by researchers at Nigeria's International Institute for Tropical Agriculture (IITA) and Indonesia's Center for International Forestry Research (CIFOR). The study was published online April 8, 2011, in the peer-reviewed journal *Environmental Management* (doi: 10.1007/s00267-010m-9602-3).

Cacao production in West Africa is an important commercial sector and a source of livelihoods for about two million households in the region. For the last 20 years, Côte d'Ivoire has been the largest producer in terms of both output and numbers of producers, followed by Ghana, Nigeria, and Cameroon, with these four countries now accounting for 70% of global cacao supply.

According to the study, cacao production in West Africa's Guinean Rainforest region doubled between 1987 and 2007, but most of this increase was fueled by clearing forest areas resulting in large losses of biodiversity and high carbon emissions.

The Guinean Rainforest (GRF) of West Africa, identified over 20 years ago as a global biodiversity hotspot, had been reduced to 11.3 million hectares (ha) , or 18% of its original area, by the start of the new millennium, the researchers reported. The principal driver of this environmental change has been the expansion of low-input smallholder agriculture that depends on environmentally destructive practices such as slash-and-burn and land clearing.

Researchers at IITA found that increasing fertilizer use on cacao-timber farms would have spared roughly 2 million ha of tropical forest from being cleared or severely degraded.

They also suggested that farmers could have achieved the same outputs without rampant deforestation through the intensified use of fertilizer and agrochemicals coupled with improved crop husbandry. By doing so, farmers would have doubled their incomes and helped to avoid deforestation and degradation of 2.1 million ha.

The IITA researchers noted that the limited use of fertilizer in the GRF (less than 4 kg of total nutrients/ha) may have been logical in 1960, when West African populations were only 25% of today's levels and forest land was still relatively abundant. That choice is no longer tenable in a context where only 15 to 20% of the GRF remains. There are no longer any frontier forests in West Africa for future generations to exploit, the researchers noted. Further, they suggest that strategies to reduce deforestation and conserve biodiversity in West Africa must focus on transforming agricultural practices from traditional to modern science-based methods.

Honey bees increase crop yields in Pakistan

Pakistan Press International (*PPI*) reported on April 15, 2011, that sunflowerseed growers in Matli and Golarchi, District Badin, have recorded a 22% increase in the crop yield owing to honey bee pollination field trials at their farms during the last year.

According to the *PPI* report, Shah Farms Pakistan has since begun an adaptive research project with sunflower growers of interior Sindh. *PPI* described a field day held April 14, 2011, in which apiculturist Asim Zafar of Shah Farms told sunflower growers of the area as well as a group of agriculture scientists and students of Tando Jam University that Pakistan can overcome the problem of declining agricultural productivity through planned honeybee pollination activities across Pakistan. The story quoted Zafar, who said that Pakistan loses millions of dollars each year by having low farm output that is also attributed to very low or no honeybee pollination activities at all.

"By developing the pollination industry the quality and quantity of the production of fruits, vegetables, and horticulture sector for producing export-quality products, including honey, can be increased many folds in the country, which can not only ensure food security through increased productivity but can also earn millions of dollars of foreign exchange through fruits, vegetables, and honey exports," the report noted.

Fat turned to soap in sewers causes overflows

Researchers from North Carolina State University (Raleigh, North Carolina, USA) have discovered how fat, oil, and grease (FOG) can create hardened deposits in sewer lines: It turns into soap. The hardened deposits, which can look like stalactites, contribute to sewer overflows.

"We found that FOG deposits in sewage collection systems are created by chemical reactions that turn the fatty acids from FOG into, basically, a huge lump of soap," said Joel Ducoste, a professor of civil, construction and environmental engineering and co-author of a paper published online in *Environmental Science & Technology* on April 21, 2011. In the paper, Ducoste and his colleagues described how hardened FOG deposits reduce the flow of wastewater in the pipes and contributed to sewer overflows, which can cause environmental and public-health problems and lead to costly fines and repairs.

The research team used Fourier-transform infrared spectroscopy to determine each sample's molecular composition and confirm that the hardened deposits were made of calcium-based fatty acid salts—or soap.

The FOG itself does not create the deposits. It must first be broken down into its constituent parts: glycerol and free fatty acids. Those free fatty acids—specifically, saturated fatty acids—react with calcium in the sewage collection system to form the hardened deposits.

"Until this point we did not know how these deposits were forming—it was just a hypothesis," Ducoste says. "Now we know what's going on with these really hard deposits." ■

Biofuels News

ETHANOL

USDA proposes funding for flex-fuel gas pumps

A US Department of Agriculture program will provide funding for the installation of flexible fuel pumps at the nation's gas stations. This action is intended to provide fuel station owners with incentives to install flexible fuel pumps, sometimes referred to as "blender pumps," that will offer Americans more renewable energy options. The Obama administration has set a goal of installing 10,000 flexible fuel pumps nationwide within five years.

Today, most cars, light trucks, and sport utility vehicles in the United States are fueled by a mixture of 10% ethanol and 90% gasoline (E10). Only about 3.2–3.5% of the approximately 250 million vehicles on the road are flexible fuel vehicles (i.e., are fueled with E85). And of the approximately 167,800 fuel stations in the country, only about 2,350 offer E85.

Results of research carried out the by US Environmental Protection Agency [*inform* *21*:616, 678, 761 (2010); *22*:118, 141 (2011)] found that US vehicles made in 2001 and since are able to run on ethanol/gasoline blends higher than E10.

German drivers distrust E10

On January 1, 2011, German fuel stations introduced E10 (10% ethanol plus 90% gasoline) for use in gasoline-powered vehicles, in compliance with European Union (EU) rules requiring reductions in CO_2 emissions associated with combustion of E10. Experts have estimated that perhaps 7% of German cars cannot use E10. But acceptance of the new fuel throughout Germany has been quite slow because drivers fear damage to their car engines. Even the German federal police service decided not to use E10 fuel in its cars to avoid potential damage.

Instead, drivers have largely avoided E10 by fueling with "super gasoline," an E5 blend that contains greater amounts of octane-boosting ethers.

Briefs

As reported by ADPNews (http://adpnews.info/?nid=439abdfd1832f427), a study by the agricultural association Consorcios Regionales de Experimentacion Agricola (CREA) found that Argentina's biodiesel industry consumed 26% of the country's soy crop in 2010. Last year, Argentina produced 55 million metric tons (MMT) of soybeans. Thus, 14 MMT were used to produce 2.6 MMT of biodiesel. Of that total, 1.1 MMT was sold in the domestic market; the rest was exported.

■■■

A market research report published by MarketsandMarkets on April 7 said that the production of bioethanol and biodiesel in top and emerging countries (e.g., United States, Brazil, France, Spain, India, Colombia, Thailand, Sweden, Belgium, and the Netherlands) is expected to grow from 103,000 million liters in 2011 to 151,000 million liters in 2016 at a compound annual growth rate of 8% for the same period. Highest growth rates are anticipated in Sweden, Colombia, India, and Thailand. Information about purchasing the report is at www.marketsandmarkets.com/Market-Reports/biofuels-market-297.html.

■■■

D1 Oils plc (home office: London, UK) announced in mid-April that Siemens (Munich, Germany), one of the world's leading manufacturers of gas turbines, would conduct a trial on behalf of a third party that involved using crude jatropha oil (CJO) to fuel turbines installed on a high-speed ferry. This is one of three trials being undertaken by three separate European multinational businesses, for which D1 Oils has recently supplied over 70 metric tons of CJO. The other trials involve a major fast-moving consumer goods business using CJO to generate power and a leading specialty chemicals business converting CJO into biobased products.

■■■

In mid-April the European Union announced its plan for a new tax structure that would make diesel more expensive than gasoline. The fear is that this move could damage Europe's highly developed market for diesel cars. Under the proposed new regulations, mandated minimum fuel taxes would be based on energy content rather than volume. ■

To allay the fears of drivers purchasing their fuel, Royal Dutch Shell has offered drivers in Germany free insurance against damage from E10. There are caveats, however. The insured car must have been certified as E10-compatible, the driver must have bought at least 80% of the fuel at Shell stations, and the driver is responsible for proving that the damage is linked to use of the biofuel.

As *Chemical News & Intelligence* reported on March 29, Gerd Billen, head of the German consumer lobby group Verbraucherzentrale Bundesverband, said, "Are there really drivers out there who would want to buy a gasoline for which they need insurance?"

BP and Total gas stations have responded by increasing their wholesale purchases of super gasoline, and curtailing those of E10. This action puts them at odds with German and EU authorities who are demanding the use of greener fuels.

On April 13, *Chemical News & Intelligence* said that Peter Ramsauer, Germany's federal transport minister, had indicated that Germany will start fining oil firms if they fail to supply sufficient volumes of E10. He added that it is up to the oil firms to explain the safety of E10 to drivers.

Cellulosic ethanol plant going up in Italy

Mossi & Ghisolfi Group (M&G; Tortona, Italy) and partner Novozymes (Bagsværd, Denmark) broke ground on April 12 for a 13 million gallons/year (50 million liters/year) cellulosic ethanol production facility in Crescentino in northwestern Italy. It is scheduled to be operational in 2012.

According to a company statement, the plant will be 10 times larger than the largest demonstration facilities in operation today and is designed to operate on a multitude of cellulosic feedstocks.

Poul Ruben Andersen, marketing director bioenergy at Novozymes, which will provide the enzymes to break down cellulose, said, "Biofuel made from lignocellulosic biomass is no longer a distant pipe dream. The technology is ready and plants will be built and run on commercial scale, offering a compelling alternative to conventional gasoline."

M&G's plant in Crescentino will be self-sufficient in power. Lignin extracted from biomass during the ethanol production process will be burned in an attached power plant that also feeds excess electricity back to the grid.

GENERAL

US energy production from biomass/ biofuels growing

According to Kenneth Bossong , executive director of the SUN DAY Campaign (Tacoma Park, Maryland, USA; a non-profit research and educational organization that promotes sustainable energy technologies as cost-effective alternatives to nuclear power and fossil fuels), "The share of domestic US energy production derived from renewable energy sources (i.e., biomass/biofuels, geothermal, solar, water, wind) rose to 10.92% in 2010, up from 10.65% in 2009. By comparison, nuclear power's share of domestic energy production dropped from 11.48% in 2009 to 11.26% in 2010."

Furthermore, among renewable energy sources, biomass and biofuels combined accounted for 51.98% of the total, followed by hydropower (30.66%), wind (11.29%), geothermal (4.68%), and solar (1.38%)." Comparison of 2010 production to that in 2009 showed that biomass/biofuels energy increased by 10%.

Bossong's article may be accessed at http://tinyurl.com/biofuel-percentage. His data came from the US Energy Information Administration (www.eia.doe.gov/totalenergy/data/monthly, released March 29, 2011).

Biofuels to be cost-competitive by 2020

The goal of the US Navy is to get 50% of its total energy requirements from alternative sources by 2020. To meet this challenge, industry must produce 8 million barrels of alternative fuels annually, according to a presentation by Navy officials on April 12 at the annual Navy League convention.

When the Navy first began exploring the viability of alternative fuels for use across the fleet, officials worked with Massachusetts Institute of Technology's Sloan School of Management to calculate the price point at which biofuels would be competitive with petroleum-based products. The resulting study showed that cost parity with the existing price of oil would occur slightly after 2020, according to Rear Admiral Philip H. Cullom, director of the Navy's energy and environmental readiness division.

If there are incentives from government to move things, to scale up in industry, then it could happen much more quickly, Cullom said. He added that the parity point could be as early as 2018, or even earlier, depending on the level of incentives.

Thomas Hicks, deputy assistant secretary of the Navy for energy, told National Defense Magazine (April 13; http://tinyurl.com/NationalDefense), "We're looking for something sooner than later. This is a role that the government has played in the past, in terms of moving markets, helping to mature markets," including coal and nuclear power. He added, "We're going to lead the way here as well."

JATROPHA

Yale University/Boeing release jatropha sustainability study

At the end of March, The Boeing Company released the results of a study it had funded on the potential for the sustainable production of aviation fuel from seeds of *Jatropha curcas*. The research, carried out by Yale University's School of Environmental Studies, concluded that jatropha can deliver environmental and socioeconomic benefits in Latin America, if cultivated properly, and can reduce greenhouse gas (GHG) emissions by up to 60% when compared with petroleum-based jet fuel.

The Yale study, conducted from 2008 to 2010, used sustainability criteria developed by the Roundtable on Sustainable Biofuels to assess actual, not theoretical, farming conditions in Latin America.

Jatropha farmers were interviewed, and field measurements were used to develop a comprehensive sustainability analysis of actual projects. The peer-reviewed data are applicable to conditions in Mexico and also provide guidance to Brazilian efforts to develop a commercial aviation biofuels market.

Small- to large-scale farms, ranging from under 10 hectares to more than several thousand hectares, formed the basis of the study. Robert E. Bailis, assistant professor, Yale School of Forestry and Environmental Studies

and principal investigator on the project, said in Boeing's account of the research, "Our team identified dozens of jatropha farmers willing to participate in our research, despite some challenges many encountered with this new crop. For most, this was the first time anyone had studied their efforts. Working with them allowed us to collect detailed data needed to build a comprehensive picture"

A major finding was that prior land use was the most import factor in determining the GHG benefits of a jatropha jet fuel. If jatropha is planted on land previously covered in forest, shrubs, or native grasses, benefits may disappear entirely. If the crop is planted on land that was already cleared or degraded, then emissions reductions can exceed the 60% baseline.

A second finding was that early jatropha projects suffered from a lack of developed seed strains, which led to poor crop yields. Advancing jatropha seed technology is critical, and many Latin American countries are now engaged in supporting such technology development.

The original refereed paper appeared in *Environmental Science and Technology 44*:8684–8691 (2010).m

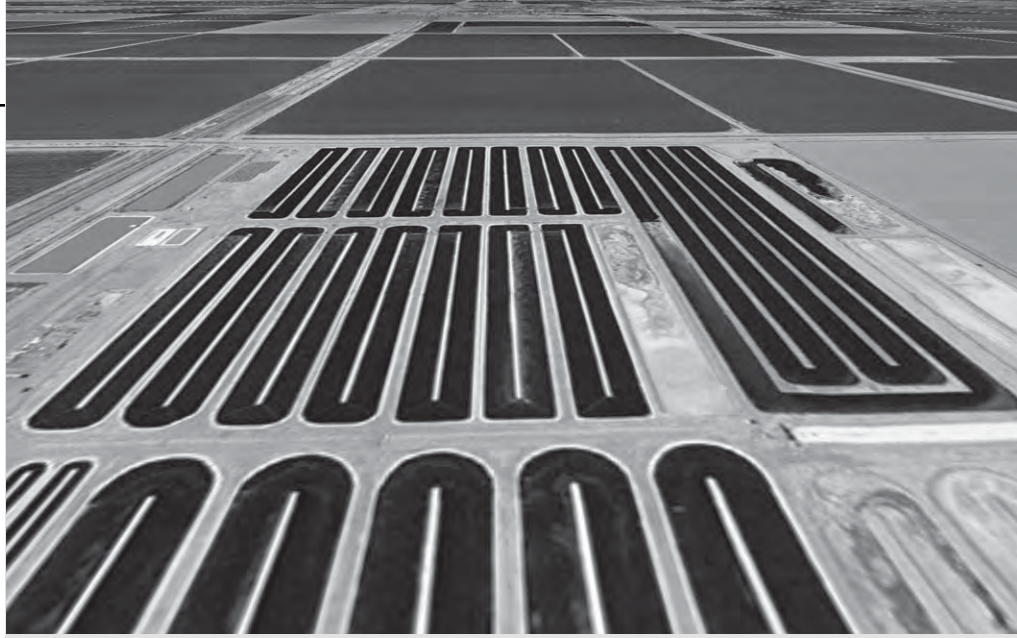
Jatropha fuels Mexican flight

Mexican airline Interjet and plane manufacturer Airbus successfully tested the first jatropha oil-based flight in Mexico on April 1. The A320 flight flew from Mexico City's International Airport to Angel Albino Corzo of Tuxtla Gutierrez airport in the southern state of Chiapas. One of the two engines was fueled with 27% biofuel from jatropha, which was harvested in Chiapas. The fuel was processed by Honeywell's UOP.

Miguel Aleman, Interject president, said, "The test flight is the realization of a two-year ambition for Interjet to develop a production chain for renewable biofuel, with the purpose of creating a Mexican platform for sustainable aviation bio-kerosene."

According to the Interjet web site, the goal of Mexican aviation is to satisfy 1% of fuel demand with biofuels by 2015, or 40 million liters, and 15% by 2020.

In testing jatropha as an aviation fuel, Interjet is following in the footsteps of Japan Airlines, Air New Zealand, Continental, and Brazil's TAM Airline, as well as the US military.



A new PNNL study shows that 17% of the United States' imported oil for transportation could be replaced by biofuel made from algae grown in outdoor raceway ponds located in the Gulf Coast, the Southeastern Seaboard, and the Great Lakes. This June 2010 photo shows raceway ponds in Southern California and was taken by the QuickBird satellite.

Are algae really feasible as fuel?

Great effort—and lots of money—is being expended to develop algae as a feedstock for transportation fuel. There doesn't seem to be a clear answer yet, however, as to whether algae will ever be economically viable for this purpose.

Research out of the US Pacific Northwest National Laboratory (PNNL; Richland, Washington). One of the biggest questions relating to growing algae for fuel is the amount of water needed for these microscopic plants. Researchers at the US Department of Energy's PNNL found that water use for this purpose will be much less if algae are grown in the US regions having the sunniest and most humid climates, that is, the coast of the Gulf of Mexico, the southeastern seaboard, and the Great Lakes.

Mark Wigmosta, lead author and a PNNL hydrologist, analyzed previously published data to determine how much algae can be grown in open, outdoor ponds of fresh water using current technologies. (For the purpose of the study, algae grown in salt water and covered ponds were not considered.)

First, the scientists developed a comprehensive national geographic information system database that evaluated topography, population, land use, and other information about the contiguous United States. This information allowed them to identify available areas that are suited for algal growth. Next, the scientists gathered 30 years of meteorological information to help them determine the amount of sunlight that algae could realistically use to photosynthesize, and how warm the ponds would become.

The researchers found that 21 billion gallons (79.5 thousand million liters) of algal oil, equal to the 2022 advanced biofuels goal set out by the Energy Independence and Security Act of 2007, can be produced with American-grown algae, or 17% of the petroleum that the United States imported in 2008 for transportation fuels. Furthermore, it could be grown on land roughly the size of South Carolina.

The authors also indicated that algae's water use isn't very diff rent from most other biofuel sources. For a standard light-utility vehicle, they estimated growing algae uses 8.6–50.2 gallons of water per mile driven on algal biofuel. Previous research indicated that corn ethanol requires 0.6–61.9 gallons of water per mile driven. For comparison, conventional petroleum gasoline, which doesn't need to be grown—as do algae and corn—uses 0.09–0.3 gallons of water per mile.

Other advantages of algae are that they are productive (algae produce more than 80 times more oil than corn per hectare per year), that algae are not a wide-

CONTINUED ON PAGE 356

BIODIESEL

Australia imposes duties on US biodiesel

In mid-April the Federal Government of Australia announced that it will apply duties on imported US biodiesel, after more than a year of investigating claims that the US has been dumping the fuel. Australian biodiesel producers allege that local producers cannot compete effectively against biodiesel produced in the United States, which has received a subsidy of $1.00 per gallon from the US government. In theory, Australian customs can apply a 95% duty on US biodiesel, according to the Australian Broadcasting Corporation (April 18), but it's likely the duty imposed will be chosen to level the playing field for Australian producers. Biodiesel Producers Ltd. (Barnawatha, Victoria) made the original complaint in June 2010 that led to the government's anti-dumping action.

This action follows imposition of duties by European Union members in 2009 [*inform 20*:219, 420, 511 (2009)] on imports of US biodiesel following similar accusations of dumping. These duties were extended this year (*inform 22*:281, 2011).

Camelina fading

The *Billings Gazette* newspaper (Billings, Montana, USA) reported on April 22 that Montana farmers' interest in planting camelina is waning. The state's farmers traditionally have depended on their wheat crops for income, but camelina has been grown experimentally in the last few years as Montana wheat farmers have searched for another crop that could bring them more profit.

The biggest single reason for the decline in interest in camelina is the rising price of wheat, which is at a historical high. The increase in wheat price results from the record price of corn, which in turn is related to the growing demand for corn for use in the manufacture of bioethanol. Wheat can be used as a substitute for corn in animal feedlots when corn demand is high, giving wheat farmers greater opportunities for profit.

The National Agricultural Statistics Service (NASS) has reported that Montana farmers planted 9,400 acres (3,800 hectares) of camelina in 2010, less than half the area planted just two years ago.

Camelina oil shows promise as an airplane fuel. In March 2011 a US Air Force F-22 Raptor fueled by a 50:50 blend of petroleum-based JP-8 and hydro-processed synthetic fuel derived from camelina oil reached a speed of 1.5 Mach (*inform 22*:279–280, 2011), and camelina oil is developing a good reputation in other airplane applications (*inform 20*:152, 696; *21*:21, 283, 347, 679m, 724–725, 780).

To be accepted as jet fuel for commercial airlines, the fuel must be certified, and that approval has been slow in coming. The *Billings Gazette* said that ASTM is meeting in the third quarter of 2011 to consider standardizing biofuels for commercial planes. Certification of camelina could come then.

Although US plantings of camelina may be down in 2011, statistics issued by NASS on April 20 showed that yields per acre are up, indicating the crop is becoming more viable. Scott Johnson, of camelina company Sustainable Oils (Bozeman, Montana), told the *Billings Gazette*, "That's a little gem of good news. We haven't cut our commitment to our breeding program."

Biodiesel product in Peru

Heaven Petroleum Operators (HPO; Lima, Peru) will invest $186 million to grow *Jatropha curcas* on a 50,000 hectare area in the Ica region of southwestern Peru. Heaven Petroleum's subsidiary Bio Agro Heaven del Sur SAC will develop the project, the objective of which is to produce raw material for biodiesel. The initial step will be to acquire the first 14,000 hectares and start cultivating jatropha immediately, expanding to 50,000 hectares within 10 years. The company expects to obtain 3.7 metric tons of jatropha per hectare a year.

Samir Abudayeh, chief executive officer of HPO, has claimed that owing to minimal cost differences, Peru's main refineries—Petroperu and Repsol—are importing biodiesel from Argentina rather than supporting domestically produced biodiesel. This is not the first time that complaints regarding biodiesel imports into Peru have been voiced. In June 2010, the government of Peru imposed an antidumping penalty of $212 per metric ton on imports of biodiesel originating in the United States (see *inform 21*:490, 2010).

Overcapacity in European biodiesel

Swiss-German biodiesel producer Biopetrol Industries said it would close its biodiesel plant in Schwarzheide in central Germany in June because of continued overcapacity and low earnings. According to the Reuters news agency, the company said the decision was based on continuing overcapacity in the European biodiesel market, which led to pressure on margins and low utilization rates across the industry.

The company said that the Schwarzheide plant, located far from export ports, could only feasibly supply companies in the oversupplied local market. Reuters said that Europe's biodiesel industry is estimated to be working at only half its capacity. Three German biodiesel producers went bankrupt in 2010.

Corn being used for biodiesel as well as ethanol

Planned expansion of corn oil production to all of POET's ethanol plants will produce enough raw material for up to 60 million gallons (230 million liters) of biodiesel annually. POET, headquartered in Sioux Falls, South Dakota, USA, is already selling Voilà™ corn oil from its POET Biorefining (Hudson, South Dakota) plant into biodiesel and feed markets, and its success has prompted POET to start plans for expanding its patent-pending corn oil production process to its other plants. The company expects to begin installation this year on the first plants.

POET claims its Voilà corn oil is a higher-quality product with a lower amount of free fatty acids than other industrial corn oils. The company says its low-energy BPX fermentation process ("cold-cook"), which eliminates heat from fermentation, is the reason for Voilà's quality.

Corn oil also can also be used as an energy component in feed production, and along with the corn oil, POET will soon introduce a new branded distillers product. POET is not considering Voilà for food markets at this time, but it could consider it in the future. Voilà today could be used for other purposes besides biodiesel, including paint, varnish, ink, and detergents. ■

Health & Nutrition News

Researchers find connection between saturated fats and insulin resistance

A diet high in saturated fat is a key contributor to type 2 diabetes, a major health threat worldwide. Several decades ago scientists noticed that people with type 2 diabetes have overly active immune responses, leaving their bodies rife with inflammatory chemicals.

In addition, people who acquire the disease are typically obese and are resistant to insulin, the hormone that removes sugar from the blood and stores it as energy.

For years no one has known exactly how the three characteristics are related. But a handful of studies suggest that they are inextricably linked. New research from the University of North Carolina at Chapel Hill School of Medicine (Chapel Hill, North Carolina, USA) adds clarity to the connection. The study, published online April 10 in the journal *Nature Immunology*, found that palmitic acid, a saturated fatty acid (FA) but not unsaturated FA can activate immune cells to produce an inflammatory protein called interleukin-1β.

"The cellular path that mediates fatty acid metabolism is also the one that causes interleukin-1β production," said senior study co-author Jenny Y. Ting, a professor in the Department of Microbiology and Immunology.

"Interleukin-1β then acts on tissues and organs such as the liver, muscle, and fat (adipose) to turn off their response to insulin, making them insulin resistant. As a result, activation of this pathway by fatty acid can lead to insulin resistance and type 2 diabetes symptoms."

Fish oil boosts responses to breast cancer drug tamoxifen

Researchers at Fox Chase Cancer Center (Philadelphia, Pennsylvania, USA) have discovered that omega-3 fatty acids—abundant in fish—could be a safe and beneficial booster for tamoxifen therapy in women with breast cancer. Jose Russo, director of the Breast Cancer Research Laboratory at Fox Chase, presented their findings on April 6, 2011, at the annual meeting of the American Association for Cancer Research.

Roughly three-fourths of all breast cancers are estrogen receptor (ER)-positive. In these cancers, endogenous estrogen promotes the growth (or recurrence) of the

Briefs

In his controversial new book, *Why We Get Fat* (Knopf, 2010), Robert Wood Johnson Foundation investigator Gary Taubes continues to assert that carbohydrates—not oils and fats—are responsible for weight gain. Taubes is well known to the oils and fats community for his 2001 *New York Times Magazine* article "What If It's All Been a Big Fat Lie?" That article was followed in 2007 by the book, *Good Calories, Bad Calories* (Knopf). In both, he argues against the cholesterol hypothesis of heart disease and the demonization of dietary fat.

On April 13, 2011, Taubes continued to stir the debate with an article entitled, "Is Sugar Toxic?" The article explores the idea that excessive sugar consumption may not only be the primary cause of obesity and diabetes but also cause other chronic ailments. Read the latter article at http://tinyurl.com/TaubesSugar.

■■■

Martek Biosciences Corp. has applied to the UK Food Standards Agency for approval to market algal oil produced from *Schizochytrium* sp. as a novel food ingredient. The oil, known as DHA-O, is rich in both docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) and has a fatty acid profile that more closely represents that of other sources of long-chain omega-3 oils. Martek plans to market DHA-O for uses in biscuits (cookies) and cooking oils as well as at use levels and in food categories that are similar to those currently approved for its DHA-rich oil.

■■■

Technological advances in food production have done as much harm to human health as they have good. That was the conclusion of a commentary by David Ludwig, director of the Optimal Weight for Life program at Children's Hospital Boston, Massachusetts, USA, that appeared in the April 6 issue of the *Journal of the American Medical Association*. Ludwig traced the history of food technology from the time of early hominids to the dissemination of ultra-processed foods. While he recognized food technology's role in feeding the world's population, he concluded that "reducing the burden of obesity-related chronic disease requires a more appropriate use of technology that is guided by public health rather than short-term economic considerations." ■

cancer cells. One way a woman with a ER-positive cancer can combat the disease is by taking tamoxifen, which interferes with the activity of estrogen.

To investigate how fish oil intensifies the effects of tamoxifen, Russo, in collaboration with a team led by Andrea Manni, from Pennsylvania State University (University Park, Pennsylvania), induced mammary tumors in rats and then divided the animals into four groups. They fed the groups either a 17% fish oil diet, with or without tamoxifen, or a 20% corn oil diet, with or without tamoxifen, for eight weeks. They then analyzed gene expression patterns in the tumors. Omega-3 fatty acids produced a greater expression of genes related to cellular specialization, or differentiation—a sign of lower cancer severity—compared to corn oil. The combination of fish oil and tamoxifen reduced the expression of genes linked to tumor growth and spreading.

"If a tumor was being treated with tamoxifen, the addition of an omega-3 fatty acid diet seemed to make the tumor, at least at the molecular level, more benign and less aggressive and responsive to tamoxifen," Russo said.

The fish oil diet also boosted the expression of genes related to immune defenses against tumors, more so than did the corn oil diet. But omega-3 fatty acids simultaneously increased the expression of genes that trigger counterproductive immune responses, such as inflammation and allergic reactions, which curtail the ability of cells to fight cancer and can even promote the migration of tumor cells.

Short-term fat splurges can protect the heart

In a new study in mice, researchers at the University of Cincinnati (Ohio, USA) have found that a high-fat diet for a very short period can protect the heart from heart attacks and result in less tissue damage when heart attacks occur.

Doctoral candidate Lauren Haar presented the team's findings at the Experimental Biology 2011 meeting held April 9–13 in Washington, DC, USA.

Haar explained that the researchers established test groups composed of seven male mice. Female mice were not included to eliminate the effects of estrogen and fat metabolism. Each group was fed a high-fat diet (lard-based, with 60% of the calories coming from saturated fat) for one of the following feeding periods: 24 hours, one-, two-, or six weeks. The control group received a standard grain and vegetable-based diet.

After the feeding periods the researchers induced ischemic injury in the hearts of the mice, similar to what humans experience during a heart attack. The animal hearts were subsequently examined for cardiac function and tissue damage.

The researchers found that injury to the heart tissue among the mice that received the high-fat diet in the short term (24 hours, one- and two-weeks) was reduced by 70% compared to the group fed a high-fat diet for six weeks. Heart damage was greater in the mice fed a long-term high-fat diet (six weeks) than in the control group, indicating that short-term "splurges" were crucial to the impact.

Further, mice that were fed a high-fat diet for 24 hours and resumed a control diet 24 hours prior to having a heart attack experienced a prolonged or late-phase protection against injury, indicating that short-term high-fat feeding in animal models could preserve cardiac function.

The counterintuitive results add to an existing body of research that has found that certain patients with high cholesterol levels have better survival rates after heart injury or heart failure than do patients with lower cholesterol levels. The reason for this phenomenon is unclear.

Haar noted, "We hope that additional studies, which are now underway, will lead us to understand why the cardioprotective effect occurs and why it goes away over time. This understanding will provide us with better insights into the interaction between diet, health, and heart diseases."

Vitamin D deficiency is serious bone health issue for older people

The first findings of the new vitamin D deficiency maps launched by the International Osteoporosis Foundation (IOF) revealed that older people across Europe are not getting enough vitamin D. Vitamin D is essential for bone health and prevents osteoporosis, which exacerbates bone damage from falls and fractures. The findings, released on March 29, 2011, showed that in every European country analyzed to date, vitamin D levels are classified as "insufficient" or "inadequate" among older people.

In the European Union (EU), someone has a fracture as a result of osteoporosis every 30 seconds. With an aging population, the yearly incidence of hip fracture is expected to more than double over the next decade in the EU alone.

Global research for 17 countries in Europe extrapolated the potential cost savings to healthcare systems of up to €187 billion if the problem of vitamin D deficiency is addressed.

Vitamin D improves bone mineral density, which lowers risks of fracture while improving muscle strength, balance, and leg function. Natural production of vitamin D through sunlight decreases with age. It is very difficult to achieve sufficient vitamin D through diet alone, which is why older people are particularly at risk.

The IOF and its project partner Royal DSM (Heerlen, the Netherlands) support an increase in recommended vitamin D intake levels in Europe. They jointly called for evidence-based proposals of 1,000–2,000 IU per day, especially for high-risk groups such as the elderly and postmenopausal women. They have also launched a joint "call to action" together with other patient alliances, which urges Europe's health care decision makers to recognize the vital role of micronutrients in preventive health.

Commenting on the findings, Heike Bischoff-Ferrari, director of the Centre on Aging and Mobility at the University of Zurich (Switzerland), said: "Vitamin D supplementation offers an effective, inexpensive, and safe public health strategy to reduce 20% of falls and fractures, including those at the hip, in a growing senior segment of the European population. This is an enormous public health benefit we could implement now."

Yeast screening method uncovers potential treatment for lipid storage disorder

Many genes that cause human diseases have parallel genes in other organisms, including yeast. Now, researchers at Columbia University (New York City, New York, USA) have used an innovative yeast-based screening method to identify a possible treatment for the fatal childhood disease Niemann-Pick C (NP-C). This "exacerbate-reverse" approach can potentially be used to study any disease. The findings were published online in the *Journal of Biological Chemistry* on April 13, 2011.

NP-C is one of a group of genetic diseases called lipid storage disorders. Lipids are in all of the body's cells. With NP-C, an inability to metabolize lipids properly causes dangerous levels of lipids to accumulate in the liver, spleen, and brain. NP-C is an autosomal recessive disorder; that is, both parents must have the defective gene for their child to have the disease. Tragically, a couple may have several children before realizing that they are carriers.

NP-C is a rare but devastating disease. The symptoms, which usually appear between the ages of four and ten years, begin with problems with balance and gait, slurred speech, and developmental delays. These inevitably progress to severe cognitive decline, dementia, and, ultimately, death. Frustrated families may spend several years seeking a proper diagnosis, while symptoms are misattributed to learning disabilities or "clumsiness."

Stephen L. Sturley, associate professor of clinical pediatrics, and Andrew B. Munkacsi, associate research scientist, showed that an existing cancer drug, suberoylanilide hydroxamic acid (SAHA), developed by Columbia researchers, has the potential to improve three diagnostic criteria of NP-C: (i) accumulation of cholesterol, (ii) accumulation of sphingolipids, and (iii) defective esterification of low density lipoprotein cholesterol. The discovery of a new use for a drug already on the market is always good news, as the drug has already been tested for safety.

Sturley and his team took advantage of the fact that the gene responsible for 95% of NP-C cases has been present throughout evolution, including in the evolutionarily distant yeast. They used what is called a "synthetic lethality screen" on a yeast model of NC-P to determine what combination(s) of otherwise insignificant mutations in two or more genes lead to cell death.

The cell nucleus contains proteins called histones. During histone acetylation, an acetyl group is substituted for a hydrogen atom, and during histone deacetylation, it is removed. When deletion of genes responsible for histone acetylation in the yeast model led to an accumulation of lipids, the researchers hypothesized that an imbalance in histone acetylation caused NP-C disease.

The researchers found that the majority of the 11 histone deacetylase (HDAC) genes were impaired. They then discovered that SAHA, an HDAC inhibitor, repaired the genes. Sturley and his team concluded that the genetic pathways that exacerbate lethality in the yeast model could be reversed in human cells, providing a novel treatment for NP-C. In short, using their exacerbate-reverse approach, they identified the pathways that exacerbate lethality in their yeast model and then used drugs to manipulate those pathways in the opposite direction.

Study shows canola oil protects against colon cancer

Canola oil reduces the size and incidence of colon tumors in laboratory animals, according to a new study by researchers at South Dakota State University (Brookings, USA) that appeared in the February 2011 issue of the journal *Nutrition and Cancer*. The research suggests using canola oil in household cooking may protect against colon cancer development. Chandradhar Dwivedi, professor in the Department of Pharmaceutical Sciences, led the study, which showed that canola oil inhibited the average number of tumors per rat by 58%, compared to one of the other two control diets in the experiment, and inhibited the size of the tumors that occurred by 90%.

"This is the first time anyone has done work on the effect of canola oil in animals on colon cancer prevention. Canola oil was able to reduce the incidence of colon cancer in animals almost to one-third," Dwivedi said.

Colon cancer causes more deaths than any other form of cancer in men and women in the United States. According to American Cancer Society statistics, there were about 102,900 cases of colon and 39,670 cases of rectal cancer in 2010, resulting in an estimated 51,370 deaths.

The research builds on earlier studies by Dwivedi and his colleagues suggesting that omega-3 fatty acids have a chemopreventive effect by inhibiting cyclooxygenase and reducing the synthesis of arachidonic acid, both of which are associated with inflammation. Studies have indicated that if consumers use canola as household cooking oil, it could push their ratio of omega-6 to omega-3 fatty acids to about 3:1.

Mom's diet during pregnancy shapes child's risk of obesity

A group led by Keith M. Godfrey, professor of epidemiology and human development at the University of Southampton (Hampshire, UK), along with collaborators from New Zealand and Singapore, have uncovered new evidence that a mother's diet during pregnancy can alter the function of her child's DNA. The process, called epigenetic change, can lead to her child tending to lay down more fat. Interestingly, the study showed that this effect acts independently of how fat or thin the mother is and of a child's weight at birth.

The epigenetic changes, which alter the function of DNA without changing the actual DNA sequence inherited from the mother and father, can also influence how a person responds to lifestyle factors such as diet or exercise for many years to come.

The researchers measured epigenetic changes in nearly 300 children at birth and showed that these strongly predicted the degree of obesity at six or nine years of age. What was surprising to the researchers was the size of the effect: Children vary in how fat they are, but measurement of the epigenetic change at birth allowed the researchers to predict 25% of this variation.

"This study indicates that measures to prevent childhood obesity should be targeted on improving a mother's nutrition and her baby's development in the womb," said Godfrey.

The study appeared ahead of print in the journal *Diabetes* (http://diabetes.diabetesjournals.org/content/early/2011/04/04/db10-0979.abstract).

EU finds "sufficient scientific evidence" for PUFA health claims

The European Food Safety Administration (EFSA) announced on April 8 that the Dietetic Products, Nutrition and Allergies (NDA) Panel had completed the evaluation of 442 additional general function health claims proposed for use on products.

Claims evaluated with a favorable outcome include the relation between walnuts and improved function of blood vessels, the antioxidant effects of polyphenols found in olive oil on low-density lipoprotein cholesterol, and the relation between caffeine and alertness and caffeine and increased physical endurance.

The panel of experts also concluded that a number of claims based on the replacement of certain nutrients were supported by sufficient scientific evidence. These include the replacement of saturated fatty acids with mono- and polyunsaturated fatty acids to maintain normal blood cholesterol levels; the replacement of digestible starch by resistant starch to lower the increase of blood glucose levels after meals; as well as the role of a range of sugar replacers (e.g., xylitol or sorbitol) in maintaining tooth mineralization or lowering the increase of blood glucose levels after meals.

The panel's opinions will help inform future decisions of the European Commission and European Union Member States, which are responsible for the authorization of the claims. EFSA is scheduled to finalize the evaluation of the remaining 600 general function health claims by the end of June 2011.

Move to block omega-3 claim on infant formula in the EU fails

The controversy over omega-3 claims on infant formula sold in the European Union (EU) appears to have been settled. Makers of infant formula are now free to claim that "DHA intake contributes to the normal visual development of infants up to 12 months of age."

The European Food Safety Authority (EFSA), which is assessing all health claims applications under the Nutrition & Health Claims Regulation, approved the Article 14 health claim submitted by infant formula manufacturer Mead Johnson Nutritionals in March 2009.

Four members of the European Parliament (MEP) subsequently drafted a resolution opposing the claim, arguing that the claim could be misleading because there is no scientific consensus on the effect that DHA-fortified formulas have on infants. The European Parliament voted on the resolution on April 6, 2011, but the resolution did not achieve the necessary majority of votes necessary to veto the claim. MEP Glenis Willmott has since written to the European Commission to block the claim, according to a report by NutraIngredients.com on April 15, 2011. ■

2011

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Biotechnology News

Canola herbicide tolerance licensed

Bayer CropScience (Monheim, Germany) and DuPont (Des Moines, Iowa, USA) announced their entry into a global licensing agreement for a canola herbicide tolerance trait in mid-April. Bayer has licensed its proprietary herbicide tolerance technology, LibertyLink®, to DuPont business Pioneer Hi-Bred for use in canola (*Brassica napus*) hybrids. Pioneer will provide Bayer access to certain proprietary juncea (*B. juncea)* genetics.

"In addition to expanding the Pioneer® brand canola lineup for our customers, the addition of Liberty herbicide tolerance will contribute to sustainable crop protection by rotating herbicides with different modes of action," said Ian Grant, Pioneer business director for Canada.

Canola is grown primarily on about 10 million hectares in Canada, the United States, and Australia while juncea is primarily grown on 7 million hectares in India and has adaptation possibilities in other geographies.

"The access to juncea germplasm will strengthen our long-term global Brassica oilseeds breeding program by expanding our portfolio and providing additional choices to growers," said Joachim Schneider, head of the BioScience Business Unit of Bayer CropScience, in a company statement.

Suit considers GM effects on organic growers

On behalf of 60 family farmers, seed businesses and organic agricultural organizations, the Public Patent Foundation (PUBPAT) filed suit at the end of March against Monsanto Company (St. Louis, Missouri, USA) to challenge the company's patents on genetically modified seed. The plaintiffs decided to sue preemptively to protect themselves from being accused of patent infringement should they ever become contaminated by Monsanto's genetically modified seed despite using their best efforts to avoid it.

The case, *Organic Seed Growers & Trade Association, et al. v. Monsanto*, was filed in federal district court in Manhattan (New York, USA) and assigned to Judge Naomi Buchwald. The plaintiff organizations have over 270,000 members, including thousands of certified organic family farmers.

"This case asks whether Monsanto has the right to sue organic farmers for patent infringement if Monsanto's transgenic seed should land on their property," said Dan Ravicher, PUBPAT's executive director and lecturer of law at Benjamin N. Cardozo School of Law in New York. "It seems quite perverse that an organic farmer contaminated by transgenic seed could be accused of patent infringement, but Monsanto has made such accusations before and is notorious for having sued hundreds of farmers for patent infringement, so we had to act to protect the interests of our clients."

In the case, PUBPAT is asking Judge Buchwald to declare that if organic farmers are ever contaminated by Monsanto's genetically modified seed, they need not fear also being accused of patent infringement. Ravicher added, "Some say transgenic seed can coexist with organic seed, but history tells us that's not possible, and it's actually in Monsanto's financial interest to eliminate organic seed. . . ."

Ben Kampelman, public affairs manager for Monsanto, responded in a written statement: "It has never been, nor will it be Monsanto policy to exercise its patent rights where trace amounts of our patented seed or traits are present in farmer's fields as a result of inadvertent means." He noted that "biotechnology crops have provided a wealth of benefits to farmers and the environment," adding that "these benefits are the reason why farmers have overwhelmingly and willingly chosen to use these technologies year after year." Further, "plaintiffs' allegations regarding patent validity are contrary to long-established legal precedent [that] supports the validity of Monsanto's patents and others in the biotechnology field."

"The plaintiffs' approach is a publicity stunt designed to confuse the facts about American agriculture," Kampelman continued. "While we respect the opinion of organic farmers as it relates to the products they choose to grow, we don't believe that American agriculture faces an all-or-nothing approach."

USDA may outsource biotech research

The US Department of Agriculture (USDA) announced a two-year pilot plan in April in which companies can pay a third-party contractor, approved by the USDA's Animal and Plant Health Inspection Service (APHIS), to carry out environmental assessments (EA) or environmental impact statements (EIS) for proposed new products (e.g., biotech crops). Alternatively, companies can submit their own research, which the USDA will use to

develop its own EA. *The Capital Press* quoted David Reinhold, assistant director for environmental risk analysis programs of APHIS, as saying, "[The consultant is] going to be a specialized company that can do agriculture and (genetic engineering) issues" (http://tinyurl.com/outsource-biotech).

The law requires APHIS to complete these reviews before a transgenic crop can be deregulated.

One goal of the study is to speed the review of genetically modified (GM) crops. According to the Dow Jones Newswire (http://tinyurl.com/DowJonesAPHIS), Karen Batra, spokesperson for the Biotechnology Industry Organization, said, "It now takes seeds nearly seven times as long to win federal approval as it did when the first product was introduced in 1996."

Reinhold told *The Capital Press* that since APHIS employees will not have to write the actual studies, they can expend more effort reviewing the studies. They can ask for further revisions, and still can decide whether to deregulate a crop.

Another goal of the study is to help lower the USDA budget. APHIS indicated that a draft EA can cost $60,000–$80,000, and a full EIS can be $1 million. Having companies do their own environmental assessments, or paying a third party to do so, would lower government costs.

GM crop opponents are concerned that the program will result in biased and inaccurate environmental reviews. Bill Freese, science-policy analyst for the Center for Food Safety (www.centerforfoodsafety.org), a nonprofit environmental group critical of GM products, contends that the issue is not the speed with which a proposed new crop is assessed, but the quality of the review.

Freese further suggests that a company that has already spent millions of dollars to develop a GM seed is unlikely to provide information that would jeopardize its chance to commercialize the seed.

The APHIS announcement of the pilot study appeared in the April 7 *Federal Register* (http://edocket.access.gpo.gov/2011/2011-8329.htm).

What will happen when biotech crop patents expire?

[*This article originally appeared on April 21, 2011, in* Southwest Farm Press. *It is reprinted with permission of Farm Press Publications.*]

Roger McEowen

In the near future, the last of the Roundup Ready (RR) soybean patents will expire.

That expiration will be followed by the expiration of other patents on biotech crops and expiring approvals in overseas markets like the European Union and China.

Those expirations could lead to the planting of so-called "generic" versions of Roundup Ready (RR) seeds that lack approval in overseas markets, complicating the export process and potentially disrupting billions in trade. Whether the expirations will lead to lower seed prices and more choices for farmers is an open question and greater use of the historic practice of saving some seed and replanting it in the next crop season remains to be seen.

But, as patents expire and regulatory approvals for overseas markets become uncertain, a significant question exists as to whether farmers will continue to have access to these markets.

Certainly, as patents begin to expire on various biotech crops, those crops will remain for a period of time in the commercial grain supply chain. That means steps will likely be necessary to ensure the crops will still meet requirements imposed by certain buyers such as the European Union and China. Without those steps, US farmers could face problems in maintaining access to those markets.

Another potential problem. Another potential problem could arise if the holder of the expired patent develops and markets a new product that could potentially compete with the product for which the patent has expired (the so-called generic product).

The patent expiration of the first generation of RR soybean trait in 2014 will be the first time that a major biotech trait will become potentially subject to competition with generic traits. That could result in lower prices and more choices for farmers. That will most likely be the case if Monsanto sticks to its pledges to maintain and extend current licensing agreements and regulatory approval for overseas markets.

Certainly, Monsanto has legal options it can utilize to extend its existing monopoly and prevent competition among generic seed products. It appears at the present time that Monsanto does not plan to utilize those options to the extent of diminishing competition in the seed market. But, this entire matter is one that is developing.

A complete brief on this topic is posted on the Center for Agricultural Law and Taxation website and can be obtained as a pdf from http://tinyurl.com/CALT-patent-expiration. This article looks at the laws governing seed sales and the current landscape.

Roger McEowen is the Iowa State University Center for Agricultural Law and Taxation director and an agricultural law professor. He can be reached at mceowen@iastate.edu or +1 515-294-4076. Source URL: http://southwestfarmpress.com/management/what-will-happen-when-biotech-crop-patents-expire.

Biotech crops boost agriculture

PG Economics, a British company specializing in plant biotechnology, agricultural production systems, agricultural markets and policy, released a report in April entitled "Sustainable, profitable and productive agriculture continues to be boosted by the contribution of biotech crop." Findings of the study included the following:

Biotech crops have reduced greenhouse gas emissions from agricultural practices, owing to less fuel use and more soil carbon storage from reduced tillage with biotech crops. Between 1996 and 2009, biotech crops reduced pesticide spraying by 393 million kilograms (–8.7%).

Adoption of no or reduced tillage practices have become feasible as a result of using herbicide-tolerant biotech crops, especially in South America, thus reducing soil erosion and increasing soil moisture.

Net economic benefits at the farm level amounted to $10.8 billion in 2009 alone, and $64.7 billion in 1996–2009. The gain in farm income in 2009 was equivalent to adding 4.1% to the value of global production of the four main biotech crops: soybeans, corn, canola, and cotton. About 50% of this gain (1996–2009) went to developing countries, and 50% to developed countries.

Biotech traits have added 83.5 million metric tons (MMT) and 130.5 MMT to global production of soybeans and corn, respectively.

Likewise, cotton lint was 10.5 MMT higher than it would have been without biotechnology, and canola was 5.5 MMT higher.

And finally, if the technology for genetic modification had not been available to the 14 million farmers using the technology in 2009, "maintaining global production levels at the 2009 levels would have required additional plantings of 3.8 million ha of soybeans, 5.6 million ha of corn, 2.6 million ha of cotton and 0.3 million ha of canola. This total area requirement is equivalent to about 7% of the arable land in the United States, or 24% of the arable land in Brazil."

The full 173-page report is available for download at http://tinyurl.com/biotech-boosts-ag.

Genetic research to improve oil palms

As part of international Oil Palm Genome Project, Neiker-Tecnalia (the Basque Institute for Agricultural Research and Development) is carrying out research with the International Cooperation Centre in Agronomic Research for Development (CIRAD; Montpellier, France) to improve oil palm crops through genetic enhancement. The biotechnology department of Neiker-Tecnalia is currently working on the development of the marker-assisted selection (MAS) technique with the goal of optimizing the production and quality of this crop. With this technique new genes having important characteristics, such as resistance to diseases, greater production of best quality oil and better adaptation to biotic and abiotic stress, can be detected.

According to FoodNavigator.com (April 12), the Neiker-Tecnalia team said, "Molecular genetic enhancement is seen as a very efficient alternative to using transgenics, which has sparked considerable social controversy."

The MAS method involves identifying a coding DNA sequence within a gene of agricultural interest, or at least near to this gene. These DNA-based molecular markers are relatively simple to use in any state of development of the plant and enable prediction of the agricultural behavior of a genotype, thus accelerating genetic breeding programs.

To obtain molecular markers and to use them in MAS, scientists at Neiker-Tecnalia used the differential cDNA-AFLP (amplified fragment length polymorphism) expression technique. They are also working to construct a reference functional genetic map, the idea being to optimize the efficiency of oil palm improvement programs.

New technologies are being acquired and implemented, using the oil palm as a crop model species. These technologies will also enable the development of applications for other traditional Spanish crops.

Participants in the Oil Palm Genome Project include companies from Malaysia, Indonesia, Brazil, and Colombia. Together they are developing molecular tools for obtaining genomic resources, such as complementary DNAs and useful genes, molecular markers and functional genetic maps.

GM cows produce "human milk"

Scientists headed by Ning Li, from the State Key Laboratory for Agrobiotechnology of China Agricultural University, and from Beijing GenProtein Biotechnology Company reported in March in *PLoS ONE* that they had inserted a gene for lysozyme, a bactericidal protein that protects human infants against microbial infection, into the genome of Holstein cattle. (Lysozyme is found in only trace amounts in cow's milk.)

The cloned cows then expressed the recombinant human enzyme in their milk. Purified recombinant human lysozyme showed the same physicochemical properties, such as molecular mass and bacterial lysis, as its natural counterpart. Levels of lactose, total protein, total fat, and total solids did not differ significantly between transgenic and nontransgenic milk.

The scientists hope that milk from herds of genetically modified (GM) cows could provide an alternative to human breast milk and formula milk for babies.

GM corn for ethanol brings objection

In February the US Department of Agriculture approved a Syngenta (Basel, Switzerland) genetically modified corn intended for ethanol production. The crop, marketed as Enogen, expresses an α-amylase enzyme, which helps break down the starch more efficiently during ethanol production. Until now, ethanol manufacturers bought this enzyme and added it to the corn at the beginning of the production process. Having the corn make the enzyme for its own breakdown is intended to reduce water, energy, and chemical use during ethanol manufacture.

The objections are based on damage that could occur if this corn variety were to enter the food processing stream, where it would damage corn-based food quality. The North American Millers' Association (Washington, DC, USA), which includes companies such as General Mills, ConAgra Mills, and ADM Milling, has pointed to examples of adverse effects such as sticky tortillas, dense corn puffs, and gummy bread.

According to *Nature Biotechnology* (http://tinyurl.com/nature-AlphaAmylase), Jack Bernens, head of technology acceptance at Syngenta, said, "I think they [the Miller's Association] have a legitimate concern."

To counter this objection, Syngenta has said that growers will sign contracts that specify how the corn will be transported and the steps they will take to clean delivery and harvest equipment. Furthermore, the seed will not be allowed to be planted within certain distances—usually 40 miles (64 kilometers)—of food corn mills.

In February the *New York Times* (http://www.nytimes.com/2011/02/12/business/12corn.html) reported that Syngenta expected Enogen would be grown on fewer than 25,000 acres (10,000 hectares) in western Kansas and Nebraska in 2011. The trait has been approved for import into Australia, Canada, Japan, Mexico, New Zealand, Philippines, Russia, and Taiwan, and for cultivation in Canada—and now the United States. ■

Surfactants, Detergents, & Personal Care News

Briefs

Seventh Generation's new 50-ounce (1.5-liter) paper laundry detergent bottle debuted in March 2011 at the Natural Products Expo West in Anaheim, California, USA. Ecologic Brands (Oakland, California) produces the bottles using 70% old corrugated containers and 30% old newsprint; the bottle is actually a shell with a low-density polyethylene liner inside that holds the product, according to *Packaging World* magazine. Seventh Generation is a household and textile cleaning products company based in Burlington, Vermont, USA.

■■■

In related news, The Procter & Gamble Co. (P&G; Cincinnati, Ohio, USA) announced in April it has started producing its new Pantene brand shampoo and conditioner bottles primarily from plant-based plastic from sugarcane. This self-proclaimed fi st for the hair-care industry initially is being introduced in Western Europe, with expansion planned to the rest of the world over the next two years.

■■■

The US Environmental Protection Agency (EPA) has stopped accepting paper submissions for new chemical notices under the Toxic Substances Control Act. Companies must now submit such notices using EPA's electronic PMN software either on optical disk (for one more year) or via EPA's Central Data Exchange (CDX). Optical disks will be phased out by April 2012. For more information on EPA's electronic reporting software and CDX, visit http://tinyurl.com/EPANewChem.

■■■

Ecolab Inc. (St. Paul, Minnesota, USA) received the "Outstanding Contribution in Leading Food Safety Efforts and Driving Sustainability in China" award at the 2011 Food & Beverage Green Tech Asia Forum, held in Shanghai in late March. The Shanghai Food Association (SFA), a trade association for food safety professionals, organized the forum. Ecolab, the only award recipient, was recognized for its outstanding achievements and contributions

CONTINUED ON NEXT PAGE

Unilever and P&G fined for price fixing

Two of the three largest detergent makers in the world—Unilever and P&G—were fined €315.2 million ($456 million) by European Union (EU) regulators in April 2011 for a pan-European price-fixing scheme.

The third member of the big three—Germany's Henkel—reportedly alerted the European Commission to the cartel after the fact and was not fined. Anglo-Dutch Unilever was fined €104 million, whereas P&G (USA) was fined €211.2 million, according to the Reuters news service.

EU Competition Commissioner Joaquin Almunia told a news conference that the price fixing began when the companies were involved in a trade association-led effort to make their detergents more environmentally friendly.

"The three companies took the opportunity of these discussions on environmental agreements promoted by their trade organization to organize a cartel," Reuters quoted Almunia as saying, adding that the three agreed not to decrease prices when making their packages smaller and even agreed later to raise prices.

The cartel affected prices in Belgium, France, Germany, Greece, Italy, Portugal, Spain, and the Netherlands between 2002 and 2005, the report noted.

Henkel officials told Reuters that the company discovered the cartel activity during internal compliance audits in 2008 and immediately informed EU regulators.

ACI fights petition to ban triclosan

In April 2011, the American Cleaning Institute (ACI) urged the US Environmental Protection Agency (EPA) to reject a petition by activist groups to ban the antibacterial chemical triclosan, claiming that the petition is deficient, lacks merit, and uniformly fails to provide relevant evidence.

in both food safety and sustainability. Ecolab provides goods and services to the global industrial and institutional cleaning market.

■■■

Chevron Phillips Chemical Co. LP (Woodlands, Texas, USA) is conducting a feasibility study in advance of constructing a world-scale ethane cracker and ethylene derivatives plant at one of its existing facilities in the US Gulf Coast region. The new facility would utilize feed sources expected from development of shale gas reserves.

■■■

In April, P&G shared the first-year results of its Environmental Sustainability Supplier Scorecard and introduced an upgraded version for 2011. The company designed the scorecard to improve the environmental performance of its nearly 400 suppliers by measuring their energy use, water use, waste disposal, and greenhouse gas emissions on a year-by-year basis. Beginning in 2011, the scorecard results will affect supplier performance ratings and will therefore influence a supplier's opportunity for future business. It has already encouraged P&G's partners to share innovation ideas that can improve the sustainability footprint of the business. Of the scorecards received by P&G, about 40% offered at least one innovation idea, the company said in a news release.

■■■

The top-selling brand of certified fair trade and organic soap worldwide—Dr. Bronner's Magic Soaps of Escondido, California, USA—is now marketing a certified fair trade and organic culinary coconut oil. Bronner's produces its "All-One" Fair Trade and Organic Virgin Coconut oil at Serendipol Ltd. in Sri Lanka's coconut triangle. The company founded Serendipol in an effort to source all of its major raw ingredients from fair trade sources. Bronner's said it has since converted about 500 growers to organic practices, adding that the premium paid by customers funds community development projects, hospital equipment, school facilities, and the supply of water and electricity. ■

In formal comments to the EPA, ACI noted that triclosan is a germ-killing ingredient in personal care and hand hygiene products, which are regulated by the US Food and Drug Administration and not the EPA.

"These products play a beneficial role in the daily hygiene routines of millions of people throughout the [United States] and worldwide," wrote Richard Sedlak, ACI's senior vice president of technical and international affairs.

ACI took exception to the activist groups' request for the EPA to ban triclosan, stating that the agency had already completed a thorough review of the ingredient in a 2008 regulatory decision that formally reregistered triclosan for its use in EPA-regulated products.

The institute pointed to science-based research and data that show triclosan is safe for use in regulated hygiene products, does not cause significant risks or harm to human health and the environment, and does not contribute to bacterial resistance.

"In real-world situations such as the home, food manufacturing, and industrial environments, there is no evidence that antimicrobials can select for antibiotic-resistant bacteria," ACI's Sedlak wrote.

FIRST-EVER SUSTAINABILITY REPORT

ACI also unveiled the first-ever sustainability report for the US cleaning products industry in April 2011. The report showcases aggregated environmental metrics data collected from producers and suppliers of cleaning products.

Twenty ACI member companies participated in the report, which summarizes data on greenhouse gas emissions (GHG), energy use, water use, and solid waste associated with US production of cleaning products. Among the report findings:

Total energy use, which includes electricity, steam, and fuel used by stationary combustion sources, decreased by approximately 18% per metric ton of production between 2007 and 2009.

The rate of GHG emission per unit of production decreased by approximately 25%, reflecting practices put in place to reduce GHG emissions among member companies, also between 2007 and 2009.

Water use decreased approximately 10% per unit of production during the same time period.

Waste generation per unit of production decreased between 2008 and 2009, but increased by approximately 2% overall between 2007 and 2009. (A member company whose overall waste generation is an order of magnitude higher than the other participating companies attributes this increase largely to an increase in waste.)

The *2011 Sustainability Report* is available at www.cleaninginstitute.org. ACI, which formerly was known as The Soap & Detergent Association, is a trade organizations based in Washington, DC, USA.

The cosmetics–biofuels connection

Veteran biofuels analysts presenting at the Advanced Biofuels Leadership Conference in April 2011 suggested that cosmetics may be a stop-gap market for renewable hydrocarbons that may allow the biobased economy "to gain traction and volume sales while the technology matures."

"Cosmetics and personal care markets offer high average selling prices (ASPs) and low volumes to technology that is not yet mature—and drop-in markets are needed to drive rapid adoption," according to *Biofuels Digest*, which sponsored the meeting. "The question becomes: What is the market opportunity in cosmetics and how large can these biofuels developers become before ASPs are negatively impacted? We estimate the current market size for emollients and personal care surfactants used in products such as lipstick and face cream at 150 million gallons [almost 570 million liters], and approximately 10–20% share as the level at which ASPs would start to see a negative impact. To put it in perspective, the entire renewable oils market could be supplied by one 'commercial' biorefinery roughly the size of a small ethanol plant in the [United States]."

EPA acts on wet wipe labeling

The US Environmental Protection Agency (EPA) will now require manufacturers of wet wipes to modify label instructions to ensure end users give the product the proper dwell time, according to *Sanitary Maintenance* magazine.

"Manufacturers are required to state on the label that surfaces must remain 'visibly wet' for the prescribed contact time in order to ensure disinfection. Some end users had been under the impression that simply wiping

People News/ Inside AOCS

Kohntopp promoted

Paul Kohntopp became executive vice president for Anderson International Corp. (Cleveland, Ohio, USA) on March 1; he continues in his position as general manager for the company as well. Kohntopp joined Anderson International in 2009 from a position as business manager for Rockwell Automation (Milwaukee, Wisconsin, USA).

Kohntopp

Anderson International makes equipment for dewatering and drying for a broad range of polymers, vegetable oil extraction systems, pet food and animal feed processing, and animal by-products processing.

Hou elected JOCS fellow

AOCS member Ching T. Hou has been elected as a fellow of the Japan Oil Chemists Society (JOCS). The official recognition was held April 29, 2011, at the annual meeting of the organization in Tokyo. Hou is the first person from outside Japan to be awarded this honor.

Hou is presently a senior research chemist at the Renewable Product Technology Research Unit, National Center for Agricultural Utilization Research, Agricultural Research Service, US Department of Agriculture (USDA), Peoria, Illinois.

Hou

During his 50 years in industry and government research, he has worked with edible oils; mycotoxins; petroleum biotechnology; and antibacterials, antifungals, antivirals and enzyme inhibitors, mainly from microbial sources.

At the USDA laboratory in Peoria, Hou has led a biotechnology group since 1989 whose mission is to convert vegetable oils to value-added products.

Hou is a fellow of AOCS and has served in a number of the organization's activities involving biotechnology. He received the AOCS Award of Merit (1999) and the Biotechnology Division Lifetime Achievement Award (2000). In addition, he was instrumental in establishing the AOCS Asian Section in 2008. Hou is a fellow of the American Academy of Microbiology, and a Fellow of the Society for Industrial Microbiology.

IN MEMORIAM

David George Cornwell

Ohio State University (Columbus, USA) emeritus professor of molecular and cellular biochemistry David G. Cornwell died March 23, 2011. He was born in San Rafael, California, on October 8, 1927.

Cornwell received his B.A. in chemistry from The College of Wooster (Ohio, USA), his M.A. from Ohio State in 1952, and his Ph.D. from Stanford University (Palo Alto, California, USA) in 1955. He held a National Research Council fellowship at Harvard University from 1954 to 1956, then returned to Ohio State where he spent the rest of his professional life. He received emeritus status in 1992.

The body of his published work included 67 papers, the last of which appeared in 2007. His research interests included phospholipids, cell membranes, prostaglandins, fatty acid monolayers, polyunsaturated fatty acids, lipid peroxidation, and tocopherol metabolism.

In addition to being a member of AOCS, which he joined in 1964, Cornwell was active in the editorial process of guiding research papers on lipids through publication. He was a member of the editorial board and the advisory board of the *Journal of Lipid Research*, the editorial board of the *Journal of Nutrition*, and the editorial advisory board of *Chemical Abstracts Service*.

He is survived by his wife Normagene, two children, and five grandchildren.

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a surface and walking away was sufficient for disinfecting. Improper disinfecting can lead to cross-contamination, an especially dangerous problem in healthcare facilities," the report noted.

Similarly, the US Food and Drug Administration (FDA) is, in its words, "cracking down on companies that break federal law by promoting their hand-sanitizing products as preventing MRSA infections and other diseases" minus agency review and approval of such claims.

MRSA (methicillin-resistant *Staphylococcus aureus*) is a bacterium that can cause severe—even life-threatening—infections that do not respond to standard treatment with the antibiotic methicillin.

"Consumers are being misled if they think these products you can buy in a drug store or from other places will protect them from a potentially deadly infection," says Deborah Autor, compliance director at FDA's Center for Drug Evaluation and Research.

Examples of unproven claims found on product labels are:

"Kills over 99.9% of MRSA."

"Helps prevent skin infections caused by MRSA and other germs."

"Is effective against a broad spectrum of pathogens, including MRSA."

"FDA has not approved any products claiming to prevent infection from MRSA, *E. coli*, *Salmonella*, or H1N1 flu, which a consumer can just walk into a store and buy" says Autor. "These products give consumers a false sense of protection."

New discovery could "green up" hundreds of everyday products

The American Chemical Society (ACS) has released a new episode in its "Global Challenges/Chemistry Solutions" podcast series highlighting a discovery that could lead to more environmentally friendly production of a key ingredient used to make everything from paint to detergent polymers.

The podcast and accompanying website focus on a new way to make acrylic acid, a key industrial material that usually is produced from propylene obtained from petroleum. The new process involves development of a catalyst that permits production of acrylic acid without using petroleum. The research appeared in *ACS Catalysis* (*1*:32–41, 2011).

Co-author Weijie Ji of Nanjing University in China says that global demand for the colorless liquid totals about four million metric tons annually. With prices rising, manufacturers have been seeking alternative ways of making acrylic acid without buying propylene. One possibility involves making it from lactic acid. But current processes for using lactic acid are inefficient and consume large amounts of energy.

The scientists' potential solution is a new catalyst that can convert lactic acid into acrylic acid more efficiently, according to Weijie. "We showed that the new catalyst can convert lactic acid to acrylic acid more selectively at lower temperatures. We are very excited about this finding and its potential benefits. The catalyst is not very complicated to prepare."

The new podcast is available without charge at iTunes (http://tinyurl.com/ACSpodcast) and from ACS' website at www.acs.org/globalchallenges.

TSCA reform attempts continue

In April 2011, Sen. Frank Lautenberg (Democrat-New Jersey, USA) introduced the Safe Chemicals Act of 2011—a revision of his 2010 re-doing of the Toxic Substances Control Act of 1976 (TSCA). Changes to Lautenberg's 2010 bill were made in response to concerns raised by both industry and environmental groups, according to Lautenberg's staff.

The original Safe Chemicals Act would require safety testing of all chemicals. Unlike the 2010 bill, however, the new legislation would divide chemicals into three categories. The lowest category would include chemicals that are considered safe. The middle category would involve those that need safety determinations, and the highest category would be for chemicals that require immediate action.

"The new bill introduced today moves in the right direction as it seeks to adopt important concepts of prioritization and tiered minimum dataset requirements," said Chris Cathcart, president and chief executive officer of the Consumer Specialty Products Association (CSPA), in a statement. "These two elements, along with the preservation of a risk-based system, are essential components of any workable regulatory framework under TSCA.

"We remain concerned about other sections of the bill, including . . . the protection of confidential business information and the safety standard," Cathcart said. "A bipartisan dialogue can resolve these issues."

CSPA is a trade association based in Washington, DC, USA. ■

ALGAE FEASIBLE AS FUEL?

(CONTINUED FROM PAGE 341)

spread food source for humans, that they are considered a carbon-neutral energy source, and that they can grow in and clean municipal wastewater of pollutants such as nitrogen and phosphorus.

In a statement from PNNL, Wigmosta said, "Water is an important consideration when choosing a biofuel source. . . . Algae could be part of the solution to the nation's energy puzzle if we're smart about where we place growth ponds and the technical challenges to achieving commercial-scale algal biofuel production are met."

Further information is available at www.pnl.gov/news/release.aspx?id=859. The original research may be accessed at http://tinyurl.com/PNNL-algae-oil.

Research out of Kansas State University (K-State; Manhattan, Kansas, USA). Peter Pfromm led an interdisciplinary team at K-State that analyzed oil produced by algae as a source of biodiesel. The team applied engineering fundamentals—mainly a carbon mass balance—to evaluate the sustainability of algae-derived biodiesel.

The first part of the study focused on the science and technology of algae biodiesel. It showed that from a technical standpoint, producing algae-based biodiesel in a sustainable way works—but not to the extent needed to eliminate dependence on petroleum diesel. From the standpoint of sustainability, they found that the amount of algae diesel produced per day was drastically lower than the projected ideal quantities from many algae production concepts.

Pfromm commented, "We found that phycologists—algae scientists—maintain that some popular estimates of producing 200 to 500 grams of algae per square meter of open pond per day weren't feasible because there's simply not enough sunlight coming through the atmosphere to do so. Unless we can change the sun, such production is physically impossible."

Using a more realistic production number—50 grams per square meter per day—they determined it would take 11 square miles of open ponds making 14,000 tons of algae a day to replace 50 million gallons of petroleum diesel per year, or about 0.1% of the US annual diesel consumption.

The team is now analyzing data on the economics of algae production. Pfromm said, "Once money is involved, technological sustainability becomes theoretical because nobody is going to use the technology or science unless there's an incentive . . . [I]f it takes 20 years before anyone starts making a buck in profit, no one's going to back it."

Open ponds are the cheapest containment unit in which to grow algae. But as a production facility increases in size, so do the number of ponds it operates—and a facility close to 11 square miles in size is a steep investment. These ponds are also problematic because they are prone to invasions by algae-eating organisms or microorganisms that can be spread by the wind.

Growing algae in photobioreactors will stop algal predators and other contamination, but they are much more costly. Cooling becomes a necessity, because sunlight warms the containers and can overheat the algae. A refrigeration unit is too costly, but cooling half-a-million containers with water spraying is also costly. Additionally, the dirty containers have to be cleaned periodically to avoid sunlight-blocking buildup that would limit production.

Pfromm concluded, "Right now, the fundamentals are the problem. . . . The best option right now is to invest in fundamental research and design so that the yield can hopefully reach beyond the 50 grams per square meter per day on our most optimistic assumption."

Further information is available at www.eurekalert.org/pub_releases/2011-04/ksu-epa040511.php. The original report appeared in *Bioresource Technology 102*:1185–1193 (2011).m ■

Patents

Published Patents

Defoamer emulsion compositions for pulp mill applications

Cheng, H.N., *et al.*, Hercules, Inc., US7893115, February 22, 2011

An oil-in-water emulsion useful as a defoamer for pulp and paper mill applications is described. The defoamer has an oil blend (of a triglyceride oil or a mixture of triglyceride oils and silicone), a stabilizing agent (to make the oil blend stable in the emulsion), hydrophobic silica particles, surfactants, dispersants, and other components. The emulsion is usable directly at low concentrations to control foam.

Use of lipid conjugates in the treatment of diseases

Yedgar, S., Yissum Research Development Company of the Hebrew University of Jerusalem, Ltd., US7893226, February 22, 2011

This invention provides compounds represented by the structure of the general formula (A): wherein L is a lipid or a phospholipid, Z is either nothing, ethanolamine, serine, inositol, choline, or glycerol, Y is either nothing or a spacer group ranging in length from 2 to 30 atoms, X is a physiologically acceptable monomer, dimer, oligomer, or polymer, wherein X is a glycosaminoglycan; and n is a number from 1 to 1000, wherein any bond between L, Z, Y and X is either an amide or an esteric bond.

Method for producing multiple unsaturated fatty acids in plants

Cirpus, P., *et al.*, BASF Plant Science GmbH, US7893320, February 22, 2011

The present invention relates to a method for the production of fatty acid esters which comprise unsaturated fatty acids with at least three double bonds, and to free unsaturated fatty acids with a content of at least 1% by weight based on the total fatty acids present in the plants, by expressing at least one nucleic acid sequence which encodes a polypeptide with Δ6-desaturase activity and at least one nucleic acid sequence which encodes a polypeptide with Δ6-elongase activity. Advantageously, these nucleic acid sequences can, if appropriate, be expressed in the transgenic plant together with a third nucleic acid sequence which encodes a polypeptide with Δ5-desaturase activity. The invention furthermore relates to the use of defined nucleic acid sequences which encode polypeptides with a Δ6-desaturase activity, Δ6-elongase activity, or Δ5-desaturase activity selected from a group of nucleic acid sequences, and/or to the use of nucleic acid constructs comprising the abovementioned nucleic acid sequences.

Lipase

Nakao, M., *et al.*, Suntory Holdings Ltd., US7893232, February 22, 2011

The present invention provides a novel lipase with a molecular weight of about 32 kDa, which is produced by a strain belonging to the genus *Tetrasphaera*, as well as a gene encoding the same. This lipase has the ability to recognize a medium-chain fatty acid as a substrate. The present invention also provides a novel lipase with a molecular weight of about 40 kDa, which is produced by a strain belonging to the genus *Tetrasphaera* and has the ability to recognize both a medium-chain fatty acid and a long-chain fatty acid as substrates, as well as a polynucleotide encoding the same. The present invention further provides *Tetrasphaera* sp. strain NITE P-154. The lipase of the present invention can be used as an immobilized enzyme and is useful in fields such as production of digestants and/or flavorings, production of clinical laboratory reagents, detergent enzymes and/or fats, as well as production of optically active intermediates for agricultural chemicals and pharmaceutical preparations.

Safflower with elevated gamma-linolenic acid

Knauf, V.C., *et al.*, Arcadia Biosciences, Inc., US7893321, February 22, 2011

The present invention relates to compositions and methods for preparing γ-linoleic acid (GLA) in safflower plants, particularly from seeds of safflower. Nucleic acid sequences and constructs encoding one or more fatty acid desaturase sequences are used to generate transgenic safflower plants that contain and express one or more of these sequences and produce high levels of GLA in safflower seeds. Provided are transgenic safflower plants and seeds that produce high levels of GLA.

Conjugated fatty acid based emulsion and methods for preparing and using same

Changaris, D.G., US7897160, March 1, 2011

Stable emulsions comprising as a base one or more diene conjugated fatty acids. Amino acids and other macromolecules can be used to stabilize the emulsion. The emulsion is also useful as a carrier and delivery vehicle of the macromolecules to humans or animals in need of the macromolecules. Plant oil extracts, such as conjugated linoleic acid and its acylated derivatives, are useful as the diene conjugated fatty acids that form the base of the stable emulsion. The emulsions formed are useful as nutritional or cosmetic adjuvant for oral-based nutrition, skin diseases, cosmetic utility, enhancing oral nutrition, or pharmacological benefit. Methods of producing and using the emulsions are also provided.

Compounded hydrocarbon oil and oil base drilling fluids prepared therefrom

Dobson, J.R., Jr., *et al.*, Texas United Chemical Co., LLC, US7897544, March 1, 2011

The invention discloses a compounded hydrocarbon oil which comprises a base hydrocarbon oil, preferably a mixture of paraffinic hydrocarbons, propylene carbonate, and a liquid fatty acid containing at least 12 carbon atoms per molecule, preferably tall oil fatty acid. The volume ratio of propylene carbonate to liquid fatty acid is from about 3.5:1 to about 7:1. Preferably the concentration of propylene carbonate is from about 0.002 gal/gal oil to about 0.0057 gal/gal oil and the concentration of the liquid fatty acid is from about 0.0003 gal/gal oil to about 0.0015 gal/gal oil. The invention further comprises a method of compounding the compounded hydrocarbon oil and an oil base drilling fluid prepared from the compounded hydrocarbon oil. Preferably the compounded hydrocarbon oil is characterized by

an increase in the low shear rate viscosity of the oil of at least 5,000 centipoise or mixing 7.5 lb/bbl of an organoclay therein.

Modified whey protein compositions having improved foaming properties

Sorensen, T., and M. Rich, Novozymes North America, Inc., US7897186, March 1, 2011

Methods for improving the foaming properties of whey protein preparations by contacting an aqueous solution containing whey protein with a phospholipase are disclosed. Treatment of a whey protein preparation with a phospholipase results in a whey protein preparation having improved foam overrun and foam stability when whipped, as compared to a whey protein preparation that is not treated with a phospholipase.

Synthesis of purified, partially esterified polyol polyester fatty acid compositions

Schaefer, J.J., and J.E. Trout, The Procter & Gamble Co., US7897699, March 1, 2011

This invention relates to processes for the production of purified, partially esterified polyol fatty acid polyesters and the compositions derived from those processes. The purified, partially esterified polyol fatty acid polyesters of the present invention are particularly well suited for use in a variety of food, beverage, pharmaceutical, and cosmetic applications and comprise less than about 5% polyol; less than about 5 ppm of residual solvent; less than about 700 ppm of lower alky esters; less than about 5% of a soap and free fatty acid mixture; less than about 3% of ash; and have an acid value of less than about 6.

Process to produce an enrichment feed

Sluijmers, J.W., *et al.*, Eastman Chemical Co., US7897809, March 1, 2011

A process is provided for producing enriched carboxylic acid compositions produced by contacting composition comprising a carboxylic acid with an enrichment feed in an enrichment zone to form an enriched carboxylic acid composition. This invention also relates to a process and the resulting compositions for removing catalyst from a carboxylic acid composition to produce a post catalyst removal composition.

Carboxylic acid derivatives

Beumer, R., *et al.*, DSM IP Assets B.V., US7906496, March 15, 2011

The present invention is concerned with novel arylalkyl carboxylic acid derivatives, more specifically, with acylates of arylalkyl carboxylic acids with naturally occurring, non-toxic hydroxy, sulfhydryl, amino or imino compounds, and to compositions containing them. The compositions are preferably cosmetic preparations.

Temperature-sensitive liposomal formulation

Needham, D., Duke University, US7901709, March 8, 2011

A liposome contains an active agent and has a gel-phase lipid bilayer membrane comprising phospholipid and a surface-active agent. The phospholipids are the primary lipid source for the lipid bilayer membrane, and the surface-active agent is contained in the bilayer membrane in an amount sufficient to increase the percentage of active agent released at the phase transition temperature of the lipid bilayer, compared to that which would occur in the absence of the surface-active agent. The surface-active agent is present in the lipid bilayer membrane so as to not destabilize the membrane in the gel phase.

Alternative organic fuel formulations including vegetable oil

Schomann, M., Alternative Fuels Group Inc., US7901469, March 8, 2011

Fuel formulations may be produced from vegetable oil without the need to remove glycerin from the vegetable oil prior to use. The fuel formulations may be used in diesel fuel vehicles and/or as a home heating oil. The fuel formulations may include vegetable oil, kerosene, a fuel stabilizer, and a cetane boost additive.

Two-stage process for producing oil from microalgae

Oyler, J.R., Genifuel Corp., US7905930, March 15, 2011

A process for production of biofuels from algae can include cultivating an oil-producing algae by promoting sequential photoautotrophic and heterotrophic growth. The method can further include producing oil by heterotrophic growth of algae wherein the heterotrophic algae growth is achieved by introducing a sugar feed to the oil-producing algae. An algal oil can be extracted from the oil-producing algae and can be converted to form biodiesel.

Process for preparing an immobilized enzyme

Sato, M., *et al.*, Kao Corp., US7906305, March 15, 2011

Provided is a process for preparing an immobilized enzyme, which comprises the steps of immobilizing an enzyme used for decomposing oil and fat on a carrier, by adsorption, without drying, bringing the immobilized enzyme into contact with a fatty acid triglyceride or fatty acid partial glyceride, or mixtures thereof, and adjusting the moisture content of the enzyme to 5% to 50% by weight based on the weight of the carrier, wherein the enzyme is used for esterification.

Biodiesel production method and apparatus

Woods, R.R., and B. Porter, Primafuel, Inc., US7905931, March 15, 2011

Methods and apparatus for the production of biodiesel are provided. The methods involve converting a fatty acid-rich material to biodiesel using a homogeneous catalyst, followed by electrodialysis of the resulting product to remove the catalyst.

Waterborne film-forming compositions containing reactive surfactants and/or humectants

Bloom, P.D., and T. Tabuena-Salyers, Archer Daniels Midland Co., US7906571, March 15, 2011

The present invention is directed to aqueous coating compositions, such as paints, containing a film-forming latex polymer and a reactive surfactant and/or a low volatile organic compound (VOC) humectant.

The reactive surfactant, a polyglycerol ester or ether of an unsaturated fatty acid, reduces or eliminates the need for traditional water-soluble additives that lower the water resistance of the dry coating. Additionally, the reactive surfactants of the invention are capable of oxidative cross-linking during the curing process, forming a dry film that is more durable and water-resistant than traditional latex paint composition. The low VOC humectant polyglycerol, isosorbide, or a derivative of isosorbide can replace at least in part traditional humectants such as propylene glycol that contribute to VOC, while maintaining an effective open time for application of the aqueous coating compositions.

Electrical contact enhancing coating

Kyle, B.K., and T.R. Mrock, US7910026, March 22, 2011

The electrical contact-enhancing coating is a composition that includes finely divided precious metal particles mixed with a dielectric carrier to form a coating. The dielectric carrier is a vegetable oil (preferably soybean-based) carrier of the type used as a dielectric coolant in power transformers, and is preferably high in antioxidant content. In a first embodiment, the precious metal is 100% silver having an average particle size of about 5–10 μm. In a second embodiment, the precious metal is about 65–85% silver and 15–35% gold (average particle size 0.5–1.8μm), by weight. In a third embodiment, the precious metal is about 65–85% silver, 12.5–30% gold, and 2.5–5% palladium (average particle size 0.5–1.8 μm), by weight. The precious metals may be cryogenically treated prior to mixing with the dielectric carrier.

Methods for identifying the effect of a drug agent on the metabolism of sugars and fats in an individual

Hellerstein, M.K., The Regents of the University of California, US7910323, March 22, 2011

Provided herein are methods for determining the metabolism of one or more sugars and/or fatty acids, and applications thereof. Such applications include determining the rate of glycogen synthesis and glycolysis, which are believed to be early markers for predicting elevated risk of diabetes and cardiovascular disease. Other applications include methods for screening drugs that effect sugar and/or fatty acid metabolism. The methods are useful for at least partially characterizing drugs for desirable or undesirable (toxic) characteristics. Drugs that are at least partially characterized using the methods of the invention can then be further developed in pre-clinical testing and clinical trials. Such drugs may be found to be useful in treating obesity, diabetes, cardiovascular disease, and other disorders of metabolism.

Process for the preparation of fatty acids

Bhaggan, K., *et al.*, Lipid Nutrition B.V./Anqing Zhongchuang Bioengineering Co., Ltd., US7910757, March 22, 2011

A process for the preparation of a material comprising conjugated isomers of a polyunsaturated fatty acid comprises: treating a first fatty acid mixture comprising saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids in the presence of ethanol to form (i) a solid fraction and (ii) a liquid fraction comprising a second fatty acid mixture, wherein the second fatty acid mixture has a higher molar ratio of total polyunsaturated fatty acids to total saturated and monounsaturated fatty acids than the first fatty acid mixture; separating the solid fraction and the liquid fraction; and subjecting the second fatty acid mixture or a derivative or reaction product thereof to treatment with a base in the presence of a solvent, to form conjugated isomers of at least some of the polyunsaturated fatty acids.

Catalytic hydrogenation process for the production of low *trans* fat-containing triglycerides

Hassan, A., *et al.*, H R D Corp., US7910758, March 22, 2011

Hydrogenated vegetable oils exhibiting superior thermal stability and containing reduced levels of saturates and trans fatty acids are produced using an activated hydrogenation catalyst and/or an improved hydrogenation process incorporating high shear. The use of a high-shear mechanical device incorporated into the hydrogenation process as a reactor device is shown to be capable of enabling reactions that would normally not be feasible under a given set of reaction pressure and temperature conditions. For example, the hydrogenation process described herein enables a reduction of hydrogenation time, and operation at lower temperatures than current processes. The resulting hydrogenated vegetable oil is particularly useful in frying, confectionery baking, and other applications where a product with a low trans fat content or higher thermal stability is desirable. The hydrogenated oil produced may comprise less than 10 wt% of trans fatty acids with less than 5 wt% of linolenic acid ($C_{18:3}$).

Process for producing hydrated oily base food

Kato, M., and T. Okawauchi, Fuji Oil Co., Ltd., US7914837, March 29, 2011

Addition of a large amount of a food additive such as an emulsifier to a food is undesirable, since it is feared that not only the flavor of the food is damaged but also the secure sense for the qualities of the product and consumers' buying intention are worsened thereby. It is intended to provide a process for conveniently producing a hydrated oily base food such as a chocolate drink powder while reducing the content of an emulsifier. Namely, an oily base food having a high hydration nature can be produced even by using a small amount of an emulsifier by densely mixing a small amount of a hydrophilic material, which contains a hydrophilic emulsifier as the essential component, with an oil-containing material, or shaping an oil-containing material into flakes or a powder as the final product by roll refining.

Tissue regeneration substrate, complex thereof with cells, and method for its production

Fukuhira, Y., *et al.*, Teijin Ltd., US7915028, March 29, 2011

A tissue regeneration substrate comprising a film with a honeycomb structure composed primarily of a polymer compound and a phospholipid. A tissue regeneration complex comprising the tissue regeneration substrate and cells held in the tissue regeneration substrate. The substrate is particularly suitable for regeneration of cartilage tissue, and allows growth of cartilage tissue in a three-dimensional fashion.

Patent information is compiled by Scott Bloomer, a registered US patent agent with Archer Daniels Midland Co., Decatur, Illinois, USA. Contact him at scott_bloomer@admworld.com.

Extracts & Distillates

Physiological functions and clinical implications of sphingolipids in the gut

Duan, R.-D., *J. Dig. Dis. 12*:60–70, 2011.

Studies of sphingolipids have become one of the most rapidly advancing fields in the last two decades. These highly diverse lipids have been known to have multiple physiological functions and clinical implications in several diseases, including tumorigenesis, inflammation, atherosclerosis, and neural degenerative diseases. Unlike other organs, sphingolipids in the intestinal tract are present not only as lipid constituents in the cells but also as dietary compositions for digestion in the lumen. The present review focuses on the presence of sphingolipids and their catalytic enzymes in the gut, the metabolism and the signaling effects of the metabolites, and their impacts on barrier functions, cholesterol absorption, inflammatory diseases and tumor development in the gut.

Recovery and characterization of α-zein from corn fermentation co-products

Paraman, I., and B.P. Lamsal, *J. Agric. Food Chem. 59*:3071–3077, 2011. l

Zeins were isolated from corn ethanol co-product distiller's dried grains (DDG) and fractionated into α- and β γ-rich fractions. The effects of the ethanol production process, such as fermentation type, protease addition, and DDG drying temperature, on zein recovery were evaluated. Yield, purity, and molecular properties of recovered zein fractions were determined and compared with zein isolated from corn gluten meal (CGM). Around 29–34% of the total zein was recovered from DDG, whereas 83% of total zein was recovered from CGM. Process variations of cooked and raw starch hydrolysis and fermentation did not affect the recovery, purity, and molecular profile of the isolated zeins; however, zein isolated from DDG of raw starch fermentation showed superior solubility and film-forming characteristics to those from conventional two-stage cooked fermentation DDG. Protease addition during fermentation also did not affect the zein yield or molecular profile. The high drying temperature of DDG decreased the purity of isolated zein. SDS-PAGE (sodium dodecyl sulfate-polyacrylamide gel electrophoresis) indicated that all the isolated α-zein fractions contained α-zein of high purity (92%) and trace amounts of β- and γ-zein cross-contamination. Circular dichroism spectra confirmed notable changes in the secondary structure of α-zeins of DDG produced from cooked and raw starch fermentation; however, all the α-zeins isolated from DDG and CGM showed a remarkably high order of α-helix structure. Compared to the α-zein of CGM, the α-zein of DDG showed lower recovery and purity but retained its solubility, structure, and film-forming characteristics, indicating the potential of producing functional zein from a low-value co-product for uses as industrial biobased product.

Comprehensive two-dimensional liquid chromatography with evaporative light-scattering detection for the analysis of triacylglycerols in *Borago officinalis*

Mondello, L., *et al., J. Sep. Sci. 34*:688–692, 2011.

An optimized two-dimensional (2-D) liquid chromatography (LC × LC) setup, based on the different selectivities of a silver ion (Ag^+) and a non-aqueous reversed phase (NARP), employed in the first (D1) and the second dimension (D2), respectively, in combination with evaporative light-scattering detection (ELSD), has been developed for the analysis of the triacylglycerol (TAG) fraction in a *Borago officinalis* oil. The 2-D setup, thanks to the complementary separation selectivity provided by the two columns, allowed the distribution of 78 TAG throughout the 2-D LC retention plane, which is otherwise unachievable by 1-D LC.

Lipidomics at the interface of structure and function in systems biology

Gross, R.W., and X.L. Han, *Chem. Biol. 18*:284–291, 2011.

Cells, tissues, and biological fluids contain a diverse repertoire of many tens of thousands of structurally distinct lipids that play multiple roles in cellular signaling, bioenergetics, and membrane structure and function. In an era where lipid-related disease states predominate, lipidomics has assumed a prominent role in systems biology through its unique ability to directly identify functional alterations in multiple lipid metabolic and signaling networks. The development of shotgun lipidomics has led to the facile accrual of high-density information on alterations in the lipidome-mediating physiologic cellular adaptation during health and pathologic alterations during disease. Through both targeted and nontargeted investigations, lipidomics has already revealed the chemical mechanisms underlying many lipid-related disease states.

Identification of diacylglycerol and triacylglycerol containing 11,12,13-trihydroxy-9,14-octadecadienoic acid in castor oil

Lin, J.T., and G.Q. Chen, *New Biotechnol. 28*:203–208, 2011.

Castor oil has many industrial uses. Molecular species of acylglycerols containing monohydroxy, dihydroxy and trihydroxy fatty acids in castor oil have been reported. We report here the identification of acylglycerols containing a tri-OH18:2 fatty acid in castor oil. The structure of this novel fatty acid was proposed as 11,12,13-trihydroxy-9,14-octadecadienoic acid by the mass spectrometry of the lithiated adducts of acylglycerols in the high-pressure liquid chromatography fractions of castor oil. The fragmentation pathways of the lithiated adduct of 11,12,13-trihydroxy-9,14-octadecadienoic acid were proposed. We also proposed the biosynthetic pathways of polyhydroxy fatty acids in castor.

Selective analysis of lipids by thin-layer chromatography blot matrix-assisted laser desorption/ionization imaging mass spectrometry

Zaima, N., *et al., J. Oleo Sci. 60*:93–98, 2011.

Thin-layer chromatography (TLC) is an essential method for food composition analyses such as lipid nutrition analysis. TLC can be used to obtain information about the lipid composition of foods. However, it cannot be used for analyses at the molecular level. Recently we developed a new method that combines matrix-assisted laser desorption/ionization imaging mass spectrometry

(MALDI-IMS) with TLC-blotting (TLC-Blot-MALDI-IMS). The combination of MALDI-IMS and TLC blotting enabled detailed and sensitive analyses of lipids. In this study, we applied TLC-Blot-MALDI-IMS for analysis of major phospholipids extracted from bluefin tuna. We showed that TLC-Blot-MALDI-IMS analysis could visualize and identify major phospholipids such as phosphatidylethanolamine, phosphatidylinositol, phosphatidylserine, phosphatidylcholine, and sphingomyelin.

The public health impacts of a fat tax

Tiffin, R., and M. Arnoult, *Eur. J Clin. Nutr.* 65:427–433, 2011.

Previous studies have analyzed impacts on average intakes. Arguably, however, intakes that are of real concern are those which are some distance away from the recommendations. Fiscal measures might have a limited impact on such diets, and as a result, on health. We measure the impact of a fiscal intervention on the risks of diet-related disease, accounting for the full range of diets

Quantification of sterol lipids in plants by quadrupole time-of-flight mass spectrometry

Wewer, V., *et al., J. Lipid Res. 52:*1039–1054, 2011.

Glycerolipids, sphingolipids, and sterol lipids constitute the major lipid classes in plants. Sterol lipids are composed of free and conjugated sterols, that is, sterol esters, sterol glycosides, and acylated sterol glycosides. Sterol lipids play crucial roles during adaptation to abiotic stresses and plant-pathogen interactions. Presently, no comprehensive method for sterol lipid quantification in plants is available. We used nanospray ionization quadrupole-time-of-flight mass spectrometry (Q-TOF MS) to resolve and identify the molecular species of all four sterol lipid classes from *Arabidopsis thaliana*. Free sterols were derivatized with chlorobetainyl chloride. Sterol esters, sterol glycosides, and acylated sterol glycosides were ionized as ammonium adducts. Quantification of molecular species was achieved in the positive mode after fragmentation in the presence of internal standards. The amounts of sterol lipids quantified by Q-TOF tandem mass spectroscopy (MS/MS) were validated by comparison with results obtained with TLC/GC (thin-layer chromatography/gas chromatography). Quantification of sterol lipids from leaves and roots of phosphate-deprived *A. thaliana* plants revealed changes in the amounts and molecular species composition. The Q-TOF method is far more sensitive than GC or high-performance liquid chromatography. Therefore, Q-TOF MS/MS provides a comprehensive strategy for sterol lipid quantification that can be adapted to other tandem mass spectrometers.

Revisiting the polar paradox theory: a critical overview

Shahidi, F., and Y. Zhong, *J. Agric. Food Chem.* 59:3499–3504, 2011

The polar paradox is a theory that illustrates the paradoxical behavior of antioxidants in different media and rationalizes the fact that polar antioxidants are more effective in less polar media, such as bulk oils, while nonpolar antioxidants are more effective in relatively more polar media, such as oil-in-water emulsions or liposomes. For two decades since it was proposed, the theory has been used to interpret results in antioxidant efficiency studies. However, more recently, new evidence from more comprehensive assessments has emerged that contradicts the polar paradox theory, hence necessitating its re-evaluation. More complex factors in addition to polarity must be taken into account to explain antioxidant efficacy.

trans Fatty acid analyses in samples of marine origin: the risk of false positives

Mjøs, S.A., and B.O. Haugsgjerd, *J. Agric. Food Chem.* 59:3520–3531, 2011.

At conditions commonly applied for *trans* fatty analyses by gas chromatography, fatty acids naturally occurring in marine lipids may overlap chromatographically with C_{16} and C_{18} *trans* fatty acids and lead to false positives. Elution patterns were studied by tracking retention indices at shifting temperature conditions on two cyanopropyl-coated capillary columns. Most overlaps can be avoided by selecting the right chromatographic conditions, but it was not possible to find a single condition that eliminates the risk of overlap between *trans* fatty acids and interferents. In total, 17 compounds were identified as potential interferents, and the amounts of these compounds were quantified in various samples of marine origin. The interferents that will most likely contribute to incorrect assessments of *trans* fatty acids in marine lipids are probably 18:3n-4 and 18:1n-11.

Stability of plant sterols in ingredients used in functional foods

Gonzalez-Larena, M., *et al., J. Agric. Food Chem.* 59:3624–3631, 2011.

The content of plant sterol (PS) and their oxidation products (POP) in eight ingredients used to enrich functional foods was studied. A gas chromatographic (GC) technique with mass-spectrometric detection was used for identification, while GC with a flame ionization detector (GC-FID) was used for quantification. β-Sitosterol was the most abundant phytosterol, and the main POP found were derived from this compound (7α/β-hydroxysitosterol, 7-ketositosterol, and sitostanetriol). The total amount of POP found in the ingredients ranged from 29.03 to 110.02 μg/100 g PS. The β-sitosterol oxidation rates ranged from 10 to 50 μg β-sitosterol oxides/100 g of β-sitosterol. In view of this low rate of oxidation in the ingredients tested, it can be concluded that the PS remain stable in these ingredients. Significant correlations ($p < 0.01$) were found between total oxysitosterols vs. β-sitosterol contents ($R^2 = 86.5\%$) and between total POP and total PS ($R^2 = 81.6\%$).

The hypocholesterolemic activity of transgenic rice seed accumulating lactostatin, a bioactive peptide derived from bovine milk β-lactoglobulin

Wakasa, Y., *et al., J. Agric. Food Chem.* 59:3845–3850, 2011.

Lactostatin is a novel pentapeptide (IIAEK) derived from bovine milk β-lactoglobulin with greater hypocholesterolemic activity than β-sitosterol, the drug commonly used to treat hypercholesterolemia. We developed transgenic rice expressing lactostatin as a fusion protein with seed storage protein (SSP) glutelins under the control of three different endosperm-specific promoters. Lactostatin accumulated in transgenic rice seed at approximately 1.6 mg/g seeds (dry seeds) without any apparent influence on seed traits such as endogenous SSP expression levels or alterations in the intracellular structures of endosperm cells. Short-term (three-day) oral administration of the glutelin fraction containing

lactostatin (namely, three times of 300 mg/kg body weight/day) extracted from transgenic rice seeds resulted in hypocholesterolemic activity in rats; namely, the serum low density lipoprotein cholesterol level was significantly reduced accompanied by a significant increase in beneficial serum high density lipoprotein cholesterol.

Comparative effects of conjugated linoleic acid (CLA) and linoleic acid (LA) on the oxidoreduction status in THP-1 macrophages

Rybicka, M., *et al., J. Agric. Food Chem. 59*:4095–4103, 2011.

The aim of this study was to investigate the effect of conjugated linoleic acids (CLA) on macrophage reactive oxygen species (ROS) synthesis and the activity and expression of antioxidant enzymes, catalase (Cat), glutathione peroxidase (GPx), and superoxide dismutase (SOD). The macrophages were obtained from the THP-1 monocytic cell line. Cells were incubated with the addition of *cis*-9,*trans*-11 CLA or *trans*-10,*cis*-12 CLA, or linoleic acid. ROS formation was estimated by flow cytometry. Enzyme activity was measured spectrophotometrically. The antioxidant enzyme mRNA expression was estimated by real-time reverse transcriptase polymerase chain reaction. Statistical analysis was based on nonparametric statistical tests (Friedman analysis of variation and Wilcoxon signed-rank test). *cis*-9,*trans*-11 CLA significantly increased the activity of Cat, while *trans*-10,*cis*-12 CLA notably influenced GPx activity. Both isomers significantly decreased mRNA expression for Cat. Only *trans*-10,*cis*-12 significantly influenced mRNA for SOD-2 expression. The CLA activate processes of the ROS formation in macrophages. Adverse metabolic effects of each isomer action were observed.

Classification of pumpkin seed oils according to their species and genetic variety by attenuated total reflection Fourier-transform infrared spectroscopy

Saucedo-Hernandez, Y., *et al. J. Agric. Food Chem. 59*:4125–4129, 2011.

Attenuated total reflection Fourier-transform infrared spectroscopy (ATR-FTIR), followed by multivariate treatment

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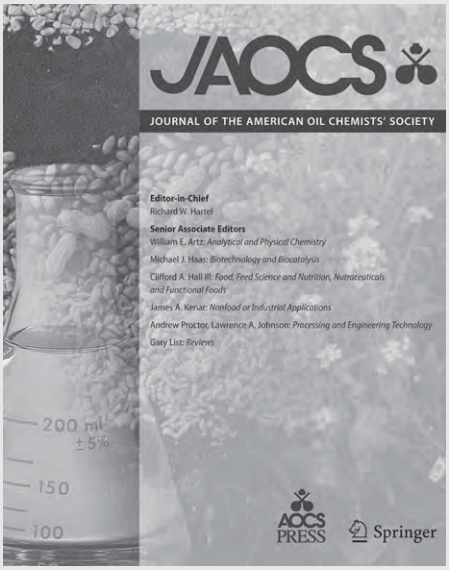

Journal of the American Oil Chemists' Society (May)

- Kinetics of lipid oxidation and degradation of flaxseed oil containing crawfish (*Procambarus clarkii*) astaxanthin, Pu, J., and S. Sathivel
- Effect of stripping methods on the oxidative stability of three unconventional oils, Mariod, A., B. Matthäus, and I.H. Hussein
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- Optimization of biomass and arachidonic acid production by *Aureispira maritima* using response surface methodology, Saelao, S., A. Kanjana-Opas, and S. Kaewsuwan
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- Classification of Turkish extra virgin olive oils by a SAW detector electronic nose, Kadiroğlu, P., F. Korel, and F. Tokatlı
- Effect of bene kernel oil on the frying stability of canola oil, Sharayei, P., R. Farhoosh, H. Poorazrang, and M.H.H. Khodaparast
- Determination of free glycerol in biodiesel via solid-phase extraction and spectrophotometric analysis, Mercer, E.J., and F. Halaweish
- Optimizing reaction conditions for the isomerization of fatty acids and fatty acid methyl esters to their branch chain products, Reaume, S.J., and N. Ellis
- Preparation and evaluation of particleboard with a soy flour-polyethylenimine-maleic anhydride adhesive, Gu, K., and K. Li
- Spectroscopic analysis of cotton treated with neutralized maleinized soybean oil, Ford, E.N.J., S.K. Mendon, J.W. Rawlins, and S.F. Thames
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- Aqueous enzymatic extraction of oil and protein hydrolysates from roasted peanut seeds, Zhang, S.B., Q.Y. Lu, H. Yang, Y. Li, and S. Wang
- Pilot plant recovery of soybean oleosome fractions by an enzyme-assisted aqueous process, Towa, L.T., V.N. Kapchie, C. Hauck, H. Wang, and P. A. Murphy

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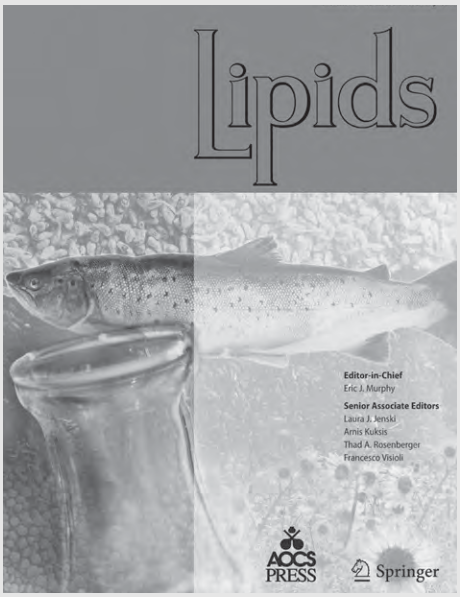
- Supplementation of monounsaturated and polyunsaturated fatty acids in nonalcoholic fatty liver disease and metabolic syndrome, Alisi, A., C. Agostoni, and V. Nobili
- PGE_2 release from tryptase-stimulated rabbit ventricular myocytes is mediated by calcium-independent phospholipase $A_2\gamma$, Sharma, J., and J. McHowat
- Oral docosapentaenoic acid (22:5n-3) is differentially incorporated into phospholipid pools and differentially metabolized to eicosapentaenoic acid in tissues from young rats, Holub, B.J., P. Swidinsky, and E. Park
- Dietary n-3 fatty acid deficiency in mice enhances anxiety induced by chronic mild stress, Harauma, A., and T. Moriguchi



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- Dietary saury oil reduces hyperglycemia and hyperlipidemia in diabetic KKAy mice and in diet-induced obese C57BL/6J mice by altering gene expression, Yang, Z., H. Miyahara, S. Takemura, and A. Hatanaka
- Growth temperature and salinity impact fatty acid composition and degree of unsaturation in peanut-nodulating rhizobia, Paulucci, N.S., D.B. Medeot, M.S. Dardanelli, and M. García de Lema
- Efficient synthesis of the very-long-chain n-3 fatty acids, tetracosahexaenoic acid (C_{24}:6n-3) and tricosahexaenoic acid (C_{23}:6n-3), Itoh, T., A. Tomiyasu, and K. Yamamoto
- Mild testicular hyperthermia transiently increases lipid droplet accumulation and modifies sphingolipid and glycerophospholipid acyl chains in the rat testis, Furland, N.E., J.M. Luquez, G.M. Oresti, and M.I. Aveldaño
- Mild method for preparation of 4,4-dimethyloxazoline derivatives of polyunsaturated fatty acids for GC–MS, Svetashev, V.I.
- Quantitative analysis of phospholipids using nanostructured laser desorption ionization targets, Colantonio, S., J.T. Simpson, R.J. Fisher, A. Yavlovich, J.M. Belanger, A. Puri, and R. Blumenthal

of the spectral data, was used to classify seed oils of the genus *Cucurbita* (pumpkins) according to their species as *C. maxima*, *C. pepo*, and *C. moschata*. Also, *C. moschata* seed oils were classified according to their genetic variety as RG, Inivit C-88, and Inivit C-2000. Up to 23 wavelength regions were selected on the spectra, each region corresponding to a peak or shoulder. The normalized absorbance peak areas within these regions were used as predictors. By using linear discriminant analysis (LDA), an excellent resolution among all categories concerning both *Cucurbita* species and *C. moschata* varieties was achieved. The proposed method was straightforward and quick and can be easily implemented. Quality control of pumpkin seed oils is important because *Cucurbita* species and genetic variety are both related to the pharmaceutical properties of the oils.

Effect of brown seaweed lipids on fatty acid composition and lipid hydroperoxide levels of mouse liver

Widjaja-Adhi, A.M. K., *et al., J. Agric. Food Chem. 59*:4156–4163, 2011.

Brown seaweed lipids from *Undaria pinnatifida* (Wakame), *Sargassum horneri* (Akamoku), and *Cystoseira hakodatensis* (Uganomoku) contained several bioactive compounds, namely, fucoxanthin, polyphenols, and omega-3 polyunsaturated fatty acids (PUFA). Fucoxanthin and polyphenol contents of Akamoku and Uganomoku lipids were higher than those of Wakame lipids, while Wakame lipids showed higher total omega-3 PUFA content than Akamoku and Uganomoku lipids. The levels of docosahexaenoic acid (DHA) and arachidonic acid (AA) in liver lipids of KK-A^y mouse significantly increased by Akamoku and Uganomoku lipid feeding as compared with the control, but not by Wakame lipid feeding. Fucoxanthin has been reported to accelerate the bioconversion of omega-3 PUFA and omega-6 PUFA to DHA and AA, respectively. The higher hepatic DHA and AA level of mice fed Akamoku and Uganomoku lipids would be attributed to the higher content of fucoxanthin of Akamoku and Uganomoku lipids. The lipid hydroperoxide levels of the liver of mice fed brown seaweed lipids were significantly lower than those of control mice, even though total PUFA content was higher in the liver of mice fed brown seaweed lipids. This would be, at least in part, due to the antioxidant activity of fucoxanthin metabolites in the liver.

Oxylipins in fungi

Brodhun, F., and I. Feussner, *FEBS J. 278*:1047–1063, 2011.

In nearly every living organism, metabolites derived from lipid peroxidation, the so-called oxylipins, are involved in regulating developmental processes as well as environmental responses. Among these bioactive lipids, the mammalian and plant oxylipins are the best characterized, and much information about their physiological role and biosynthetic pathways has accumulated during recent years. Although the occurrence of oxylipins and enzymes involved in their biosynthesis has been studied for nearly three decades, knowledge about fungal oxylipins is still scarce as compared with the situation in plants and mammals. However, the research performed so far has shown that the structural diversity of oxylipins produced by fungi is high and, furthermore, that the enzymes involved in oxylipin metabolism are diverse and often exhibit unusual catalytic activities. The aim of this review is to present a synopsis of the oxylipins identified so far in fungi and the enzymes involved in their biosynthesis. ■

The trouble with crystal polymorphism

Editor's Note: The following article is based on a Hot Topics: Tough Topics to Teach presentation, "Everything You Wanted to Know About Lipid Polymorphism, but Were Afraid to Ask," at the 102nd AOCS Annual Meeting & Expo (May 1–4, 2011) in Cincinnati, Ohio, USA.

Alejandro Marangoni

Crystal polymorphism is one of the most widely studied structural characteristics of fats used in spreads, shortening, and confectionery applications. Simply put, polymorphism refers to the fact that triacylglycerols (TAG), and other lipids, can crystallize in different crystal types—all having, on average, the same chemical composition. Each polymorph will have a characteristic melting temperature, powder X-ray diffraction pattern, infrared spectral signature, or Raman spectra. At least three main polymorphic forms have been identified, and are ever-present in "fat lore." These include the alpha, beta prime, beta forms (listed in order of increasing stability), melting point, and packing density. Good-quality chocolate is associated with its content of cocoa butter in the beta, form V, polymorph, while "good shortening" or "good spreads" are associated with the presence of fat crystallized in the beta prime form. Even though this relationship is very poorly understood and many times is not verifiable, we still like to use statements such as these.

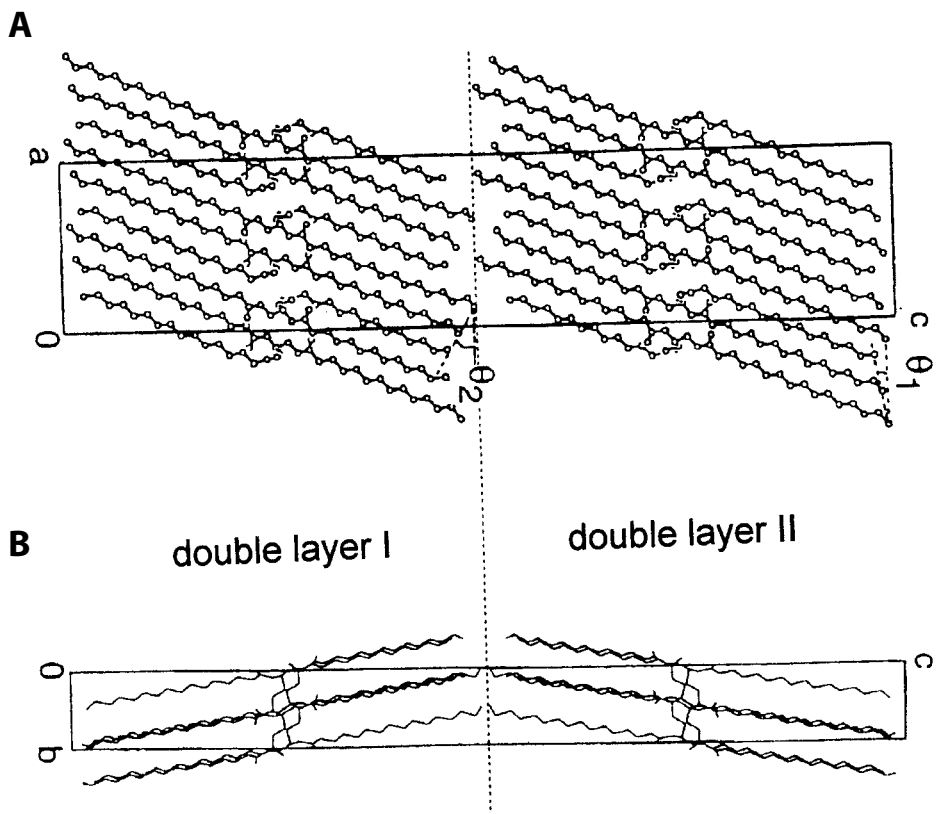

FIG. 1. *Molecular packing of beta prime-2 of 1,2-dipalmitoyl-3-myristoyl-*sn *glycerol projected along the* b *axis (A), and along the* a *axis (B).*

When they crystallize, TAG pack in very specific structural arrangements with characteristic symmetries. The symmetry properties of a crystal are given by the type of unit cell present in such crystal. The packing arrangement of atoms within the crystal defines the type of unit cell structure present in the crystal (Fig. 1).

Fig. 1 shows the packing arrangement of the beta prime polymorph of 1,2-dipalmitoyl-3-myristoyl-*sn* glycerol determined by Professor Kiyotaka Sato's group from Hiroshima University (*J. Lipid Res. 42*:338–345, 2001). Sato is a past recipient of the prestigious AOCS Stephen S. Chang Award. Indicated are the long axis (c) of the unit cells and the two small axes (a and b). Notice that two TAG molecules are stacked on top of each other in the long axis direction. This is often where the trouble begins.

We like to talk about what type of "unit cell" is present in the different polymorphs. However, we do not do this; we resort to the concept of a "subcell," some imaginary substructure within the fatty acid chains of the TAG. Thus, in this way, we consider TAG to be a collection of alkanes. The alpha form is supposed to have a hexagonal unit cell, the beta prime is supposed to be orthorhombic, while the beta form is supposed to be triclinic.

However, close inspection of Sato's beta prime structure quickly reveals that the unit cell is monoclinic, but we call this polymorph orthorhombic. How can this be? We have the same problem in all single-crystal

structures for the beta form—they are not triclinic! So, we are left with this concept of the subcell. This concept has many problems, including that it is not possible to define the type of subcell present experimentally due to a lack of sufficient information that can be gathered from powder X-ray diffraction experiments. For example, Fig. 2 shows the characteristic powder X-ray diffraction patterns for the three different polymorphic forms of fully hydrogenated canola oil.

In the wide angle region (small spacings), we have only one peak for the alpha and beta forms and two for the beta prime forms. We need about 20 peaks to carry out good indexing. So how do we know these structures are what we think they are?

If the food chemistry instructor wants to delve into structural discussions about the different polymorphs, it is necessary to take another approach. In short, we need to understand the concept of a unit cell of a TAG, not of a subcell of a TAG. We need to understand that a crystal is made up of many crystal planes formed by the regular arrangement of atoms within the crystal. These planes can be characterized by their Miller indices. Ultimately, the position of a powder X-ray diffraction "peak" is defined by the inter-planar distance for one of the many planes present in the crystal, while the relative intensity of the peaks is given by the structure factor. Here we will give a brief peek at some of the work carried out by Stefan Idziak at the University of Waterloo (Ontario, Canada) and David Pink (St. Francis Xavier University, Antigonish, Canada) in collaboration with Alejandro Marangoni at the University of Guelph (Ontario), trying to define why we obtain these characteristic powder X-ray spectra for the different polymorphs. It is intriguing that fats with very dissimilar TAG compositions all, more or less, give the same characteristic diffraction patterns for the different polymorphs. Here we will show how this is only a function of the enormous asymmetry of the TAG molecules' unit cell of the TAG molecules—a huge long axis and two very small short axes.

In the end, however, we can/should go back to the basic concept of polymorphism,

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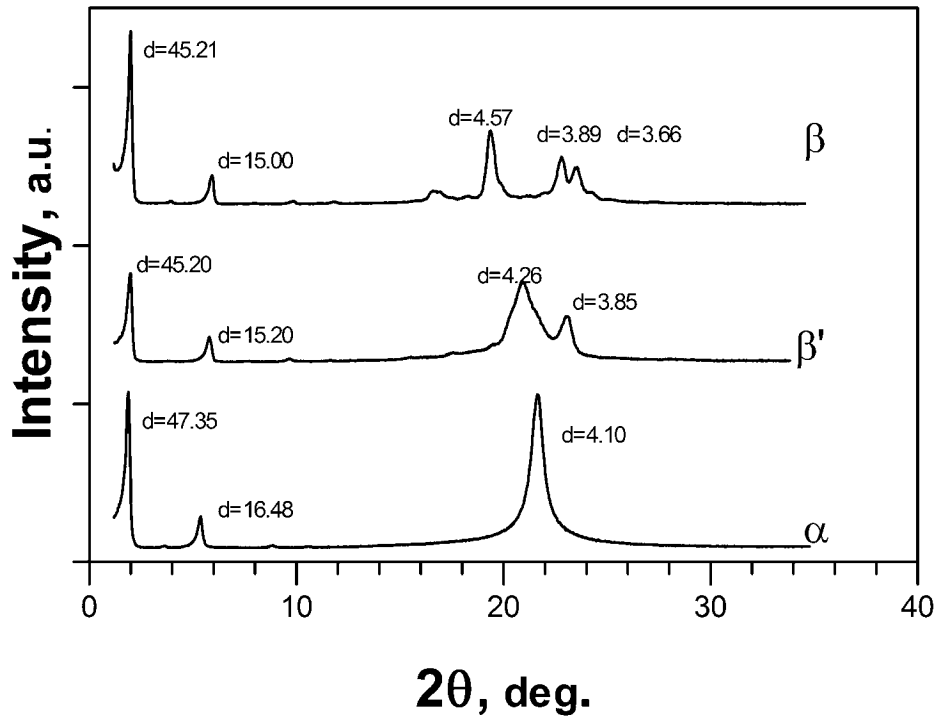

FIG. 2. *X-ray spectra showing the three diffe ent polymorphic forms for fully hydrogenated canola oil. Abbreviations: a.u., arbitrary units; deg., degrees.*

Combustion of biofuels

Analytical and computational techniques examine the process of biodiesel combustion pathways.

Editor's note: Reprinted with permission from the March 2011 issue of TLT, *the official monthly magazine of the Society of Tribologists and Lubrication Engineers, a not-for-profit professional society headquartered in Park Ridge, Illinois, USA.*

Neil Canter

A better understanding of the positive and negative characteristics of biofuels such as biodiesel and ethanol is essential in order to maximize their effectiveness. Biofuels are composed of different organic molecules than their petroleum counterparts. This means there is every expectation they also will exhibit different performance properties.

In a previous article, Canter discussed the inherent tendency of biodiesel derived from soybean oil to oxidize. Soybean oil contains a large concentration of the polyunsaturated fatty acid linoleic acid (approximately 55%). Linoleic acid readily oxidizes, which can have a long-term impact on the viability of biodiesel derived from soybean oil. The use of a proprietary antioxidant at low treatment rates has been found to retard the oxidation of biodiesel.

In contrast, biodiesel produced from canola oil has much lower levels of linoleic acid and higher levels of oleic acid, which is more stable than linoleic acid. Canola oil is the largest source of biodiesel fuel in Europe, while soybean oil is the largest source in the United States.

Fuel combustion is an important area because of the growing challenge to reduce emissions. Hydrocarbon-based fuels generate such pollutants as hydrocarbons, carbon monoxide, particulates, and NO_x.

With the greater use of biofuels, greater insight is needed to learn more about the combustion pathways of these fuels and how they differ from hydrocarbons. A discussion was held with Drs. Nils Hansen, principal member, technical staff at Sandia National Laboratories in Livermore, California, USA, and Charles Westbrook, physicist at Lawrence Livermore National Laboratory in Livermore, California. Both individuals are actively involved in learning more about the combustion pathways of biofuels and are coauthors of a 2010 review.

Oxygen is the difference

Westbrook indicates that the biggest difference between the combustion of hydrocarbon-based fuels and biofuels is the presence of oxygen inside the actual fuel molecules. He says, "They differ from hydrocarbons in that the biofuels will undertake combustion to form other oxygenated derivatives such as alcohols, aldehydes, ethers, and ketones."

The researchers have taken two different approaches to understanding biofuel combustion that are complementary. Hansen says, "Analysis of general combustion is very difficult due to the active chemistry and fluid dynamics. We chose an experimental approach in which the combustion process is simplified by premixing known

Key concepts

- Biofuel combustion diff rs from hydrocarbon-based fuels in that oxygenated derivatives such as alcohols, aldehydes, ethers, and ketones are formed.
- Biofuel combustion pathways are studied through complementary analytical and computational techniques.
- Diff rent toxic species derived from the oxygen in biofuels are produced during combustion compared to larger amounts of purely hydrocarbon pollutants detected with petroleum-based fuels.

Tailoring fungi-based biofuels for advanced combustion engines

Engine experts and biofuels researchers at Sandia National Laboratories are working on a project that aims to modify an endophytic fungus so that it will produce fuel-type hydrocarbons for transportation purposes (Fig. 1).

The biofuels being investigated for the project are produced by a class of fungi—endophytes—that live between plant cell walls. The cellular material in plant walls can be converted into hydrocarbon compounds that work well as fuels for internal combustion engines. Sandia is collaborating with Professor Gary Strobel from Montana State University, a known expert in *Ascocoryne sarcoides* and other similar fungi.

The beauty of the endophytic fungi, Sandia biochemist Masood Hadi said, is that there is no need for the cost-intensive industrial processes that are typically required to break down biomass. "These things can turn crystalline cellulosic material directly into fuel-type hydrocarbons without any mechanical breakdown," he said.

These fungi, in other words, are designed by nature to grow on cellulose and to digest it, forming fuel-type hydrocarbons as a by-product of their metabolic processes. Through genetic manipulation, the Sandia team hopes first to identify these pathways, and then to improve the yield and tailor the molecular structure of the hydrocarbons they produce.

Sandia's bioscience team is using genetic sequencing to catalog the pathways and other molecular biology techniques to understand how changes in feedstock determine the type and amount of hydrocarbons the fungi make, with a long-term goal of engineering greater quantities of the desirable fuel species. Meanwhile, Craig Taatjes and John Dec, both engine combustion researchers at Sandia, are experimenting with the main compounds produced in the molecular "soup" and giving feedback to their bioresearch counterparts on their ignition chemistry and engine performance. The ideal outcome, Dec said, is to "dial in" the right feedstocks combined with the right set of genes to produce the preferred blend of compounds to go into an engine.

The first step has been to learn what kinds of compounds the fungus makes naturally on its own. "We just don't know much about some of the compounds, so we need to do research on their ignition chemistry and how they behave in an engine," Taatjes said. The team, he says, is working with William H. Green at the Massachusetts Institute of Technology (Boston, USA) to develop an ignition chemistry model that can predict the performance of the classes of compounds made by the fungus.

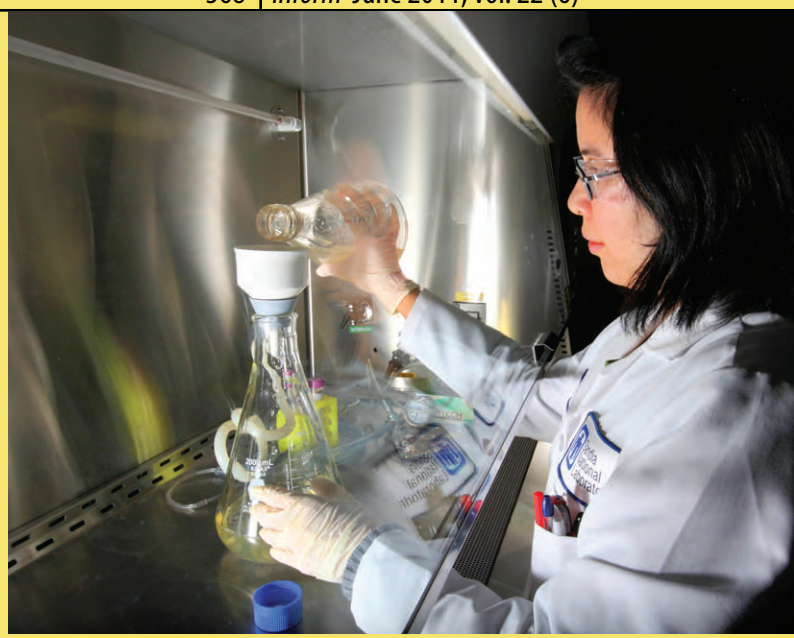

FIG. 1. *Sandia researcher Eizadora Yu prepares biomass harvested from liquid fungal cultures for nucleic acid analysis. The cultures come from the endophytic fungus* Hypoxylon *sp., which produces compounds potentially useful for fuel. (Image by Dino Vournas)*

Hadi and his colleagues are doing their part to build up the understanding of the distribution of molecules produced by the various fungi, at which point they can genetically tailor them to produce more of the "right" kinds of compounds that suit the needs of engine combustion.

Eventually, the team anticipates that enough hydrocarbons will be extracted from those produced by the fungus to test in the lab, or even in an engine. "We hope, in the end, to have a biofuel that was developed in conjunction with the development of the combustion model for that biofuel," Taatjes said.

Additional information on the work being done to examine the combustion of biofuels can be obtained by contacting Mike Janes of Sandia National Laboratories at mejanes@sandia.gov. ■

biofuels and even simpler organic molecules with the oxidizer before the flame front."

Two major analytical techniques were used by Hansen to better understand the species formed during combustion. He says, "We used laser diagnostics and mass spectrometry to better understand the molecules that are formed during biofuel combustion and how they differ from molecules formed during combustion of conventional diesel fuels."

Westbrook has taken a computational approach through the use of simulations to analyze combustion pathways. He says, "We compare our results with experiments run by Hansen and use kinetic chemistry to better understand how the chemical composition is changing in the laboratory-based model flames. Then we will pass our results and questions back to Hansen so that he can design additional experiments."

Biodiesel is an interesting case because its combustion pathways are relatively simple. Westbrook says, "Biodiesel consists of five or six different methyl ester species ranging in size from C_{14} to C_{25} which undergo combustion to eventually produce carbon dioxide and water. Simulation studies with specific methyl ester chains have been very helpful in determining the combustion pathway for biodiesel."

One of the reasons for this finding is that the molecules in biodiesel are entirely straight-chain organics. There are no aromatics present in biodiesel. In contrast, combustion of petroleum-derived diesel is much more complex. Diesel contains not only straight-chain and branched hydrocarbons, but also aromatics.

Hansen says, "Diesel contains thousands of chemical species, and its combustion pathway is much more complicated. The variability of

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High-stearic/high-oleic sunflower oil: a versatile fat for food applications

Eduardo Dubinsky and Rafael Garces

High-stearic/high-oleic sunflower oil (HSHOSO) comes from seeds obtained through conventional breeding techniques (i.e., nongenetically modified organisms). Interest in the oil and its increasing commercial availability make it worthwhile to know more about the technical properties of high-stearic/high-oleic sunflower oil.

Seeds and plants that produce HSHOSO are so similar to the regular sunflower that both grains and oils should be produced under identity preservation schemes through all the value chain steps until final distribution. The Instituto de la Grasa of Sevilla, CSIC (Consejo Superior de Investigaciónes Científicas), Spain, and Advanta Seeds Nutrisun Business Unit in its Biotechnological Center in Buenos Aires Province, Argentina, jointly carried out the development of hybrids. These are currently commercialized by Advanta under the Nutrisun™ brand.

The main difference between fatty acid (FA) profiles of HSHOSO and regular sunflower oil lies in the stearic acid content, which is four times greater in HSHOSO than in regular sunflower oil (18% vs. 4%), whereas the oleic acid content is about three times higher compared with regular sunflower oil (69% vs. 23%; see Fig. 1).

The composition and distribution of FA in the triacylglycerol (TAG) molecules produce a significant difference in the physical behavior of HSHOSO and regular sunflower oil. Whereas the latter is liquid at any temperature above –10°C, HSHOSO begins to behave as a solid fat at temperatures below 15°C (Fig. 2).

Another important difference that arises from different FA profiles is the higher oxidative stability of HSHOSO—even in blends with other vegetable oils such as soybean, rapeseed, canola, and palm and its fractions.

Thus, HSHOSO offers significant advantages when used in different types of foods, including increased shelf life and much higher yields in fast food and industrial frying, compared with any other fat.

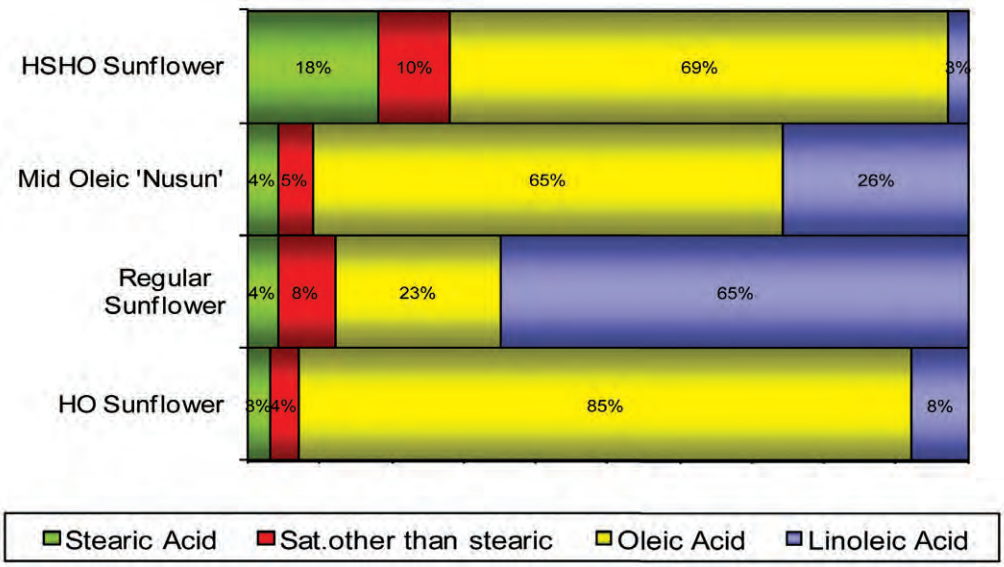


FIG. 1. *Comparison between fatty acid profiles of high-stearic/high-oleic (HSHO) vs. other commercial sunfl wer oil types.*

Because of its high contents of oleic acid (omega-9) and stearic acid, HSHOSO is a healthful alternative to partially hydrogenated oils that are rich in *trans* FA (TFA) as well as to other animal and vegetable fats, such as tallow and palm, which have FA contents that raise cholesterol blood levels and lead to increased risk of cardiovascular disease.

Made-to-order fats

By using different processes such as fractionation by dry or wet crystallization, chemical or enzymatic interesterification, and blending with other fats and oils, HSHOSO and its different products obtained from those modification processes are potentially the most versatile fats that could be used in food and cosmetic applications.

During the past three years, numerous laboratory, pilot plant, and industrial trials have been performed around the world that combine all the modification processes mentioned above. The results have been tailor-made fats aimed at replacing *trans* fats and palmitic acid in all food applications. Fractionation by crystallization proved to be particularly useful in tailoring HSHOSO to match almost every food application requiring fats and oils.

FIG. 2. *Regular sunfl wer oil (left) is liquid at any temperature above –10°C, while high-stearic/high-oleic sunfl wer oil (HSHOSO; right) begins to behave as a solid fat at temperatures below 15°C.*

By means of different fractionation types and conditions a whole range of different stearin fractions were obtained, having melting profiles—in terms of solid fat content (SFC)—ranging from that of the original HSHOSO to hard stearin fractions

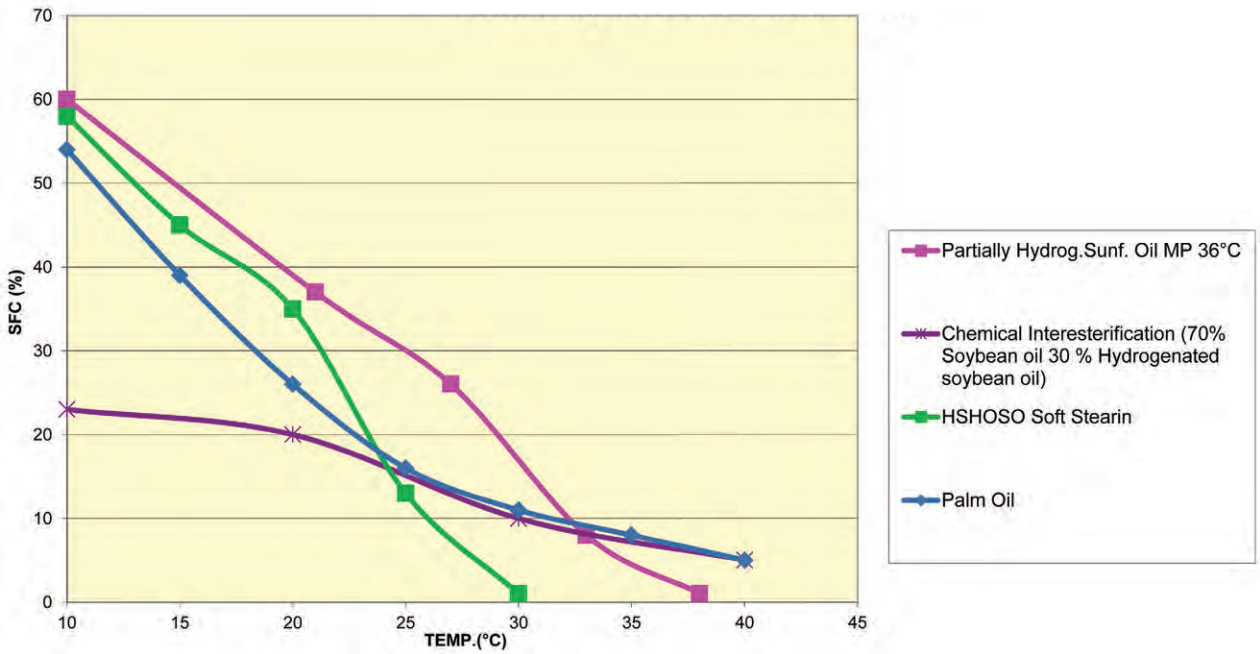


FIG. 3. *Comparison of solid fat content (SFC) content vs. temperature for partially hydrogenated sunfl wer oil, chemically interesterifie fat, and HSHOSO stearin. MP, melting point; for other abbreviation see Fig. 2.*

with SFC values above cocoa butter (CB). Another important fact is that the olein fraction is similar to the oil in terms of FA composition and SFC profile. One of the main reasons is that an important portion of the stearic acid content is as the triglyceride type StOO (stearic acid–oleic acid–oleic acid), which during fractionation remains in the olein fraction. As a consequence, the stability of olein is very high and the olein can be used instead of nonfractionated oil in frying or in some bakery applications.

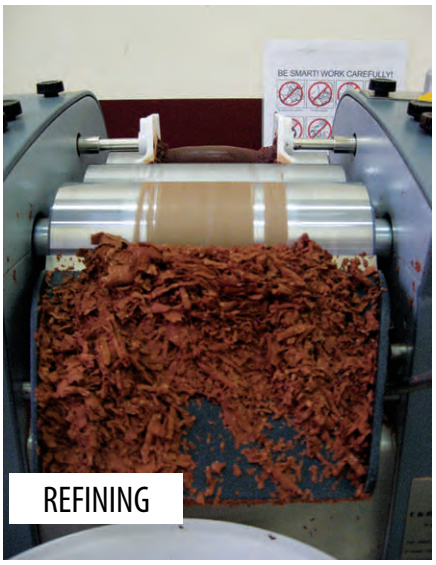
Food applications

Until the beginning of this century, hydrogenation was widely used to modify fats for food applications. The reason for this was that the partial hydrogenation of vegetable oils yields a high level of TFA, which contribute to a significant percentage of solids (SFC) at room temperature and a melting point close to body temperature. These characteristics confer good structure and a pleasant mouthfeel to end products, especially in margarine and confectionery applications.

Since the 1990s, there has been growing evidence on the deleterious health effects of TFA. TFA are known to increase low-density lipoprotein and decrease high-density lipoprotein cholesterols, which subsequently raise the risk for cardiovascular disease. For that reason, many changes in food labeling and legislation have taken place during the last decade in almost all countries, including the United States, Canada, and Mercosur (labeling rules since 2006). Danish regulations limited TFA from partially hydrogenated oils used by the food industry to 2% in margarine and 5% in other foods (grams of TFA/100 grams of fat added to the food). In the near future, similar rules will be applied in Canada and Argentina.

This was a dramatic change for the fats and oils and food industries, which have been pressed to use TFA alternatives. Some have turned to chemical and enzymatic interesterification, while others have returned to animal fats such as tallow or lard and to palm oil and its fractions. None of these alternatives are a complete solution, either because of nutritional drawbacks (such as those associated with animal fats and palm oil) or because of technical reasons such as the lack of a good SFC profile (significant solids at room

FIG. 4. *HSHOSO bakery products. For abbreviations see Figs. 1 and 2.*



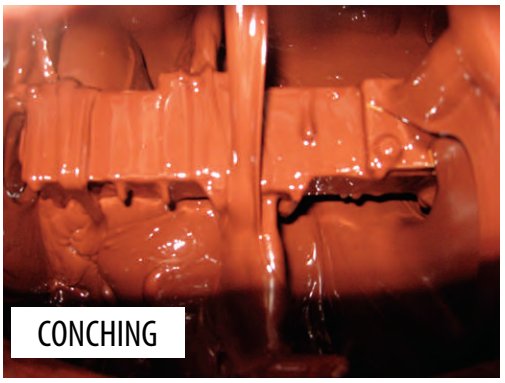


FIG.5. *Diffe ent steps in manufacture (pilot plant) of dark chocolate bars with HSHOSO hard stearin. For abbreviation see Fig. 2. Pictures courtesy of Lab of Food Technology, Ghent University (Belgium).*

temperature and good melting behavior at body temperature). HSHOSO stearins meet all of these goals. In Fig. 3, the SFC of a partially hydrogenated vegetable oil (melting point 36°C) is compared against a HSHOSO stearin fraction, palm oil, and a chemically interesterified product.

Baked goods

HSHOSO, its fractions, and blends with other oils and fats can be used in bakery products. Croissants, bread, and cookies can be made with 100% HSHOSO and its blends with butter (Fig. 4). In cookies and crackers HSHOSO can be used in the dough or as a spraying oil. HSHOSO soft stearins can also be used in fillings for sandwich cookies or wafers.

Confectionery and specialty fats

One of the most interesting food applications for HSHOSO is in the field of confectionery fats, CB alternatives, and specialty fats. HSHOSO can yield variations of stearins and oleins that cover almost the entire range of fats used in foods. Recent crystallization trials showed the SFC of hard stearins to be even higher than CB. Such stearins could be used for CBE (CB equivalent) or CBI (CB improver) formulations as an alternative source of StOSt (stearic acid–oleic acid–stearic acid) TAG.

In recent trials made in the Lab of Food Technology and Engineering at Ghent University (Belgium), formulations of dark chocolate bars made with 100% HSHOSO stearin (Fig. 5) met with high acceptance by chocolate manufacturers.

Frying

Because of its low content (less than 4%) of polyunsaturated FA, HSHOSO is a very stable oil, imparting unique properties to packaged foods that enhance their shelf life. It also provides very good frying resistance, one of the most demanding applications in terms of thermal stress. The OSI (oil stability index) at 110°C of HSHOSO is 1.6 times greater than HO sunflower oil, and six times higher than regular sunflower oil (Fig. 6).

Industrial frying conditions are completely different from fast food ones. In the former, frying is performed continuously and the oil is always in contact with the food. This generates a double protective effect: isolation of the oil surface from the oxygen of the air due to a steam layer coming from the boiling water content of the food, and a continuous renewal of the oil that is being replenished as it is absorbed by the food. There are basically two types of industrial frying: fried snacks, such as potato chips, and par-fried foods that are then frozen, such as French-fried potatoes. In snacks, the oil is an important part of the final food (potato chips are 30–35% oil). So oil stability (along with other aspects

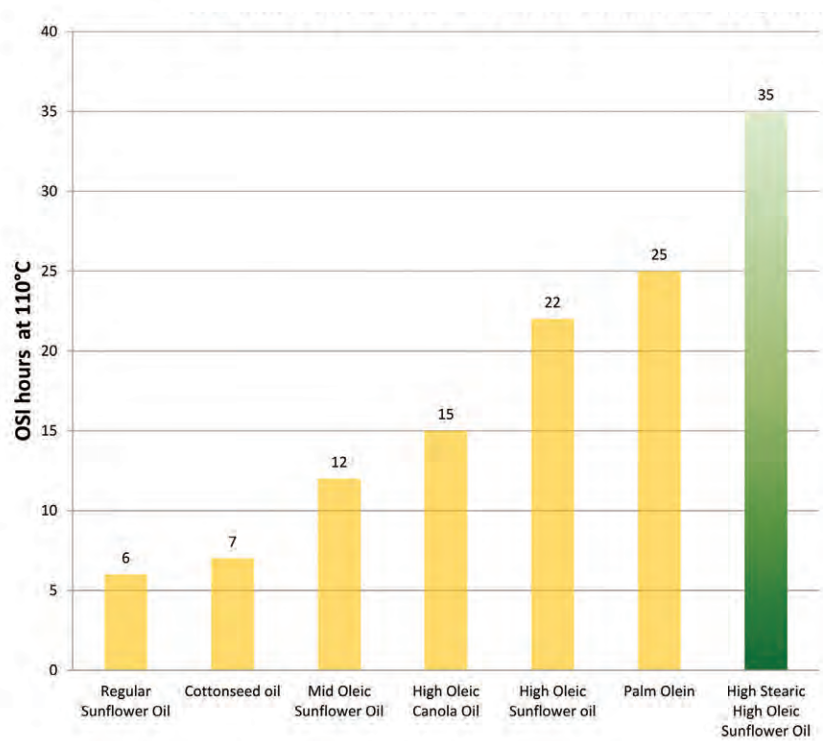


FIG. 6. *Oxidative stability index (OSI) values of HSHOSO compared with other commercial oils. For abbreviations see Fig. 2.*

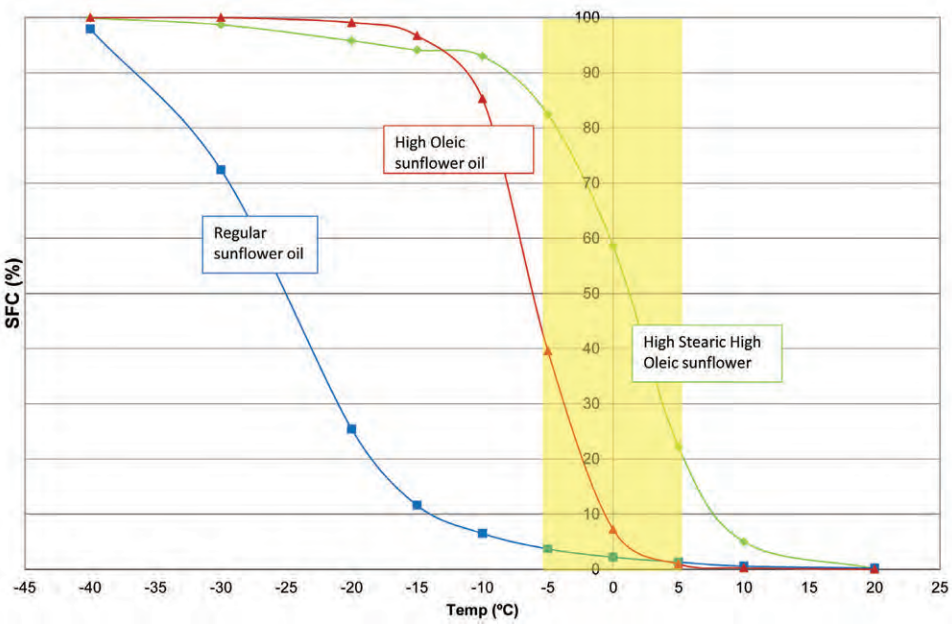


FIG. 7. *Comparison of SFC between HSHOSO and other sunfl wer oils at low temperature. For abbreviations, see Figs. 2 and 3.*

such as packaging and the use of nitrogen gas) determines the shelf life of the fried food. The high oxidative stability of HSHOSO makes it an excellent choice for this application. In frozen par frying, it is very important to avoid the clumping or dusting that originates when using very low melting fats (liquid oils crystallize under 0°C). The presence of certain solid levels in the oil is very important in the range between −5°C and +5°C, as shown in Fig. 7 (SFC in the range shaded yellow is much higher for HSHOSO than for the other oils).

In Fig. 8 some frying trials comparing the increase of total polar materials (TPM) vs. days of frying, with HSHOSO, high-oleic sunflower oil, and palm olein, are shown. The performance improvement compared with commercial frying oils has been verified in full-scale fast-food trials.

Current and future situation of HSHOSO development

The first HSHOSO crop in Argentina was harvested in 2008; in Spain, in 2009; and in the United States, 2010. Currently, volumes are available for performing industrial trials with the oil and lab and pilot trials with the fractions. A new wave of hybrids will be released in 2013 that will lead us to better yields in terms of grain and fat content.

HSHOSO received approval from regulatory authorities in Argentina and Spain, and it is expected to receive GRAS (generally recognized as safe) status in the United States this year.

Stearic acid has recently been recognized as a fat that does not raise cholesterol in the US 2010 *Dietary Guidelines for Americans* (see www.cnpp.usda.gov/dietaryguidelines.htm) and in the recent release of the FAO–WHO round of experts on Fats and Nutrition (see http://foris.fao.org/preview/25553-0ece4c-b94ac52f9a25af77ca5cfba7a8c.pdf).

For more information on HSHOSO, see www.nutrisunoil.com.

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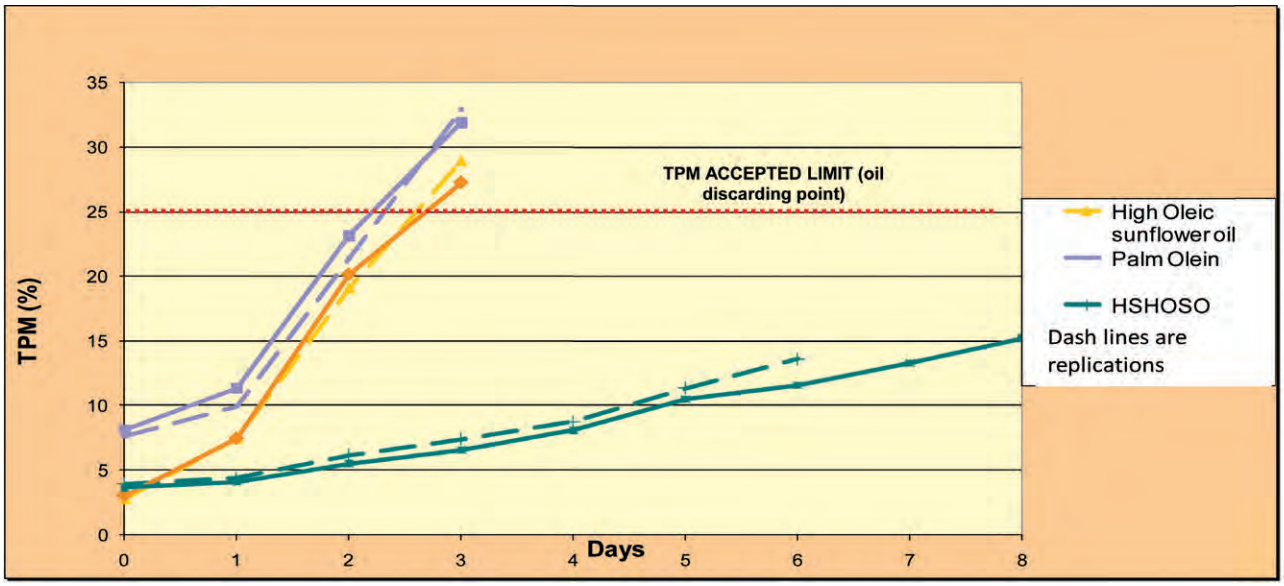
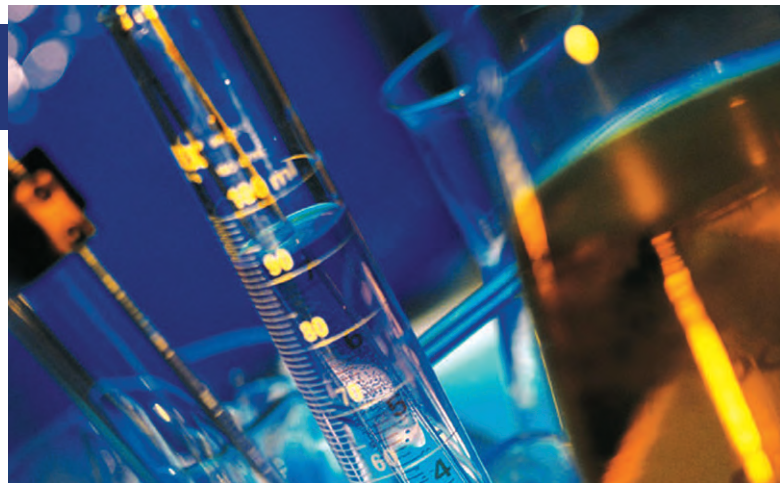


FIG. 8. *Comparison of total polar materials (TPM) in batch deep frying of French fries with diffe ent oils. For other abbreviation, see Fig. 2.*

Preventing the adulteration of food protein with better analytical methods: Avoiding the "next melamine"

This article originally appeared in the November/December 2010 issue of NutraCos *magazine.*



Jeffrey C. Moore, Markus Lipp, and James C. Griffiths

Intentional (economically motivated) adulteration fueled by knowledge of chemistry and immoral intent allowed deceitful criminals to fraudulently add melamine to the animal and human food supply in 2007 and 2008 (Xin and Stone, 2008; FDA, 2009). That melamine could be used in this situation took advantage of an analytical weakness of the widely used test procedures for assessing protein content in foods.

Both the Kjeldahl and Dumas procedures determine hard-to-measure protein as the fraction of easy-to-measure nitrogen using a historically-derived nitrogen-to-protein conversion factor. For example, the Dumas analysis generally measures all forms of nitrogen, and the Kjeldahl analysis measures only organically bound nitrogen plus ammonia with incomplete or no recovery of nitrates and nitrites. Unfortunately, the use of these surrogate approaches to quantify protein can be exploited by simply adding a cheap source of nitrogen (Abernethy *et al.*, 2008).

These ill-fated incidents not only took human and animal lives and sickened many more but also resulted in severe financial consequences for food producers and consumers because of price increases, market disruptions, trade restrictions, product liability costs, loss of revenues, and brand damage (Ingelfinger, 2008; Kennedy, 2008). The food safety paradigm needs to be refocused by new analytical strategies whose vulnerabilities cannot be as readily exploited to protect consumers from a future intentional adulteration of protein-based foods with the next adulterant.

Testing to absolute safety is not possible. This is especially true considering the food industry's use of complex formulations and convoluted global supply chains to produce finished products. The current worldwide food market offers more products to consumers at competitive prices; however, it also introduces more challenges to maintain the integrity and safety of food ingredients and the food products to which they are added as they move internationally. Chemical-analytical verification of identity and quality is an essential tool as food ingredients pass through the supply chain; however, frequent testing introduces time delays, logistical complexities, and costs that are ultimately passed on to consumers. A manufacturer's decision about when to test a food ingredient and what analytical method to employ is often driven by a risk–benefit analysis that weighs the assurance and protection gained by testing against the costs in time and money incurred.

There are two ways to use analytical chemistry to verify the integrity of food ingredient, (i) testing to confirm the absence of adulterants or (ii) testing to confirm the identity, quality, and purity of an ingredient. That is, one can test for what is not supposed to be there (melamine) or test for what is supposed to be there (food protein). By late 2007 it was widely known that melamine ($C_3H_6N_6$) was being added to Chinese wheat gluten intended for use in pet food in order to artificially boost the apparent protein content of this high-protein ingredient. However, this knowledge was not immediately translated into a realization that other high-protein-content ingredients were equally vulnerable to this type of adulteration. In fact, only the clustered occurrence of renal failure in babies less than two years later led to the discovery of the melamine adulteration of the Chinese dairy supply chain and the development of reactive monitoring strategies and new methods to test for melamine in different food matrices (Huang *et al.*, 2009; Mauer *et al.*, 2009; Wang *et al.*, 2009; Zhu *et al.*, 2009).

Testing for the absence of a specific adulterant has one critical limitation—it requires the *a priori* knowledge of the existence and nature of an adulterant and it prevents only adulteration with this specific, known adulterant and not other known or unknown adulterants. Additionally, *a priori* knowledge of the adulterant does not always prevent its fraudulent use.

The risk–benefits analysis to use testing to detect adulteration presumes a decrease in testing if data suggest that a particular adulterant is not a threat in order to shift resources to other adulterants that have a higher likelihood of occurrence. This process, however, may lead to a cyclical re-occurrence, as exemplified by the adulteration of wheat with urea. One of the first reports of the adulteration of feed with nonprotein nitrogen compounds such as urea was published in 1959 (Huss, 1959). As time passed, the perceived risk of urea adulteration in wheat decreased notably, perhaps because of efficient monitoring programs employed throughout the wheat supply chain. In 1988 this specific type of adulteration resurfaced when wheat was again adulterated with urea (Folkenberg, 1990).

Reactive monitoring strategies for specific adulterants are also limited by the ever-increasing sensitivity of analytical methods that are capable of detecting the adulterant at levels that may be toxicologically irrelevant and/or not the result of intentional adulteration. For example, recently proposed international safety limits for melamine are in the 0.5–2.5 parts per million range (*Codex Alimentarius*, 2010),

but LC-MS/MS (liquid chromatography-tandem mass spectrometry) methods are capable of detecting melamine in the parts per billion range where melamine levels have been reported from pesticide residues and other sources that are not related to adulteration (Taylor *et al.*, 2008; WHO, 2009).

Other strategies to prevent adulteration are available and may help to circumvent the disadvantages of reactive monitoring. One is to specifically look and test for the identity, quality, and purity of a food ingredient—that is, what should be in a food ingredient instead of what should not. This is the compendial strategy, which comprehensively compares the authenticity, identity, and purity of test ingredients vs. established criteria. Examples include monograph testing standards in the *Food Chemicals Codex* (*FCC*) published by the United States Pharmacopeial Convention (USP), the *Compendium of Food Additive Specifications* published by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), and others.

This compendia strategy employs complementary analytical testing approaches: qualitative identification methods to determine if an ingredient is authentic and quantitative purity assessment methods to precisely quantify what should be in an ingredient. This approach can be used to detect known and unknown adulterants that are present in sufficient amounts to influence the identity and or purity of a food ingredient. Hence, this approach can be one of the best defense mechanisms against economically motivated adulteration where adulterants typically are added in significant amounts. Analytical accuracy and sensitivity, however, may limit the use of this approach for low-level adulteration. For example, to detect the presence of an adulterant at 900 ppm using a purity assessment approach, one must reliably detect the difference between 99.91% and 100% purity, a goal that may be well beyond the capability of most routine measurement techniques. Although this may appear to be a real limitation in preventing intentional adulteration with known or unknown adulterants, in reality most adulterants must be present at much higher levels to make adulteration for economic gain profitable. In the case of melamine, for example, to reduce the cost of wheat gluten by 50%, adulteration with melamine at 10% would be necessary (DeVries, 2009).

Unfortunately, in the recent melamine incidents, a reliable compendial approach for protein-based ingredients did not exist. Compendial standards for testing the purity of protein-based ingredients still rely on total nitrogen determination techniques with a numerical conversion to apparent protein content, and their lack of specificity renders these methods susceptible to the presence of other, nonproteinaceous sources of nitrogen. This vulnerability indicates an urgent need to advance analytical science in these areas to prevent future economically motivated adulteration of high protein content food ingredients.

The challenge ahead in developing new procedures for testing protein-based food ingredients lies in the analytical performance requirements. New test methods must be specific, validated for each matrix, precise, suitable for routine analysis, inexpensive, and rapid because a large quantity of food protein must be tested—the estimated annual total global production of food protein is 400 million metric tons or more (Owusu-Apenten, 2002).

To reliably and quantitatively determine the purity of food protein, new total protein determination methods need to be established with higher discrimination power against the presence of nonprotein nitrogen sources. A recently published review sheds some light on opportunities and challenges in this area (Moore *et al.*, 2010). This report suggests a few promising analytical techniques such as modifications to existing total nitrogen approaches to selectively isolate protein before analysis, use of well-known colorimetric techniques such as Bradford, or measurement of total amino acid contents. All of these techniques, however, require further evaluation to determine their suitability for this specific analytical need. Also, many of these promising techniques may be compatible only with food ingredients that consist mainly of protein and/or show a relatively low degree of variability in compositions. It should be noted that the dairy industry has already improved the basic Kjeldahl method for the bovine milk matrix by selectively precipitating and separating "true" protein from nonprotein nitrogen before performing the Kjeldahl total nitrogen procedure (Barbano and Clark, 2006).

For qualitative authentication of protein-based food ingredients, new rapid techniques capable of detecting the presence of nonauthentic proteins and unexpected nonprotein compounds must be established. Conceptually, such methods could compare the compositional fingerprint of a test ingredient and a library of authentic fingerprints for that ingredient to yield a simple answer about whether a sample is abnormal or normal. For more than a decade, use of spectral

or hyphenated chromatographic–detector techniques combined with chemometric data analysis (e.g., principal component analysis) has been reported in single lab studies for authenticating foods (Downey, 1996; Tzouros and Arvanitoyannis, 2001; Karoui and Baerdemaeker, 2007). Several challenges must be resolved before this approach can gain widespread utility in routine analysis of protein food ingredients, including ensuring comparability of results among instruments and labs and accounting for the compositional variability of authentic food ingredients produced around the world.

An opportunity to correct for the latter is the generation, maintenance, and dissemination of ingredient-specific fingerprint data libraries that represent the entire range of authentic materials in commerce. This is a significant issue because of the number of factors that can influence the composition of food protein ingredients, including genetic variation across species, differential within-species metabolic responses to the environment, and variation in processing. For comparability of results between instruments, calibration transfer standards are needed to standardize the data libraries to the unique performance of each instrument. In terms of current analytical capabilities, the use of infrared spectroscopy is already commonplace for quantitative quality assessment, particularly in the dairy industry, and could potentially be adapted for use in assessing authenticity (Barbano and Clark, 2006).

In conclusion, detection of potential adulterants in food proteins remains a challenge as the status quo is the status quo. Currently available testing procedures to ensure the quality of protein-based food ingredients are still based on determining the total nitrogen content and that is not likely to change rapidly or soon given the extensive investment by the food manufacturing industries in these methodologies. The low discrimination power of these surrogate nitrogen procedures leaves consumers vulnerable to current and future economically motivated adulterations. Because the nature and thus the safety implications of adulteration are entirely in the hands of criminals, an important but often unknown public health threat exists. The compendial testing strategy has the potential to significantly mitigate this risk whether from known or unknown adulterants, but requires critical advancements in analytical science to develop and establish new authenticity and purity analytical methods. To be useful, methods following a compendial test strategy must meet the demanding analytical performance requirements of the food industry that sources protein-based ingredients through complex and global supply chains, rapidly and definitively assesses the quality and safety of raw materials, all to produce safe and affordable foods.

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Using genetic engineering to increase canola seed oil content

Randall Weselake

In Canada, it is estimated that an absolute 1% increase in the seed oil content of canola would result in an additional $70 million per year for the oilseed extraction and processing industry (Canola Council of Canada, 2010). Increases in seed oil content do not differentially benefit the farmer who produces higher oil content canola because the farmer only is paid for the quantity of seed. In contrast, producers in Europe are paid premiums for producing seed with elevated oil content.

Increasing global production of plant oils is of importance for food and nonfood applications such as biodiesel, but there are concerns that using oils from food crops for biodiesel production could drive up the cost of food oil and even result in shortages (Durrett *et al.*, 2008). There has been considerable activity with regard to using canola as a source of oil for biodiesel production. However, the total amount of vegetable oil produced on a yearly basis amounts to less than 4% of the petroleum used for energy; therefore, in the long term, plant oils will not solve the world's energy shortage problems (Carlsson, 2009). In contrast, global annual plant oil production amounts to approximately one third of the petroleum that is used for industrial feedstock. Therefore, plant oils could make a substantial contribution in this sector. Many industrial oleochemicals are derived from oleic acid (Carlsson, 2009), and high-oleic acid canola could represent a valuable feedstock for this purpose. Other possibilities for securing more appropriate plant oils for conversion to biodiesel during our transition phase to alternate forms of energy could involve cultivating oleaginous plants producing oils, which are not suitable for human consumption, and/or using oilseed crops that only grow on marginal land (Carlsson, 2009). Methods for inducing oil accumulation in vegetative tissue and roots are being examined (Durrett *et al.*, 2008; Carlsson, 2009).

In Brassica oilseed species (BOS) breeding, quantitative trait loci (QTL) for seed oil content are useful for the selection of cultivars with increased seed oil content (Weselake *et al.*, 2009). Recently, Yan *et al.* (2009) constructed a molecular marker linkage map for *Brassica napus* using recombinant inbred lines. Between 5.2 and 13.6% of the variation in seed oil content was accounted for by 11 QTL. The study suggested that it might be possible to combine favorable alleles at different QTL to elevate seed oil content.

In the past two decades, several genetic engineering strategies for increasing seed oil content in BOS and other oilseeds were pursued (Weselake *et al.*, 2009; Baud and Lepiniec, 2010). Specific targets for modification included key steps in fatty acid and triacylglycerol (TAG) synthesis, other aspects of carbon metabolism, and transcription factors, which can potentially orchestrate several steps in carbon flow leading to seed oil production.

In an earlier study, Roesler *et al.* (1997) expressed the cytosolic homomeric acetyl-CoA carboxylase of *Arabidopsis* in *B. napus* and targeted the enzyme to the plastid where fatty acid synthesis occurred. Acetyl-CoA carboxylase catalyzes the production of malonyl-CoA using bicarbonate, acetyl-CoA, and ATP (Harwood, 2005). Because the cytosolic form of the enzyme was subject to different regulatory controls from the plastidial form of the enzyme, it was hypothesized that the cytosolic form of the enzyme might be more effective in a plastidial metabolite environment. A relative increase in seed oil content of about 5% was achieved.

The first TAG assembly enzyme examined as a target for manipulation of oil content was lysophosphatidic acid acyltransferase (LPAAT). Expression of a mutated yeast *sn*-2 acyltransferase gene (*SLC1-1*) during seed development in high-erucic acid rapeseed (HEAR) *B. napus* resulted in relative increases in seed oil content

ranging from 8 to 48% (Zou *et al.*, 1997; Taylor *et al.*, 2001). Recently, Maisonneuve *et al.* (2010) demonstrated that cDNAs encoding rapeseed LPAAT isozymes of the endoplasmic reticulum could be used to increase seed oil content in *Arabidopsis*.

Diacylglycerol acyltransferase (DGAT) catalyzes the formation of TAG from *sn*-1,2-diacylglycerol and acyl-CoA (Lung and Weselake, 2006). Numerous lines of evidence suggest that the level of DGAT activity may have a substantial effect on the flow of carbon into TAG (Perry and Harwood, 1993; Weselake *et al.*, 1993; Weselake, 2005). Antisense suppression of *DGAT1* in *B. napus* DH12075 resulted in approximately 30% relative reduction in seed oil content at maturity with reciprocal increase in seed protein content (Lock *et al.*, 2009). However, the resulting plants exhibited several developmental abnormalities. Overexpression of *Arabidopsis DGAT1* or *B. napus DGAT1-3* during seed development in various cultivars of *B. napus* under greenhouse and field conditions resulted in increased seed oil content at maturity (Weselake *et al.*, 2007, 2008; Taylor *et al.*, 2009). *Tropaeolum majus DGAT1* was also overexpressed in *Arabidopsis* and HEAR, resulting in relative seed oil content increases ranging from 11 to 30% (Xu *et al.*, 2008). In the same study, site-directed mutagenesis was used to induce an amino residue change in *T. majus DGAT1* that resulted in increased DGAT activity. In addition, overexpression of *Arabidopsis DGAT1* in *B. napus* reduced the penalty in seed oil content caused by drought under field conditions (Weselake *et al.*, 2007, 2008). Recently, a yeast-based high throughput system was developed for screening for mutated cDNAs encoding *B. napus* type-1 DGATs and quantifying the activity of the resulting enzyme variants (Siloto *et al.*, 2009a,b). This technology may prove useful in the generation of DGATs with increased catalytic efficiency for evaluation in molecular breeding programs aimed at increasing seed oil content in BOS.

Other steps in carbon flow were also examined as potential targets for increasing seed oil content in BOS. *sn*-Glycerol-3-phosphate dehydrogenase catalyzes the conversion of dihydroxyacetone phosphate, produced in glycolysis, into *sn*-glycerol-3-phosphate, which in turn serves as a building block for TAG assembly (Weselake, 2005). Vigeolas and Geigenberger (2004) showed that the availability of *sn*-glycerol-3-phosphate limited the amount of TAG formed during seed development in *B. napus*. Overexpression of the cDNA encoding glycerol-3-phosphate dehydrogenase during seed development resulted in up to a 40% relative increase in seed oil content at maturity (Vigeolas *et al.*, 2007).

Mitochondrial pyruvate dehydrogenase complex catalyzes the conversion of pyruvate and CoA into acetyl-CoA and carbon dioxide and connects glycolysis to the citric acid cycle. A mitochondrial pyruvate dehydrogenase kinase catalyzes the phosphorylation of the pyruvate dehydrogenase complex, resulting in a decrease in the activity of the pyruvate dehydrogenase complex. Antisense repression of the gene encoding the kinase resulted in increased seed oil content in *Arabidopsis* and *B. napus* (Zou *et al.*, 1999; Marillia *et al.*, 2003; Weselake *et al.*, 2009). It was hypothesized that the acetyl-CoA produced in the mitochondria was hydrolyzed to acetate in the mitochondria, followed by movement of the acetate into the plastid where it was reconverted to acetyl-CoA to serve as a substrate for acetyl-CoA carboxylase in fatty acid synthesis. Interestingly, the gene encoding mitochondrial pyruvate dehydrogenase kinase was identified as one of the downregulated genes in a high-oil *B. napus* in comparisons of gene expression between two near-isogenic lines differing in seed oil content (Li *et al.*, 2006). The same study revealed that expression of pyruvate kinase was higher in the near-isogenic line with increased seed oil content.

Pyruvate kinase catalyzes the irreversible formation of pyruvate and ATP from phosphoenol pyruvate and provides the pyruvate precursor for the plastidial pyruvate dehydrogenase complex catalyzing the production of acetyl-CoA (Plaxton and Podesta, 2006). Andre *et al.* (2007) reduced seed oil content in *Arabidopsis* by 60% through disruption of a gene encoding one of the subunits of the plastidial heteromeric pyruvate kinase complex. The original seed oil content was restored in the mutant by expression of the cDNA encoding the functional subunit. Thus, plastidial pyruvate kinase is essential for producing precursors for fatty acid synthesis.

Biochemical studies of carbon metabolism in developing zygotic embryos of *B. napus* can provide insights that are valuable in designing strategies to alter carbon flow. One of the major breakthroughs in understanding carbon metabolism in photosynthetic zygotic embryos of *B. napus* was that ribulose 1,5-bisphosphate carboxylase/oxygenase acts outside of the Calvin cycle to increase carbon use during seed oil accumulation (Schwender *et al.*, 2004). This metabolic process provides 20% more acetyl-CoA for fatty acid synthesis with a 40% decrease in carbon loss as carbon dioxide when compared with glycolysis.

Transcription factors from BOS were examined for efficacy in *Arabidopsis*. *WRINKLED1* (*WRI1*) encodes an APETALA2-ethylene-responsive element-binding protein that regulates carbon flux and possibly fatty acid synthesis (Cernac and Benning, 2004; Baud *et al.*, 2007). Overexpression in *Arabidopsis* of two cDNAs from *B. napus* representing orthologues of *Arabidopsis WRI1* resulted in 10–20% increased seed oil content and increased seed size and mass (Liu *et al.*, 2010). In *Arabidopsis*, knockout of the homeobox gene *GLABRA2* increased seed oil content through an unknown mechanism (Shen *et al.*, 2006). Recently, Chai *et al.* (2010) identified four distinct orthologues of *GLABRA2* from *B. napus* (AC genome), *B. rapa* (A genome), and *B. oleracea* (C genome). Phylogenetic analysis showed that *B. napus BnaC.GL2.b* was the most similar orthologue to *Arabidopsis GLABRA2*. Overexpression and suppression with *B. napus BnaC.GL2.b* resulted in *Arabidopsis* transgenic lines with increased seed oil content. Results based on overexpression of *BaC.GL2.b* were surprising and suggested that this transformation interrupted the action of endogenous *GLABRA2* in *Arabidopsis*. The investigators went on to develop functional markers for the four orthologous genes for use in breeding programs aimed at increasing the seed oil content in BOS.

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More information and reference citations can be found in chapter 3 of *Canola: Chemistry, Production, Processing and Utilization*, edited by James Daun, Michael Eskin, and Dave Hickling. AOCS #257, ISBN 978-0-9818936-5-5 [http://www.aocs.org/Store/ProductDetail.cfm?ItemNumber=16901]

Sime Darby Unimills opens Innovation Centre Europe

Willem van Nieuwenhuyzen

In October 2010, Sime Darby Group opened its Innovation Centre Europe (ICE) at the Sime Darby Unimills Refinery in Zwijndrecht, the Netherlands. What better way for the company to demonstrate its ongoing commitment to innovation than to place all of its modern vegetable oil processing techniques under one roof! At least, that was the impression I received as I visited the new center and plant exclusively for AOCS' *inform* magazine (Fig.1).

Sime Darby ICE

My host, Gerhard de Ruiter, head of the innovation centers of Sime Darby Plantation's research and development (R&D) arm, explained that the ICE is part of the company's bigger €34 million ($45 million) investment program for the Zwijndrecht site to improve quality and expand capacity. Highlights include a new fat-blending and truck-loading hall equipped with state-of-the-art computerized telescopic bottom-loading technology that will enhance product delivery and the construction of new processing lines to increase the company's enzymatic rearrangement capacity in manufacturing hardstocks.

ICE is part of the large R&D organization of the Sime Darby group. It underlines the Malaysian company's commitment to sustainable innovation and to serving European food processor industries with high-quality vegetable oil-based ingredients. Innovation facilities are an important tool to fulfill customer needs and to develop tailor-made oil products with the best functional properties as well as excellent flavor, taste, and stability characteristics.

FIG. 1. *Neelie Kroes, vice president of the European Commission (right), visits with Sime Darby Unimill's president and group chief executive Mohd Bakke Salleh during the opening of the company's new innovation center.*

The innovation center features state-of-the-art laboratories for both quality control and product development, an R&D application kitchen, and a unique food-grade oil-processing pilot plant that provides the food industry with shorter lead times and reduces complexity via special analytical equipment for measuring solid fat content and triglyceride and fatty acid compositions (Fig. 2).

This investment is the next step in the execution of the company's global strategy to partner with customers for better and quicker product innovation at the lowest costs. For larger-scale application tests, Sime Darby cooperates with external expertise application laboratories associated with Dutch Food Valley Consortium in Wageningen, the Netherlands.

Sime Darby Plantations has two other innovation centers: IC Africa in Boksburg, South Africa, and IC Asia based in Johor, Malaysia, which serves Asian customers. The Group has five research centers in Malaysia, with a total of 200 scientists and 1,300 supporting employees. Sime Darby Group invests 2–3% of the company's plantation division's turnover toward R&D. The program includes projects that involve the breeding of new oil palm varieties, new technologies for integrated pest management, green fertilizers, and best agricultural practices.

Company strengths

Sime Darby manages the world's largest publicly owned plantation company with oil palm and rubber tree estates. Its head office is in Kuala Lumpur, Malaysia. The company is registered on the Kuala Lumpur stock exchange with a market capitalization of RM55.11 billion ($18.2 billion) as of March 2011, and also manages other activities such as energy and utilities, motors, industrial, and property. The revenues of the Sime Darby Plantation Group are more than RM10 billion ($3.3 billion)—about one-third of the total Sime Darby turnover.

The merger of Sime Darby Bhd, Golden Hope Plantations Bhd, and Kumpulan Guthrie Berhad in 2006 established the Sime Darby Plantation Group, which uses approximately 500,000 hectares for oil palm plantations out of a land bank of 600,000 hectares in Malaysia

and Indonesia to produce about 2.4 million metric tons (MMT), or 6%, of the world's crude palm oil output annually.

Sime Darby has a history in plantations that goes back as far as 1844, and it has been involved in oil processing since 1913. Modern market needs prompted the company to develop a new strategy in 2004 based on innovation, responsibility, and partnership with customers. The aim is to be the preferred supplier of tailor-made vegetable oil-based ingredients.

Recently, the company started planting 5,000 hectares of oil palm nurseries in Liberia, Africa, having received a concession for 220,000 hectares.

The Sime Darby Unimills plant in Zwijndrecht, the Netherlands, has available a variety of oil refining and modification processes, including dry fractionation, modern enzyme technology, and fat flaking.

Sustainability of palm oil crops

Worldwide, palm oil production has tripled during the past 15 years. In 2005 palm oil became the largest oil crop in the world. Today the harvested production is 47 MMT, followed by soybean oil at about 36 MMT. Palm oil trees bear fruits during a 20-year period with an annual yield of more than 4 metric tons (MT) of palm oil per hectare. This figure can be compared with soybean crops, which yield 0.5 MT soybean oil (plus 2 MT soybean meal) per hectare. Palm oil yields in Indonesia and Malaysia are the highest in the world. Palm oil fruits also contain palm kernels, a source of lauric palm kernel oil, whose fatty acid pattern and technological performance are very different from palm oil.

Sime Darby's managers are proud of such high productivity figures, but they also realize their responsibility for sustainable plantation management, processing, and development of the rural environment. The rapid expansion of oil palm plantations to meet the global demand for edible oils has caused industry stakeholders to initiate measures to ensure the sustainability of palm oil. The company's sustainable practices include its zero-burning replant techniques, soil management and conservation, integrated pest management, and palm oil mill effluent treatment in its 70 palm oil mills, along with optimal use of by-products. The company is a founding member of the Roundtable on Sustainable Palm Oil (RSPO), the group that advocates the production of sustainable palm oil. The Sime Darby Plantation Group produces approximately 31% certified sustainable palm oil in 2010, and plans to reach 100% certification by the end of 2011.

Product diversity

Apart from the main businesses of oil palm cultivation, palm oil processing, and downstream product manufacturing, Sime Darby is involved in other plantation and agriculture-related businesses. The company markets more than 50 industrial brands for the food industry. Other types of vegetable oils are used in the optimal blends for serving industrial customers.

In Southeast Asia, cooking oils are also marketed as consumer goods.

Palm oil is a healthful and stable clean oil with 50% saturated fatty acids (primarily C16:0), 40% monounsaturated fatty acids, and 10% polyunsaturated fatty acids. Refined and fractionated palm oil is *trans*-fatty acid free.

In the European market the Dutch refinery delivers Cremex ice cream fats, Delico hardstocks with a large market share in the margarine and fat spread industry, GoldBake dough fats, MasterCraft confectionery fats, Prifex flaked fats, and Vitolio oil (Fig. 3) with natural oil carotene colorant and natural tocotrienol antioxidants. The MasterCraft products are divided into cream layer fats, center filling fats, solid barrier fats, and top coating fats.

In 2009 Sime Darby Unimills integrated the neighboring lecithin specialty plant from Loders Croklaan into its portfolio, which now includes a range of both soybean- and sunflower-based lecithin specialties. For further information please visit the websites: www.simedarby.com and www.unimills.com.

FIG. 2. *The author's behind-the-scenes tour included a visit to the center's pilot plants.*

FIG. 3. *Vitolio oil contains natural oil carotene colorant and natural tocotrienol antioxidants.*

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CRYSTAL POLYMORPHISM

(CONTINUED FROM PAGE 365)

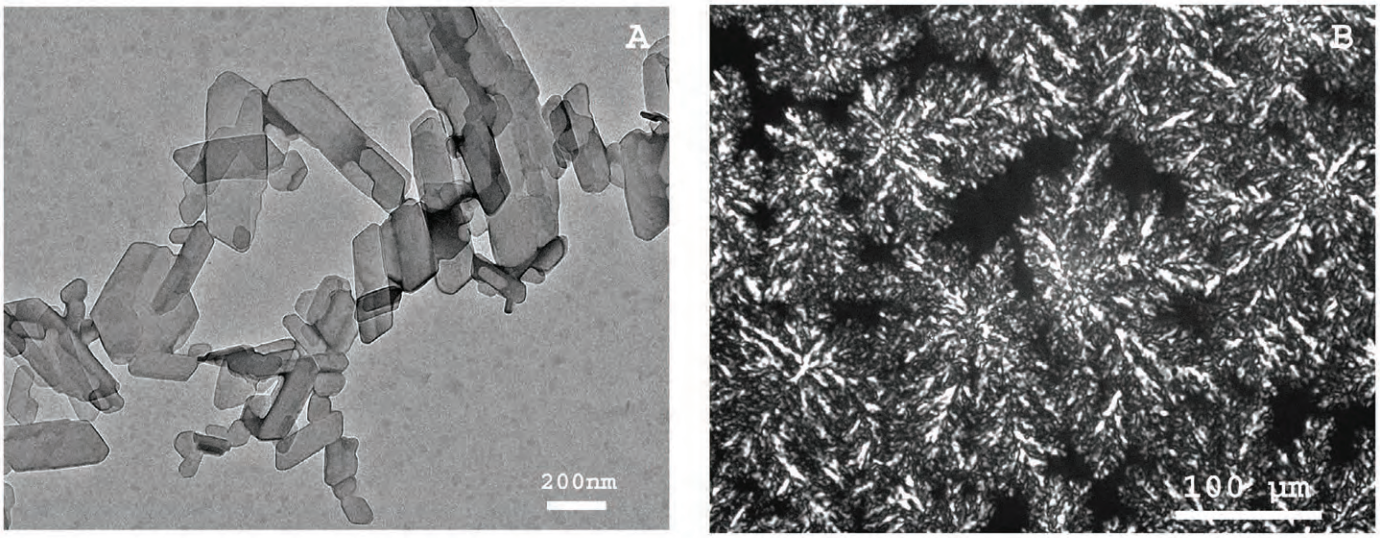

FIG. 3.: *Cryo-transmission electron microscopy (left) and polarized light microscopy (right) for blends of fully hydrogenated canola oil and high-oleic sunfl wer oil in the beta polymorphic form. (Left) Structures corresponding to single crystallites; (right) microstructural aggregates.*

refer to the differences in melting points and stability, and discuss the importance of the crystal type to fat functional properties. One may want to take this concept further and qualify the statements about the importance of polymorphism on functional properties. Polymorphism is important since it defines the melting properties of the material, but the nanostructure and microstructure of the material are equally or more important (Fig. 3), and not necessarily always linked to a particular polymorphic state. One can have a very small beta crystal or a huge alpha spherulite.

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COMBUSTION OF BIOFUELS

(CONTINUED FROM PAGE 368)

diesel also does not make it any easier to determine the mechanism of the combustion process. To make matters even more difficult, we can go down to the local fuel station and the composition of the diesel fuel will vary on a daily basis. Analysis of diesel is very much similar to shooting at a moving target."

Another challenge facing the researchers is how to evaluate the combustion pathways of blends of petroleum-derived fuels with biofuels. One example is the use of up to 15% biodiesel in petroleum diesel.

Westbrook comments, "The oxygen that is present in biodiesel fuel actually reduces some toxic emissions from diesel engines. For example, we know that when oxygen is added to diesel fuel, less soot is produced in diesel combustion, so oxygenated diesel fuels reduce soot emissions."

The combustion of biofuels does not eliminate the formation of toxic species. Westbrook says, "With biofuels, significant levels of oxygenated toxic species are generated during combustion that are derived from oxygen in the fuel. Examples include aldehydes such as formaldehyde and acetaldehyde, as well as other species such as methanol and methyl ethyl ketone. Petroleum-based fuels produce smaller levels of these toxic oxygenated species and larger amounts of purely hydrocarbon pollutants such as 1,3-butadiene."

One other factor under consideration with biofuels is the presence in diesel fuel of nitrogen-containing species. The researchers indicate that nitrogen species must be examined because they will generate NO_x during combustion.

Future work for the researchers will involve looking further at butanol and biodiesel. Hansen says, "Butanol has become a more popular biofuel due to the potential for algae and bacteria to produce it in large quantities."

Westbrook will be looking at developing better models for the combustion of biodiesel. He says, "Biodiesel can be produced from such different feedstocks as palm oil and beef tallow oil. We are now looking to use computer simulations to determine how a specific raw material will affect the combustion of biodiesel."

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*inform*ation

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Today's Education, Tomorrow's Innovation

14th AOCS Latin American Congress and Exhibition on Fats and Oils

The Resource for the Ibero-American Market

October 17–21, 2011 | Hilton Cartagena | Cartagena, Colombia | www.aocs.org/LACongress

Save up to $160 when you register by September 16—visit www.aocs.org/LACongress to register.

Short Courses

Basics of Edible Oil Processing and Refining
October 17, 2011

Oilseed Processing and Solvent Extraction
October 17, 2011

Oils and Fats Modification
October 18, 2011

SODEOPEC: Soaps, Detergents, Oleochemicals, and Personal Care Products
October 18, 2011

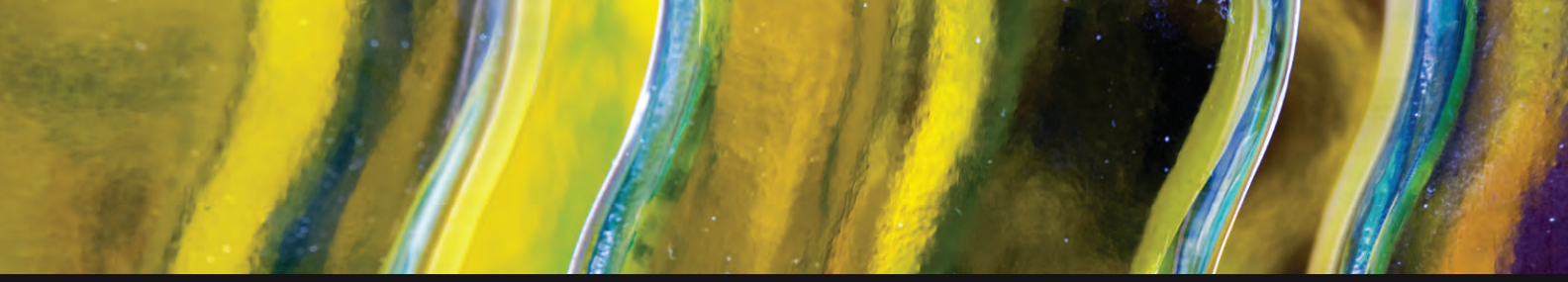
Fats and Oils for Confectionary and Chocolates: Structure and Function
October 18, 2011

Questions?
Contact the AOCS Meetings Department:
Email: meetings@aocs.org
Phone: +1 217-693-4g821

Spanish or English translations will be available for all oral presentations.

Organized by
LA-AOCS
Latin American Section of AOCS

In cooperation with:
AOCS, ASAGA, Corchiga, Fedepalma, and SBOG



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International Fats and Oils Congress Comes to Colombia

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Dates to Remember

September 16, 2011
Early Registration Deadline

September 30, 2011
Last Day to Register Online

September 30, 2011
Housing Deadline

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The Program

This congress provides an international forum for professionals, scientists, researchers, and students involved in fats and oils industries. The congress will focus on current issues affecting the **Ibero-American marketplace**, including processing, refining and packaging, health and nutrition, analytical and quality control processes, industrial applications, biodiesel, environmental impacts, and new developments.

The Exhibition

Held in conjunction with the congress, the exhibition will feature international companies that supply processing equipment, engineering services, reagents, additives and ingredients, laboratory instrumentation, and much more.

Cartagena, Colombia

Cartagena is a charming city of colonial style located in the Caribbean seaboard on the northern coast of Colombia, South America. With easy access by air, land or sea, Cartagena is a popular destination for both business and leisure travelers.

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