INFORM October 2014 Volume 25 (9) 545–608

INFORM

International News on Fats, Oils, and Related Materials

Water-saving technologies

ALSO:

Membrane separation

Automated analysis

Sustainable castor oil

AOCS

Lipotech™

Engineering... Excellence

Engineering, Procurement, Construction and Commissioning (EPCC)

LIPOTECH specializes in providing Project Consultancy, Project Design & Engineering and Complete turnkey Project Management Services related to:

- **BIO DIESEL PLANTS**
  Starting from Crude and Refined Oil
- **EDIBLE OIL REFINING PLANTS:**
  Chemical and Physical Refining Plants
- **FAT MODIFICATION PLANTS:**
  Fractionation, Hydrogenation, Interesterification leading to Specialty Fats and Shortening/Margarine
- **OLEOCHEMICAL PLANTS:**
  Fat Splitting, Fatty acid distillation & Fractionation, Glycerine Refining, Soap Noodles, Soap finishing lines
- **OTHER SERVICES:**
  Oil/Fat packaging lines, Continuous soap stock splitting plants, Effluent treatment Plants for Edible oil refineries and Oleo chemical plants, Plant upgrading, Plant Automation and Oil Terminals and Bulk installations

We are currently building several refineries, Oleo chemical and Biodiesel plants all around the world.

SINGAPORE • MALAYSIA • INDIA • INDONESIA

www.lipotechprojects.com

LIPOTECH PROJECT ENGINEERING PTE LTD (200309837G)
HQ > 21 Bukit Batok Crescent, #27-75 WCEGA Tower
Singapore 658065
Tel +(65) 6515 0027
Fax +(65) 6515 0037
Email sudarshan@lipotechprojects.com

LIPOTECH ENGINEERING SDN BHD (737912-M)
KL > Unit D-515 Block D, Kelana Square, 17 Jln SS 7/26
47301 Petaling Jaya, Selangor Malaysia
Tel +(6)03 7806 2748/2741
Fax +(6)03 7806 2749
Email sudarshan@lipotechprojects.com

JB > 02-03 Block A3, Permas Mall, Jalan Permas Utara
Bandar Baru Permas Jaya, 81750 Johor Bahru
Johor, Malaysia
Tel +(6)07 388 5970
Fax +(6)07 388 6970
Email sudarshan@lipotechprojects.com

LIPOTECH ENGINEERING PVT LTD
INDIA > 12, Lower Rawdon Street, Kolkata 700020
West Bengal, India
Tel +(91) 33 3008 3995/6/7/8
Fax +(91) 33 3008 3999
Email sudarshan@lipotechprojects.com

PT LT TEKNIK INDONESIA
INDONESIA > Wisma Geha, 3rd Floor, Jl Timor No 25
Jakarta Pusat 10350, Indonesia
Tel +(62) 21 315 2229
Fax +(62) 21 315 2224
Email sudarshan@lipotechprojects.com

CONTENTS

DEPARTMENTS

GERSTENBERG SERVICES A/S

• a G&A company •

Visit us at

- *OFI Asia 2014, 5-7 November 2014, Kuala Lumpur Convention Centre - Stand no. 38 in Hall 5*
- *Gulfood Manufacturing, 9-11 November 2014, Dubai World Trade Centre - The Pavilion of Denmark in Hall 2*

Need optimized spare parts for your margarine equipment?

We deliver various redesigned and optimized spare parts for SSHE Perfector units in the margarine industry:

→ longer durability
→ all parts are fully interchangeable with standard Perfector parts
→ short delivery time, which reduces your production down-time

Process cylinder

High pressure product coupling

Seal ring set

Coming soon:
New tubular SSHE for crystallization of margarine

We will soon introduce our new flexible high pressure tubular SSHE for crystallization of all types of margarine and related products:

→ the most versatile tubular SSHE in the fat crystallization industry
→ new advanced cooling system for CO_2 or NH_3

The new Gerstenberg tubular scraped surface heat exchanger from Gerstenberg Services A/S

GERSTENBERG SERVICES A/S

GD Process Design, LLC
N76W30500 County Rd. Vv
Hartland, WI 53029, USA
Tel.: +1 262 966 0300
sales@gdprocessdesign.com
www.gerstenbergs.com

Gerstenberg Services A/S
Vibeholmsvej 21, 2605 Brøndby
Denmark
Tel.: +45 43 43 20 26
info@gerstenbergs.com
www.gerstenbergs.com

INFORM

www.aocs.org

AOCS MISSION STATEMENT

AOCS advances the science and technology of oils, fats, surfactants, and related materials, enriching the lives of people everywhere.

INFORM

International News on Fats, Oils, and Related Materials

ISSN: 1528-9303 IFRMEC 25 (8) 481–544

INDEX TO ADVERTISERS

***Corporate member of AOCS who supports the Society through corporate membership dues.**

2710 South Boulder Drive
P.O. Box 17190
Urbana, IL 61803-7190 USA
Phone: +1 217-359-2344
Fax: +1 217-351-8091
Email: publications@aocs.org

ADVERTISING INSTRUCTIONS AND DEADLINES

Closing dates are published on the AOCS website (www.aocs.org). Insertion orders received after closing will be subject to acceptance at advertisers' risk. No cancellations accepted after closing date. Ad materials must be prepared per published print ad specifications (posted on www.aocs.org) and received by the published material closing dates. Materials received after deadline or materials requiring changes will be published at advertisers' risk. Send insertion orders and materials to the email address below.

NOTE: AOCS reserves the right to reject advertising copy which in its opinion is unethical, misleading, unfair, or otherwise inappropriate or incompatible with the character of *Inform*. Advertisers and advertising agencies assume liability for all content (including text, representation, and illustrations) of advertisements printed and also assume responsibility for any claims arising therefrom made against the publisher.

AOCS Advertising:

Valorie Deichman
Phone: +1 217-693-4814
Fax: +1 217-693-4858
valoried@aocs.org

Christina Waugh
Phone: +1 217-693-4901
Fax: +1 217-693-4864
Christina.waugh@aocs.org

Formerly published as *Chemists' Section*, *Cotton Oil Press*, 1917–1924; *Journal of the Oil and Fat Industries*, 1924–1931; *Oil & Soap*, 1932–1947; news portion of *JAOCS*, 1948–1989. The American Oil Chemists' Society assumes no responsibility for statements or opinions of contributors to its columns.

Inform (ISSN: 1528-9303) is published 10 times per year in January, February, March, April, May, June, July/August, September, October, November/December by AOCS Press, 2710 South Boulder Drive, Urbana, IL 61802-6996 USA . Phone: +1 217-359-2344. Periodicals Postage paid at Urbana, IL, and additional mailing offices. **POSTMASTER:** Send address changes to *Inform*, P.O. Box 17190, Urbana, IL 61803-7190 USA.

Subscriptions to *Inform* for members of the American Oil Chemists' Society are included in the annual dues. An individual subscription to *Inform* is $190. Outside the U.S., add $35 for surface mail, or add $120 for air mail. Institutional subscriptions to the *Journal of the American Oil Chemists' Society* and *Inform* combined are now being handled by Springer Verlag. Price list information is available at www.springer.com/pricelist. Claims for copies lost in the mail must be received within 30 days (90 days outside the U.S.) of the date of issue. Notice of change of address must be received two weeks before the date of issue. For subscription inquiries, please contact Doreen Berning at AOCS, doreenb@aocs.org or phone +1 217-693-4813. AOCS membership information and applications can be obtained from: AOCS, P.O. Box 17190, Urbana, IL 61803-7190 USA or membership@ aocs.org.

IDEAS THAT HOLD WATER

Laura Cassiday

The predictions are dire: According to the United Nations, by 2025 two-thirds of the world's population could be living under water-stressed conditions. Parched farmlands in California and Australia, dust storms and wildfires in the southwestern United States, and withering coffee crops in Brazil may be harbingers of drier times to come. As the global population swells past 7 billion people, communities, industry, and agriculture compete for dwindling water resources.

Yet not everybody is waiting until the sky falls (or doesn't fall, in the case of rain) to take action. Many companies in oil- and fat-related industries are embracing new water-saving technologies to cut back on water usage and recycle wastewater for other purposes.

Their motivations vary. "Water sustainability is very much a geographically driven challenge," says Eugenia Erlij, director of global marketing at Ashland Water Technologies, a specialty chemicals and equipment company based in Wilmington, Delaware, USA. "Drought-ridden regions are pushing the envelope in terms of water-saving innovations and water reuse." In contrast, such improvements are usually not cost-effective in water-rich regions.

However, Erlij notes that environmental sustainability is part of a global brand strategy for certain companies and industries, even in water-rich areas. "The brewery industry is highly conscious of water usage," she says. "If you

- **World population growth is intensifying competition for dwindling water resources.**
- **By 2025, two-thirds of the world's population could be living under water-stressed conditions.**
- **This feature presents examples of how companies in oil- and fat-related industries are increasingly embracing water-saving technologies to cut back on water usage and recycle wastewater.**

walk into a brewery plant, they have large signs that show how much water they're using to produce a liter of beer." Similarly, reducing water usage is a major component of Unilever's Sustainable Living Plan (http://tinyurl.com/Unilever-sustain-living).

Some companies want to reduce water consumption to save money. And others make changes to comply with increasingly stringent regulations on both water use and the discharge of effluents to the environment. But whatever the motivation, "We observe that more and more customers would like to save water," says Per Henning Nielsen, senior manager in the department of sustainability development at Novozymes in Bagsværd, Denmark.

Novozymes offers enzymes and microorganisms that help customers save water and energy. The company grows bacteria and fungi in large tanks to produce enzymes and other proteins by fermentation. They sell the microorganisms for wastewater treatment and agriculture (for example, bacteria that protect crops from pests), and enzymes for the household care, food and beverage, textile, and biofuels industries.

Novozymes' products offer the greatest water savings for the textile industry. During textile production, fabrics are pretreated and then dyed. The process usually requires three steps that consume large amounts of water: bleach cleanup, in which fabrics are rinsed to remove prior bleaching agents; biopolishing, the removal of small fibers or "pills" from the surface of the fabric; and dyeing. However, a Novozymes product called Cellusoft® Combi allows manufacturers to combine these three steps into one. Cellusoft® Combi is a blend of catalase and cellulase that can be added to a single water bath. "When you avoid two baths, you can save a lot of water," says Nielsen.

When a textile mill in India started using Cellusoft® Combi, it saved 13 m^3 of water per metric ton of knitted fabric produced. If all knitted fabric were produced with this technology, 65 million cubic meters of water could be saved globally per year. According to Nielsen, this translates to the annual water consumption of 1.7 million Indian people. In addition, the combined process reduces energy consumption because only one water bath needs to be heated, saving 350 kg carbon dioxide per ton of knitted fabric. If used globally, Cellusoft Combi would save an estimated 1.5 million metric tons of carbon dioxide annually. "This corresponds to taking 600,000 cars off the road," says Nielsen. "Also, the quality of the products is better, and the price is lower. So it's a win for all."

Novozymes also sells enzyme blends that can replace some of the surfactants in laundry detergents. "Enzymes are biological catalysts that act like small scissors," explains Nielsen. "They cut the dirt into pieces and make it easier for surfactants to remove the stains." The Novozymes blends contain up to eight enzymes, mostly hydrolases, that target different kinds of stains. Enzymes work at lower temperatures than traditional hot-water washes, reducing energy consumption and carbon dioxide emissions.

Also, enzymes are less toxic to the environment than the surfactants they replace because the enzymes degrade quickly, and they can be used at much lower concentrations than surfactants. This is particularly important for developing countries in which households often release their wastewater directly into rivers or other bodies of water. But even in the United States, detergents can be released into the environment by heavy rains that stress wastewater treatment plants, or by incomplete degradation of surfactants by microorganisms at the plant. Novozymes researchers estimate that if detergents in the United States were reformulated to have only 70% surfactant and 2.55% by weight of a multienzyme solution, more than 3.6 billion Olympic swimming pools worth of water could be safeguarded from detergent toxicity in one year (Nielsen *et al.*, 2010).

Enzymes can also save water and reduce pollution in the processing of oils and fats. In the degumming process of vegetable oil production, phospholipids are removed from the oil because they adversely affect oil quality and stability. The conventional method involves alkaline degumming, with a number of cleaning steps. "Because enzymes are very specific, they do the process with fewer cleaning steps and thereby save water, energy, and chemicals," says Nielsen.

Likewise, manufacturers typically produce emollient esters, common ingredients in cosmetics, with a chemical catalyst. Because the chemical catalyst tin(II) oxalate is not very specific, it produces many by-products that cleaning steps must remove. In contrast, the enzyme lipase B from the yeast *Candida antarctica* is highly specific, producing only the emollient ester and saving water and energy required for the cleaning steps (Cowan *et al.*, 2008). In addition, the enzyme eliminates the production of tin-containing solid waste.

CONTINUED ON NEXT PAGE

Fig. 1. The D-CARBONATOR soak tank gets kitchen equipment cleaner, while consuming less water, energy, and time. Left: pots and pans before soaking in the D-CARBONATOR. Right: after soaking. Credit: Gary Shifren

In the food industry, an innovative water-saving product called the D-CARBONATOR™ won the International Baking Industry Exposition's B.E.S.T. (Becoming Environmentally Sustainable Together) in Baking Award in 2013. The D-CARBONATOR, developed by ChemxWorks in Del Mar, California, USA, is an appliance used in restaurants and bakeries to remove black carbon buildup from metal and aluminum equipment, such as pots, pans, hood filters, and baking racks. Carbon buildup results when fats, oils, and grease are baked onto metal equipment.

Most commercial kitchens wash their soiled equipment in a three-compartment sink, says Gary Shifren, president of ChemxWorks. They fill the first sink with detergent, the second with rinse water, and the third with sanitizer. Kitchen workers typically change the water in each sink every two hours as it cools or the sanitizer is depleted. "Many operations change their water 6, 8, or 10 times a day at 120 or 150 gallons a pop," says Shifren. "So that's over 1,000 gallons [4 m^3] per day." In addition, much worker time and effort are required to scrub the equipment clean. Some kitchens use dishwashing machines, but they also consume lots of water and are ineffective at removing carbon buildup.

Shifren developed the D-CARBONATOR out of "a need to save water and the time wasted on trying to clean equipment that is almost impossible to clean," he says. The appliance is a heated soak tank that is filled with water and CarbonZyme™, a proprietary detergent sold by ChemxWorks, once per month. The D-CARBONATOR comes in several sizes, with capacities ranging from 25 gallons, or 100 liters (which will hold 12 sheet pans) to 500 gallons (which can accommodate a double-size baking rack of the type that is wheeled into ovens).

"Carbon builds up in layers over time, and this product works similar to paint stripper, stripping off the carbon layer by layer," explains Shifren. "After just a few hours in the tank you see the carbon start to soften and loosen its attachment to the metal." Hood filters or other equipment with superficial fats, oils, and grease require only about 20 minutes in the D-CARBONATOR, whereas a heavily carbonized pot may need an overnight soak. The equipment emerges from the appliance clean and sanitized, needing only a light rinse to remove any residue (Fig. 1).

Because the tank is only filled once per month, significant water savings can be achieved. Shifren estimates that the 40-gallon model saves 750,000 gallons (2,800 m^3) of water per year. "If you extrapolate that to one million restaurants in this country, we could save 7 trillion gallons of water per year," says Shifren. The D-CARBONATOR is also energy efficient. Electric current only kicks in when the temperature drops below 185°F (85°C). And the CarbonZyme detergent is biodegradable and safe to dump in drains and sewer systems.

"This is a relatively unknown technology in the United States," says Shifren. "When people start to understand what the D-CARBONATOR is and how it can work, it will really start catching on like wildfire."

Many manufacturers are striving to maximize the reuse of water within their plants. Companies such as Ashland Water Technologies can help by providing specialty chemicals and equipment for water treatment. Treated water can be used for a variety of purposes, including makeup water for cooling towers, steam production, or cleaning, says Erlij.

"Process optimization is one way to save water in a manufacturing plant," says Glen Bowen, platform team launch manager at Ashland Water Technologies. "Our products are focused on minimizing the problems that arise when you start to use water more efficiently." Cooling towers, with capacities of up to 2,000 m^3, are major consumers of fresh water. This water is recirculated, but over time the quality degrades. Without proper treatment, it could damage

Fig. 2. Ashland's OnGuard™ i controller utilizes powerful pre-programmed algorithms to anticipate upsets and quickly implement knowledge-based corrective actions. Credit: Ashland Water Technologies.

equipment or otherwise negatively affect the manufacturing process. Ashland supplies water treatment chemicals that prevent microbiological growth, inorganic scale deposition, and corrosion in cooling tower water.

In the past, these chemicals were added at a dose rate proportional to the water flow rate. Any changes in the water quality or manufacturing process required adjustments to the chemical feed rates. "For plants that use lakes and rivers for their cooling water makeup, the water quality can change quite dramatically," says Bowen. "And changes in the incoming water will require different dose rates of chemicals for cooling water and effluent treatment."

To automate water treatment, in 2013 Ashland Water Technologies introduced the OnGuard™ *i* controller (Fig. 2). This device continuously monitors system performance and makes adjustments to prevent upsets in water quality. For example, if the *i* controller detects a spike in corrosion, the device automatically increases the amount of corrosion inhibitor that is added to the water until the corrosion rate returns to the target level. Using performance-based control,, the OnGuard *i* controller can "learn" from the system's responses to its corrective actions. As a result, the *i* controller reduces water and energy consumption, prolongs equipment life, and increases facility productivity.

Performance-based control capabilities of the OnGuard *i* controller have been used successfully in boiler, cooling, and wastewater applications. A dairy that implemented OnGuard technology reduced its wastewater pollution, avoiding over $500,000 in municipal surcharges.

Nalco, an Ecolab company with headquarters in Naperville, Illinois, USA, offers the 3D TRASAR® technology for cooling water monitoring and optimization (Fig. 3, page 554).

Similar to the OnGuard *i* controller, the 3D TRASAR continuously monitors cooling water and adds appropriate chemicals when needed. In 2008, 3D TRASAR technology won the Presidential Green Chemistry Challenge Award, given by the US Environmental Protection Agency.

Over 20,000 3D TRASAR systems have been installed in facilities worldwide, ranging from manufacturing plants to luxury hotels. A counter on the Nalco website provides a running total of the estimated water savings attributed to the 3D TRASAR (http://www.nalco.com/services/3d-trasar-cooling-water.htm). As of the writing of this article (May 12, 2014), the water savings for 2014 were in excess of 162 million cubic meters.

"From our perspective, the major way that you can reduce the water usage rate in cooling towers is by reducing the amount of blowdown," says Lance Cox, regional marketing manager for water at Nalco. Most of the water in cooling towers eventually evaporates, leaving behind dissolved solids that can damage equipment. "The solids concentrate up, and when they get to a certain point at which the risk of deposition is too great, you open a valve and allow some of the water to enter the wastewater system. We call that blowdown," explains Cox. Fresh water,

CONTINUED ON NEXT PAGE

Fig. 3. Nalco's 3D TRASAR system detects system variability (scaling, corrosion, and biofouling), determines the appropriate response, and delivers water and energy savings in cooling water systems. Credit: Nalco

called makeup water, is added to compensate for evaporation and blowdown.

The 3D TRASAR system allows manufacturers to reduce the amount of blowdown water. By automatically adjusting the levels of dispersants, scale and corrosion inhibitors, and microbiocides, and by controlling variables such as pH and conductivity, 3D TRASAR allows manufacturers to increase the solids content of the cooling water, so that they blow down only the amount of water that is necessary. The system continuously monitors the concentration of solids, ensuring that the level stays within a safe range.

When a food processing plant in the western United States installed the 3D TRASAR system, its cooling tower discharged 19,000 m^3 less water per year into the wastewater system. This resulted in a savings of $10,000 per year in sewer costs. In addition, the 3D TRASAR reduced chemical costs by $8,000 per year and extended the expected lifetime of manufacturing equipment.

Cox notes that Quantum Technical Services (Pasadena, Texas, USA), a Nalco Champion company, conducts water audits for companies. "They go in and accurately map the water systems within a plant, and then they model the impact of equipment installation or operational changes on water savings," he says.

Agribusiness and Water Technology (AWT), a consulting and engineering services company based in Cumming, Georgia, USA, helps customers in the agribusiness, foods, and biofuels industries find ways to conserve and recycle water. According to Michael Boyer, president of AWT, the agribusiness industry in North America has reduced water consumption by about one-half over the past 40 years. "I don't think big industry gets enough credit here," he says.

THE SCIENCE OF SOCIO-HYDROLOGY

Traditional hydrology, the study of water's movements on Earth, considers humans only as external influences to the natural flows of water. The emerging field of socio-hydrology seeks a more realistic picture of the dynamic interactions and feedbacks between water and people.

"Humans impact basically every aspect of the earth," says Megan Konar, assistant professor of civil and environmental engineering at the University of Illinois at Urbana-Champaign (USA). "It's important to take those impacts of humans directly into account to get a more exact representation of what's going on." An interdisciplinary field, socio-hydrology draws from the natural sciences, social sciences, and humanities (Sivapalan *et al*., 2014).

Important to the field of socio-hydrology is the concept of the water footprint. "If you quantify the water footprint of various goods throughout their entire production process, you can start to pinpoint where most water is consumed and maybe highlight those areas to focus on for reducing water consumption," says Konar.

Her research focuses on how global trade in food affects water resources. In other words, how much water would the world use if every country produced its own food instead of importing it? "I find that the current trade system saves a lot of water," says Konar, which she finds interesting given that, for the most part, trade occurs for economic and political reasons rather than for concerns about water.

Also interesting is the finding that trade tends to follow water efficiency, or water use per unit of food, rather than overall water abundance. "Trade goes from countries that are efficient in using their water to produce food to countries that are less efficient at growing that same crop," says Konar.

"They're all trying to do the right thing. There's no lack of commitment or funding for water-saving projects."

In oilseed processing plants, water savings can be achieved in three ways: controlling in-plant water use, choosing processes and equipment that minimize water use, and treating wastewater effluent for reuse (Boyer, 2013). Zero or near-zero wastewater discharge is a goal for the industry, and several oilseed processing plants in North America have installed their own wastewater treatment facilities to meet this goal, Boyer says.

One of these is Fuji Vegetable Oil in Savannah, Georgia. In the 1990s, Fuji's water treatment facility was about the size of a pool table, recalls Nick Baker, chief operating officer. "Frankly, it was 'out of sight, out of mind,'" he says. Wastewater from the facility was discharged to the local sewage treatment plant. For a while, the company was small enough to be off the city's radar, but as Fuji expanded in size, "Any time we had an upset in the water, it would slug our unit with oil and then cause problems at the city's sewage treatment plant," says Baker. "We were in the doghouse with the state and local environmental folks over these oily discharges."

So in 1996, Fuji Vegetable Oil embarked on a water-saving mission. Sixteen years and more than $2 million later, they declared success. Fuji now has a state-of-the-art water treatment plant with zero wastewater discharge. All water used in manufacturing is reused as cooling water. The facility processes 110–150 m^3 of water per day.

When wastewater enters the treatment plant, it first passes through a grease trap that removes much of the contaminating vegetable oil. From there, the water enters a 230 m^3 equalization tank, which helps ensure a steady flow rate and contaminant load. In an acidulation tank, the pH of the water is lowered to 2, and more oil floats to the top and is removed. Then, in a process called dissolved air flotation, flocculants and coagulants are added, and air is injected in the bottom of the water solution. This causes more oil to rise to the top of the solution, where it is skimmed off.

Finally, the water enters a membrane bioreactor (MBR), which contains microorganisms that ingest and degrade any remaining oil and other contaminants. The water is then pumped through ultrafiltration membranes. "The water is crystal clear and pretty close to drinkable at this point, and it goes to the cooling tower," says Baker.

According to Baker, even with a beautiful wastewater treatment facility in place, "we went through years and years of substandard performance because we weren't operating it correctly." For example, Baker and his coworkers observed tremendous pH swings in the water entering the equalization tank. They eventually discovered that pH measurement devices weren't being calibrated or monitored correctly, and large amounts of acid and base were being introduced to the system. "It's critical for a water treatment

CONTINUED ON NEXT PAGE

INFORMATION

- Boyer, M.J., How to save water in oilseed processing, *Inform 24*:110–112, 2013.
- Cowan, D., K.M. Oxenbøll, and H.C. Holm, Enzymatic bioprocessing of oils and fats, *Inform 19*:210–212, 2008.
- Nielsen, A.M., T.J. Neal, S. Friis-Jensen, and A. Malladi, How enzymes can reduce the impact of liquid detergents, *HAPPI*, pp. 78–83, September 2010.
- Sivapalan, M., M. Konar, V. Srinivasan, A. Chhatre, A. Wutich, C.A. Scott, J.L. Wescoat, and I. Rodríguez-Iturbe, Socio-hydrology: use-inspired water sustainability science for the anthropocene." *Earth's Future 2*, http://dx.doi.org/10.1002/2013EF000164, 2014.

plant to have the same type of water and the same amount of water on a routine basis," says Baker.

Another problem the Fuji team had to overcome involved optimizing the MBR. "We thought we had an MBR, but we couldn't measure any of the microorganisms yet," says Baker. So the team bought a $5,000 microscope and learned how to use it. "At the end of the day, I told my boss, the good news is that we know how to measure bugs," says Baker. "The bad news is, we don't have any." So Baker and his colleagues optimized the amount, size, and species of microorganisms to add to the MBR. Once added, it was important to keep the microorganisms healthy, as the remains of dead "bugs" can clog ultrafiltration membranes.

Another major improvement came with the hiring of dedicated wastewater treatment plant operators. "We hired some really good operators, and it made a huge, huge difference in maintaining the quality of operations," says Baker.

Every day at the morning staff meeting, the head water treatment plant operator briefs the entire group on the 24-hour operations of the plant. They examine a detailed report that includes measurements such as the amount of grease in the grease trap, the chemical oxygen demand, and the pH of the equalization tank. "We have a feel for what's going on at each and every point throughout the system," says Baker. "If you don't get at this level of detail, you're going to fail."

Baker acknowledges that Fuji's journey to water sustainability "took a lot of blood, sweat, and tears." He says that the Fuji plant in Savannah went from being a "redheaded stepchild" to a model of efficiency for the industry. If other companies likewise take advantage of the spectrum of water-saving technologies available today, people just might be able to defy the predictions and ensure water sustainability for generations to come.

Laura Cassiday is a freelance science writer and editor based in Hudson, Colorado, USA. She has a Ph.D. in biochemistry from the Mayo Graduate School and can be contacted at lauracassiday@yahoo.com.

Development of the first efficient membrane separations of cis fatty acids

Ned Bowden

Fatty acids are an important feedstock for the chemical industry and are expected to increase in global worth at a rate of about 13.6% per year (from 2012) to $13 billion by 2017. The growth in this market is due to several chemical and economic factors. Fatty acids are easily isolated from vegetable, algal, and fish oils as well as animal fats. They are biorenewable and environmentally safe, so their use allows the manufacture of "green" products that are desired by consumers. Fatty acids are also rich in carbon and hydrogen, and for the most part they contain only two oxygen atoms per fatty acid. These traits make them very stable and unreactive, which is important for commercial products, such as engine oils and lubricants, that are placed under harsh conditions.

- **This article describes the development of the first membranes that can rapidly separate and purify both cis fatty acids and cis fatty acid esters.**
- **The membranes separate molecules based on their sizes, which are determined largely by the number and location of the cis-double bonds rather than whether an acid or ester is present.**
- **Oleic, linoleic, linolenic, eicosapentaenoic, and docosahexaenoic acids can be purified to >95% purities.**

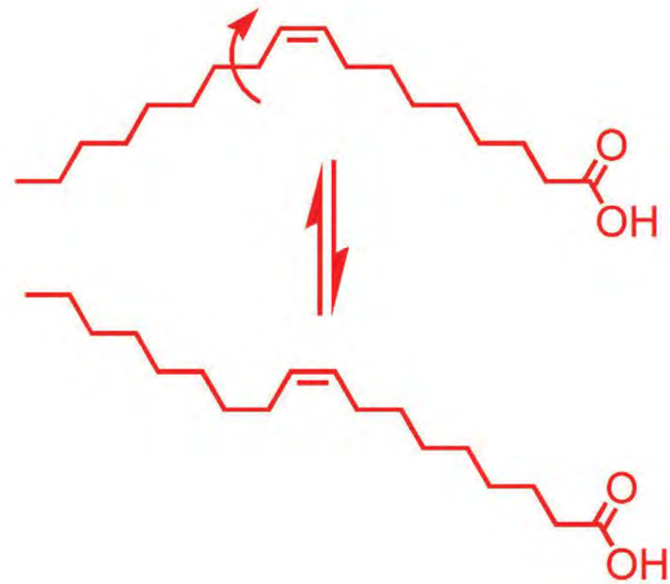


FIG. 1. *The size of a fatty acid is constantly changing due to bond rotations such as the one shown. Bond rotations about the carbon–carbon single bonds yield different conformations for fatty acids that have different sizes.*

Currently and historically, the chemical industry has used petroleum feedstocks to produce everything from oils to paints to pharmaceuticals. Because the price of crude oil has gone up by a factor of 10 in the last 15 years, the price of petroleum feedstocks has also increased. This cost increase has made it financially attractive for the chemical industry to use inexpensive, plentiful, biorenewable feedstocks such as fatty acids.

A challenge to developing commercial applications of fatty acids is that they are isolated as a mixture of five or more different fatty acids. It is simple to react an oil to yield either fatty acids or their methyl esters, but the isolated mixture of fatty acids is very similar to the composition of the original oil. This represents a challenge in the chemical industry because although one fatty acid may be highly desired for a product, another fatty acid in the same mixture may be unwanted. Companies that develop commercial applications of fatty acids must "make do" and use mixtures of fatty acids even if the presence of undesired fatty acids adds cost or limits what can be manufactured.

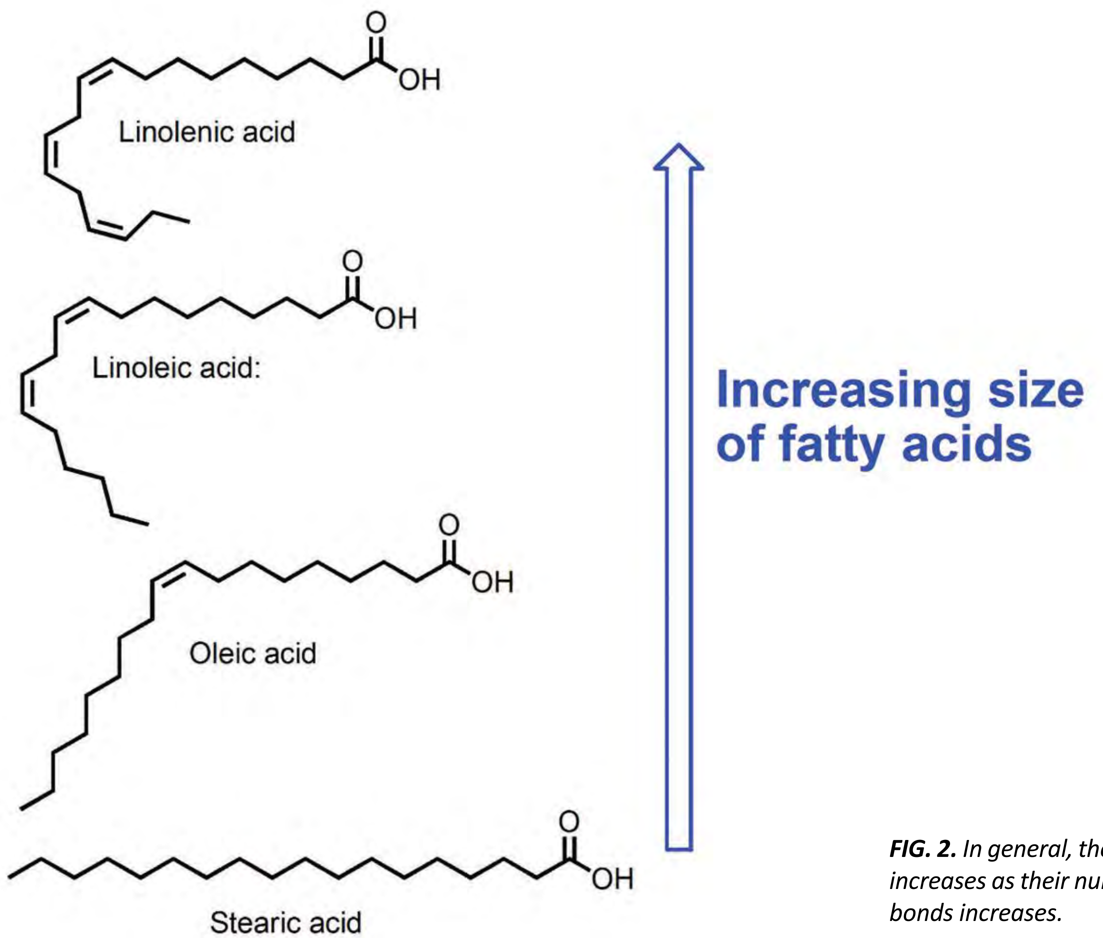


FIG. 2. *In general, the size of fatty acids increases as their number of cis-double bonds increases.*

Fatty acids have very similar chemical and physical properties, which make separating them a challenge. Current methods to separate fatty acids on an industrial scale, which are decades old, can separate fatty acids to reach purities of an individual fatty acid of 80% and, in some instances, up to 90%. The costs associated with these purifications increase with increasing purity, and there are significant limits on what purities can be reached at a reasonable cost.

In 2013 the Bowden group at the University of Iowa (Iowa City, USA) developed the first membranes that can rapidly separate and purify both cis fatty acids and cis fatty acid esters. These membranes can convert low-purity fatty acid mixtures (e.g., 45% oleic acid) to a high-purity fatty acid (i.e., 97% oleic acid). The University of Iowa has filed patents, and a start-up company, Pure Oleochemicals, has the exclusive license for these patents.

Separations based on membranes are an exciting new method that can potentially change how fatty acids are purified and what purities are economically possible to reach. Membrane separations are well integrated into the chemical industry and are generally viewed as an attractive purification method. The best membrane purifications can be completed at room temperature or slightly above, do not require additional solvent, and use pressures up to 1,000 pounds per square inch (7 megapascals). They are typically a very low-cost way to purify molecules. As an example, a common use of membranes on a large scale is spiral-wound reverse osmosis membranes that purify water by removal of salt or other unwanted impurities.

Before 2013, no membrane that could separate and purify fatty acids was known. This is not surprising since fatty acids possess nearly identical molecular weights and small sizes that make separating them with a membrane very challenging. Most membranes separate molecules based on their different sizes, similarly to how a coffee filter retains large coffee grinds but allows water to pass through. Unfortunately, not only are the sizes of fatty acids similar to one another, but the size of each fatty acid is constantly changing due to bond rotations (Fig. 1).

In 2013 the Bowden group developed a class of membranes that could differentiate fatty acids based on the number and location of cis-double bonds. The cis-double bonds are “kinks” that lead to slightly different sizes for fatty acids (Fig. 2). An increase in the number of cis-double bonds leads to a higher curvature of a fatty acid and a slightly larger size. For instance, oleic acid is larger than stearic acid because it has one double bond, but oleic acid is smaller than linoleic acid,

CONTINUED ON NEXT PAGE

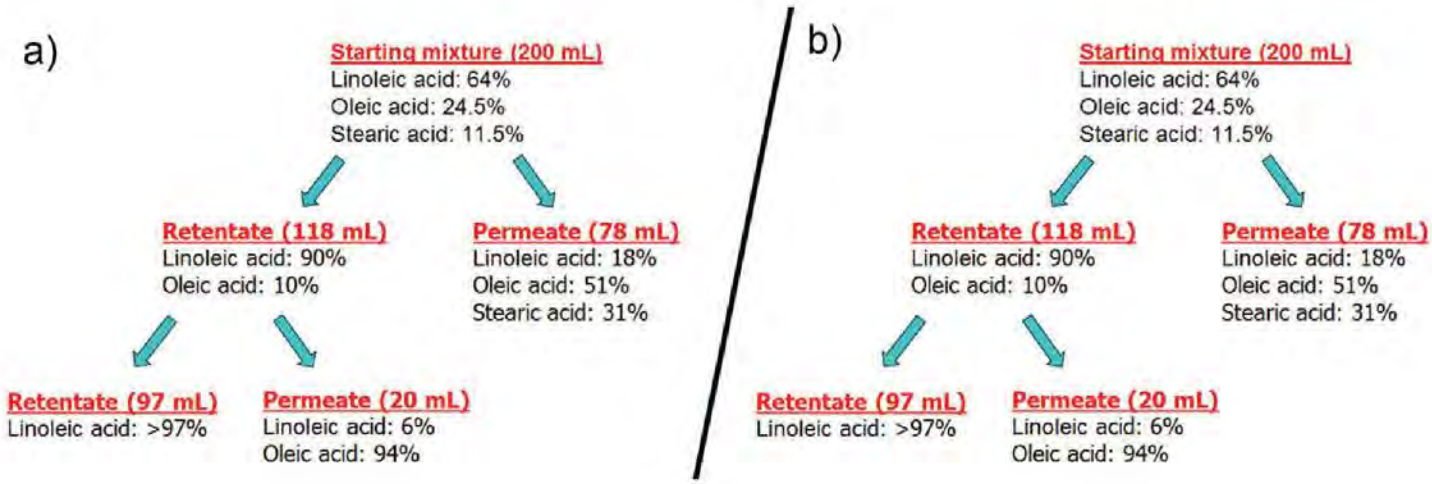


FIG. 3. *(a) A mixture of linoleic acid, oleic acid, and saturated acids was passed through one membrane to yield a retentate mixture highly enriched in linoleic acid. The mixture of 90% linoleic and 10% oleic acids was passed through a second membrane, and two high-purity streams were isolated. (b) A mixture primarily composed of oleic acid and saturated acids was passed through one membrane to yield a high-purity stream of oleic acid.*

which has two cis-double bonds. Linolenic acid, with three cis-double bonds, is even larger than oleic and linoleic acids.

The membranes developed by Bowden's group can be tuned to selectively retain fatty acids (Fig. 3). For instance, a mixture of 64% linoleic acid, 24% oleic acid, and 12% saturated acids was added to a separation vessel with one membrane. After pressurization at 150 psi, the linoleic acid was selectively retained and constituted 90% of the retentate. After passing the retentate through a second membrane having identical composition, a stream that was enriched in linoleic acid (>97% purity) and a stream enriched in oleic acid (94% purity) were isolated. These separations show that linoleic acid could be rapidly separated from oleic acid and saturated acids.

In a different series of experiments it was shown that oleic acid could be separated from stearic acid (Fig. 3b). In this case, a mixture of 2% linoleic/linolenic acids, 72% oleic acid, and 26% saturated acids was added to a separation vessel with a membrane designed to retain oleic acid. After pressurizing, the retentate was highly enriched in oleic acid (97% pure) and the permeate was enriched in saturated acids. In fact, oleic acid from inexpensive feedstocks could be purified to >99% using these membranes.

In addition to separating and purifying mixtures of fatty acids, we were able to separate and purify mixtures of methyl esters of fatty acids. The membranes separate molecules based on their sizes, which are determined largely by the number and location of the cis-double bonds rather than whether an acid or ester is present. The separations of mixtures of the common fatty acids found in vegetable oils (stearic, oleic, linoleic, and linolenic acids) was similar regardless of whether fatty acids or the esters were used.

This work was extended to the purification of eicosapentaenoic acid ethyl ester (EPA-EE) and docosahexaenoic acid ethyl ester (DHA-EE). These omega-3 fatty acid esters originate from fish and are sold as health supplements worldwide. Fish oil typically contains only 30% EPA and DHA in the form of triglycerides; to purify EPA and DHA, one must convert them into ethyl esters. Because EPA (C_{20} and five cis-double bonds) and DHA (C_{22} and six cis-double bonds) have high molecular weights and high degrees of unsaturation, they are challenging to purify. The membranes that we developed can quickly and easily separate the saturated, monounsaturated, and other polyunsaturated fatty acid esters from EPA-EE and DHA-EE. In addition, these membranes can separate EPA-EE from DHA-EE. For example, in one experiment a mixture of 39% EPA-EE and 40% DHA-EE was passed through a membrane. The retentate had a composition of 17% EPA-EE and 62% DHA-EE, and the permeate had a composition of 52% EPA-EE and 24% DHA-EE. Further passes through membranes allowed the purification of both EPA-EE and DHA-EE to >90% purities.

Many aspects of these separations indicate that they will be successful when applied on an industrial level. The flux of these experiments was typically 10–50 L m^{-2} h^{-1} despite little optimization. The separations can be completed at room temperature or slightly elevated temperatures, and only a few passes through a membrane are needed to reach high purities (>90%). Mild pressures of 150 psi were used for many experiments, so the pressure can be increased to accelerate the flux through these membranes. These separations have been applied on less than 1 kilogram size scales so far, but Pure Oleochemicals is working to scale these separations to be appropriate for industrial applications.

Membrane-based separations compare favorably to the current methods used to separate fatty acids, including distillation, winterization, and urea clathration. Distillation requires large amounts of energy due to the high boiling points of the fatty acids. Winterization involves the addition of a solvent and cooling to precipitate the high-melting-point fatty acids. After filtration, the solvent must be removed and recycled. To increase the effectiveness of winterization an additive such as urea can be added, but this additive must also be removed at the completion of the separation. These technologies are mature and been used for several decades, but there are limits to the purities of fatty acids that can be produced at economically viable prices. The use of membranes is a radically new purification method that will open up new opportunities to complete current purifications for a lower cost, to solve purification challenges that are not possible with current technologies, and to produce high purity fatty acids for a low cost.

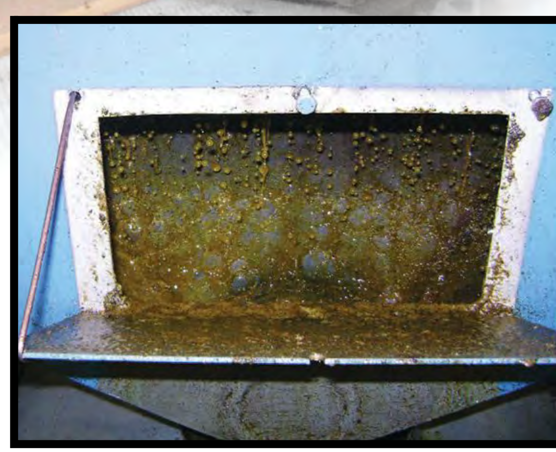
Ned Bowden is a professor of chemistry at the University of Iowa and the CEO of Pure Oleochemicals. He can be reached at nedbowden@gmail.com.

DURABILITY | **REPEATABLE RESULTS**

Introducing the Anderson 8" Dox/Hivex™ Series Expander

High Oil Content Seed Capacities, From 30-65 MTPD

This new Anderson Dry Dox/Hivex™ Expander reduces oil content to 19-25% R.O. and efficiently shears the oil cells to increase Expeller® capacities 40-100%.



Features:

- Oil Drainage Cage
- Anderson Expeller® Shafts
- V-Belt Drive
- Manually Operated Choke
- VFD Driven Feeder

ANDERSON INTERNATIONAL CORP

Contact us today to learn more about how this unique oilseed processing machinery can benefit your current or future requirements.

4545 Boyce Parkway, Stow, Ohio 44224 U.S.A.
Phone: (216) 641-1112 • Fax: (330) 688-0117
Web Site: http://www.andersonintl.net

The US Centers for Disease Control and Prevention (CDC) has published updated data in its report on human exposure to environmental chemicals. *The Fourth National Report on Human Exposure to Environmental Chemicals* covers 39 new chemicals, including perfluorinated surfactants as well as phytoestrogens and their metabolites. The updated data are available at http://tinyurl.com/CDC-Update.

■■■

The first loaded vessel has departed Archer Daniels Midland Co.'s (ADM; Chicago, Illinois, USA) new export terminal in Barcarena, in the northern Brazilian state of Pará. ADM acquired the terminal in 2012. The terminal currently has an approximate annual capacity of 1.5 million metric tons (MMT) of grain. The company said it intends to expand the terminal's capacity to 6 MMT by 2016.

In other company news, ADM announced at the end of August 2014 that it has opened its new global headquarters and customer center in downtown Chicago, Illinois, USA. About 70 employees will be based in the two-floor space. ADM's North American base of operations will remain in Decatur, Illinois.

■■■

A Cargill facility in eastern Ukraine may have been struck by a missile in mid-August 2014, according to the *Star Tribune* newspaper in Minneapolis, Minnesota, USA.

"We have received reports that there was a fire at one of the grain silos at our facility in Donetsk which was attended by the local fire brigade," the company said in a new release. "Unconfirmed reports suggest this may have been the result of a missile hit."

■■■

Sweden's AAK has acquired the oils and fats business of bakery fats supplier CSM Benelux NV in Merksem, Belgium, effective July 1, 2014. AAK also is acquiring the Turkish frying oil brand Frita from Unilever. Frita, a market leader in the frying oil segment in Turkey, covers a significant part of the local food service market, according to AAK. ■

NEWS & NOTEWORTHY

Latest USDA oilseed outlook

The August 2014 US Department of Agriculture (USDA) *Oil Crops Outlook* report—the most recent data available as *Inform* went to press—forecast a reduction in the estimated 2014/15 global soybean production. USDA also said that although Canada will experience reduced canola production, that decrease will be countered by better European rapeseed yields.

International outlook. The 2014/15 forecast of global soybean production was trimmed 96,000 metric tons (MT) from July 2014 to 304.7 million metric tons (MMT). US gains were offset by a forecast reduction in India's soybean crop. A larger US carryout for 2014/15 may still swell global ending stocks to 85.6 MMT.

In India, delayed monsoon rainfall this year has greatly shortened the planting season for soybeans. By August 7, Indian farmers had sown 10.3 million hectares of soybeans, compared to 11.9 million a year earlier. Many producers had already switched to sowing cotton, which has a longer window for planting.

This year's planting delays are expected to prevent Indian soybean area from exceeding 11 million hectares. The area estimate is down 600,000 hectares from the July report. On this basis, Indian soybean production for 2014/15 is forecast down 600,000 MT in August to 11 MMT. Consequently, the country's soybean crush for 2014/15 is forecast 550,000 MT lower in August to 9 MMT. Lower output of soybean meal may then reduce Indian exports in 2015 by 400,000 MT to 3 MMT. Indian consumption of soybean oil would also be curtailed but could be offset by rising imports of sunflowerseed oil.

CONTINUED ON NEXT PAGE

Global rapeseed production for 2014/15 is forecast 200,000 MT higher in July to 70.4 MMT. Higher yields for the European Union (EU), Ukraine, and China are offsetting a lower area estimate for Canada.

Although it was quite wet throughout Europe in July, rapeseed harvesting was advancing well. EU crop yields were very good, and USDA raised its production forecast in August by 250,000 MT to 22.65 MMT. A better yield outlook for France, Romania, and Bulgaria is primarily responsible for this increase. Higher domestic rapeseed supplies could trim EU imports in 2014/15 to 2.8 MMT from 3.45 MMT in 2013/14. Limited prospects for growth in the EU rapeseed crush are also likely to cause season-ending stocks to accumulate.

Similarly, the Ukraine rapeseed crop for 2014/15 is expected to be very good. Despite a 15% decline in Ukraine rapeseed area this year, the August report finds that excellent yields will boost production by 200,000 MT to 2.2 MMT. Despite a smaller crop than last year, Ukraine rapeseed exports are forecast to remain high at 1.9 MMT.

Global rapeseed trade may shrink in 2014/15 as the leading importing countries have improved domestic crops. The biggest impact of larger EU and Ukraine rapeseed crops may be on exports from Australia, which are forecast 200,000 MT lower in August to a four-year low of 2.45 MMT. In addition, lower rapeseed imports for China will likely deter Australian shipments. China rapeseed imports for 2014/15 are forecast 300,000 MT lower in August to 3.2 MMT owing to an increase in domestic supplies. Good growing weather pushed China's rapeseed yields for 2014/15 to an all-time high, which boosted production to a record 14.7 MMT.

In Canada, June flooding is expected to reduce harvested area for canola by 300,000 hectares this year to 7.7 million. Canola fields that avoided flooding are doing very well but the washed-out croplands reduce the 2014/15 production forecast for Canada by 450,000 MT in August to 15.25 million. Total supplies in Canada are reduced even further owing to smaller expected carryover stocks. Strong second-quarter exports reduced the expected stocks carryout for 2013/14 to 2.5 MMT from the previous estimate of 3.1 MMT. That reduction contributes to a lower forecast for 2014/15 ending stocks at 2.3 MMT.

US outlook. As of August 10, 70% of the US soybean crop was rated in good-to-excellent condition—a level surpassed only once for this date in 1994. Average July temperatures for the Corn Belt ranked as the second coolest since 1895. In 2009—when the region had its coolest July on record—the US soybean yield had set its previous all-time high.

In its August *Crop Production* report, USDA published its first objective yield forecast of 2014 for soybeans at an all-time high 45.4 bushels (almost 1 MT) per acre. Coupled with a record harvested area estimate of 84.1 million acres (about 34 million hectares), a higher yield raised the 2014/15 soybean production estimate to a record 3.816 billion bushels. Total supplies edged up by 16 million bushels from July projections.

The outlook for 2014/15 soybean demand was unchanged in August. Thus, higher supplies would raise season-ending soybean stocks to 430 million bushels—more than triple the expected 2013/14 carryout.

Owing to recent Census Bureau revisions of 2013 data, soybean exports for 2013/14 were forecast 20 million bushels higher in August 2014 to 1.64 billion bushels. Likewise, the soybean import forecast was trimmed 5 million bushels to 80 million. Offsetting changes were made by decreasing the estimate of the 2013/14 residual, which is a measure of the unaccounted difference between total supplies and total use. Now—at 94 million bushels—the residual implies a larger-than-estimated supply. Except for a 150-million-pound increase in 2013/14 soybean oil exports (to 1.85 billion pounds or roughly 840,000 MT), no changes were forecast in August for production and use of soybean meal and soybean oil.

Larger peanut and cottonseed crops are anticipated. The US peanut (groundnut) crop for 2014/15 was forecast at 5.1 billion pounds—second in size only to the record 2012

SUSTAINABILITY WATCH

LCA on pine chemicals available

Results of a third-party peer-reviewed life cycle assessment (LCA)—"Greenhouse Gas and Energy Life Cycle Assessment of Pine Chemicals Derived from Crude Tall Oil and Their Substitutes"—found that diverting Crude Tall Oil (CTO) into biofuel production in Europe would not have a significant effect in either reducing carbon emissions or fossil fuel consumption. CTO is a sustainable raw material that has been used for decades in biorefining to produce pine chemicals such as tall oil fatty acid and tall oil rosin.

The LCA study, sponsored by the American Chemistry Council's (ACC) Pine Chemistry Panel and conducted by Franklin Associates, a division of Eastern Research Group, found that:

- The global carbon footprint of pine chemicals produced from CTO is 50% lower than substitute products used in the same situation, including hydrocarbon resins and alkyl succinic anhydride.
- CO_2 equivalent emissions will be essentially the same if CTO is used as a fuel or in chemical products in Europe.
- The amount of fossil fuel required to manufacture the substitute products of pine chemicals substantially offsets any fossil fuel reduction that might occur if CTO were used in fuel.

"This study proves that the pine chemicals industry makes a significant positive contribution to achieving the twin bio-economy goals of reducing greenhouse gas emissions and fossil fuel consumption," said Kevin Moran, director, Chemical Products & Technology Division at the ACC, a trade association based in Washington, DC, USA. "It provides a baseline of solid, scientific evidence for policymakers to consider in the debate around the use of CTO as a raw material for biofuel."

Industries compete in the marketplace to purchase CTO, a co-product of papermaking and a constrained resource. "Government mandates and subsidies [encouraging] use of this finite biomass material in fuels damage the pine chemical biorefining industry by limiting CTO availability," ACC noted in a news release.

The Executive Summary of the LCA study is available in PDF format at http://tinyurl.com/pine-chemicals.

■■■

Swiss specialty chemicals manufacturer Clariant announced in August 2014 that its plant in Gendorf, Germany, has received Roundtable on Sustainable Palm Oil (RSPO) Mass Balance supply chain certification. The Gendorf facility is the first of Clariant's plants to achieve RSPO certification.

The company said in a statement that it plans to have all "relevant" production sites certified by 2016. Clariant uses oleochemicals derived from palm-based oils in its surfactants, emulsifiers, and preservatives for personal care and home care products. ■

harvest. USDA estimated the national average yield at 3,964 pounds per acre, which would rank third behind only the 2012 and 2013 crops. Large supplies of peanuts will buoy demand throughout 2014/15. Forecast growth for domestic consumption in food is 2% to 2.94 billion pounds. Although strengthening competition from Argentina next year may curtail US exports of peanuts, a comparatively high 1.02 billion pounds is still forecast for 2014/15. That might not be enough, though, to reduce season-ending stocks greatly, which are expected to hover around 2 billion pounds.

US cottonseed production for 2014/15 was forecast to increase 37% from 2013/14 to 5.8 million short tons (ST). Most of this year's increase can be attributed to a lower rate of acreage abandonment for cotton.

Estimated harvested acreage for cotton increased to 10.2 million acres from 9.7 million in July. Cottonseed prices are anticipated to grow considerably less expensive, so demand will rebound. Cottonseed crushing for 2014/15 was forecast to expand by 25% to 2.5 million ST, while feed use could swell 27% to 2.85 million ST. ■

106th AOCS Annual Meeting

and Industry Showcases

May 3–6, 2015

Rosen Shingle Creek | Orlando, Florida, USA

HOT TOPICS

Submit Your Proposal

The fats and oils industries are always in a state of flux—new technologies emerge, innovative research is published, and regulations change. The Hot Topics Symposia at the 106th AOCS Annual Meeting will feature global discussions on these current critical issues and expound on their implications for the future.

AOCS invites you to submit a proposal to organize a special symposium on a pressing topic within our industries. The symposia will take place on Monday, May 4, and a limited number of sessions will be chosen.

AnnualMeeting.aocs.org/HotTopics

Call for Papers

AOCS also invites you to submit an abstract and present your research. The technical program will feature invited, volunteer, and poster presentations.

AnnualMeeting.aocs.org/CallForPapers

October 20, 2014: Submit your abstract or proposal for optimal consideration

February 2, 2015: Final deadline for abstracts

March 6, 2015: Final deadline for Hot Topic proposals

Experience the science and business dynamics driving the global fats and oils industries.

BRIEFS

Thailand's Alternative Energy Development and Efficiency Department has completed two years of B20 (20% biodiesel, 80% petrodiesel) trials in large trucks, both in the lab and in the field, according to the *Bangkok Post*. Large trucks consume 60% of the diesel in Thailand, or about 30 million liters a day, the report noted. One challenge of moving to commercial production is the cost, with pure biodiesel priced at 32–33 bahts/liter (about $1, excluding taxes), compared with 25–26 baht/liter (about $0.80) for petrodiesel.

■■■

The Ethiopian and Norwegian governments have together invested $2.8 million in producing biodiesel from jatropha, according to AllAfrica.com. A spokesperson from Ethiopia's Water, Irrigation and Energy Ministry said that the five-year project aims to produce 500 million liters of biofuel in an unspecified period of time.

■■■

Sustainable Aviation—a coalition of key players in the United Kingdom's aviation industry—is committed to finding ways to reduce CO_2 emissions. Toward that end, the group has published a manifesto of sorts calling for an "urgent review" of the government's sustainable aviation fuels policy. According to the group, the potential exists for reducing UK aviation's carbon emissions by 1.7 million metric tons/year by 2030 (see http://tinyurl.com/sus-aviation).

■■■

Commercialization of zero-emission hydrogen fuel-cell vehicles has been hindered by the high cost of critical materials and infrastructure. Now, Toyota says it has cut costs by 90%, and German industrial gases and engineering company Linde AG will start small-series production of hydrogen fueling stations. Some of the stations are slated to open in California when Toyota debuts its Highlander hydrogen fuel-cell electric vehicle in 2015. The Highlander can travel five times farther than currently available electric vehicles before recharging, refuels in minutes, and emits only heat and water vapor, according to Toyota. ■

ENERGY

Hybrid tobacco plants at a test farm for aviation biofuel production in Limpopo province, South Africa. Photo credit: Sunchem South Africa.

Boeing partners with South African Airways

Boeing, South African Airways (SAA), and SkyNRG are collaborating to make sustainable aviation biofuel from a new type of tobacco plant.

SkyNRG (Amsterdam) is expanding production of the hybrid tobacco plant known as Solaris as an energy crop. Test farming of the nicotine-free plants is underway in South Africa with biofuel production expected in the next few years. Initially, oil from the plant's seeds will be converted into jet fuel. In coming years, Boeing expects emerging technologies to increase biofuel production from the rest of the plant.

In October 2013, Boeing and SAA said they would partner to develop a sustainable aviation biofuel supply chain in Southern Africa. As part of that effort, they are working with the Roundtable on Sustainable Biomaterials to position farmers with small plots of land to grow biofuel feedstocks that provide socioeconomic value to communities without harming food supplies, fresh water, or land use.

Carbon dioxide 'sponge' could ease transition to cleaner energy

A sponge-like plastic that sops up the greenhouse gas carbon dioxide (CO_2) might ease the transition away from polluting fossil fuels and toward new energy sources such as hydrogen. The material—a relative of the plastics used in food containers—could

CONTINUED ON NEXT PAGE

play a role in cutting CO_2 emissions as well as being integrated into power plant smokestacks in the future.

"The key point is that this polymer is stable, it's cheap, and it adsorbs CO_2 extremely well. It's geared toward function in a real-world environment," says Andrew Cooper of the University of Liverpool. "In a future landscape where fuel-cell technology is used, this adsorbent could work toward zero-emission technology." Cooper reported on the material at the 248th National Meeting & Exposition of the American Chemical Society in August 2014.

CO_2 adsorbents are most commonly used to remove the greenhouse gas pollutant from smokestacks at power plants where fossil fuels such as coal or gas are burned. However, Cooper and his team intend the adsorbent, a microporous organic polymer, for a different application—one that could lead to reduced pollution.

The new material would be a part of an emerging technology called an integrated gasification combined cycle (IGCC), which can convert fossil fuels into hydrogen gas. Hydrogen holds great promise for use in fuel-cell cars and electricity generation because it produces almost no pollution. IGCC is a bridging technology that is intended to jump-start the hydrogen economy, or the transition to hydrogen fuel, while still using the existing fossil-fuel infrastructure. But the IGCC process yields a mixture of hydrogen and CO_2 gas, which must be separated.

Cooper says that the sponge works best under the high pressures intrinsic to the IGCC process. Just as a kitchen sponge swells when it takes on water, the adsorbent swells slightly when it soaks up CO_2 in the tiny spaces between its molecules. When the pressure drops, he explains, the adsorbent deflates and releases the CO_2, which can then be collected for storage or converted into useful carbon compounds.

The material, which is a brown, sand-like powder, is made by linking together many small carbon-based molecules into a network. Cooper explains that the idea to use this structure was inspired by polystyrene, a plastic used in styrofoam and other packaging material. Polystyrene can adsorb small amounts of CO_2 by the same swelling action.

One advantage of using polymers is that they tend to be very stable. The material can even withstand being boiled in acid, proving it should tolerate the harsh conditions in power plants where CO_2 adsorbents are needed. Other CO_2 scrubbers—whether made from plastics or metals or in liquid form—do not always hold up so well, Cooper notes. Another advantage of the new adsorbent is its ability to adsorb CO_2 without also taking on water vapor, which can clog other materials and make them less effective. Its low cost also makes the sponge polymer attractive.

"Compared to many other adsorbents, they're cheap," Cooper says. "And, in principle, they're highly reusable and have long lifetimes because they're very robust."

Use of biofuels declines in Europe

The growth of biofuel consumption used in transport in the European Union between 2012 and 2013 dropped by about one million metric tons of oil equivalent (Mtoe) to 13.6 Mtoe, according to the EurObserv'ER Biofuels Barometer report. EurObserv'ER is a consortium that monitors the development of the various sectors of renewable energies in the European Union.

On the other hand, certified sustainable biofuel consumption increased slightly by 0.8% to 11.8 Mtoe. Looking at the historical trend, EurObserv'ER notes that this is the first time that consumption of biofuels has decreased since the European Union began expanding the use of biofuels in 2003.

"After an analysis of the individual country consumption trends, our conclusion is that the European Union no longer has an overall trend," EurObserv'ER said in a news release. "The decline in biofuel consumption in 2013 is essentially related to Spain, where incorporation targets were cut, and Germany, where biofuel consumption declined after abolishing the last tax exemptions enjoyed by the biodiesel sector from 2013 onwards." By contrast, a number of countries—the United Kingdom, Sweden, and Denmark—significantly increased their incorporation rates, while others such as France, Austria, and Belgium, experienced steady usage rates in 2013.

Download Biofuels Barometer at http://tinyurl.com/EurObserv-2014.

New catalyst could convert carbon dioxide to fuel

Scientists from the University of Illinois at Chicago (UIC; USA) have synthesized a catalyst that improves their system for converting waste carbon dioxide (CO_2) into syngas, a precursor of gasoline and other energy-rich products, bringing the process closer to commercial viability.

Amin Salehi-Khojin, UIC professor of mechanical and industrial engineering, and his coworkers developed a unique two-step catalytic process that uses molybdenum disulfide and an ionic liquid to transfer electrons to CO_2. The new catalyst improves efficiency and lowers cost by replacing expensive metals like gold or silver in the reduction reaction.

The discovery is a big step toward industrialization, said Mohammad Asadi, UIC graduate student and co-first author on the paper.

"With this catalyst, we can directly reduce CO_2 to syngas without the need for a secondary, expensive gasification process," he said. In other chemical-reduction systems, the only reaction product is carbon monoxide. The new catalyst produces syngas, a mixture of carbon monoxide plus hydrogen.

The high density of loosely bound, energetic d-electrons in molybdenum disulfide facilitates charge transfer, driving the reduction of the CO_2, said Salehi-Khojin, principal investigator on the study.

"This is a very generous material," he said. "We are able to produce a very stable reaction that can go on for hours."

The proportion of carbon monoxide to hydrogen in the syngas produced in the reaction can also be easily manipulated using the new catalyst, said Salehi-Khojin.

"Our whole purpose is to move from laboratory experiments to real-world applications," he explained. "This is a real breakthrough that can take a waste gas—CO_2—and use inexpensive catalysts to produce another source of energy at large scale."

The study appeared in *Nature Communications* (http://dx.doi.org/ 10.1038/ncomms5470, 2014).

Report aims to guide sustainable biofuels procurement

Amid increasing interest in alternative transportation fuels, a new report aims to demonstrate how federal agencies and other large commercial customers in the United States can buy sustainably produced biofuels.

The report—"Biofuel Sustainability Performance Guidelines"—was commissioned by the Natural Resources Defense Council (NRDC; New York City, USA) and written by LMI, a nonprofit government consultancy based in McLean, Virginia, USA. Publication comes as large fuel consumers are looking at more biobased fuel options to boost their "green" credentials and sustainability efforts. "Biofuels can be a clean alternative to dirty fossil fuels, but they're not all created equal," said Brian Siu, senior energy policy analyst at NRDC. "Some biofuels are produced in ways that endanger precious land, wildlife, and the environment. As the US government and large businesses expand their use of biofuels, they should ensure they come from sustainable sources, and relying on the best certification systems can help them make these smart choices."

Today, many large fuel buyers are beginning to understand the risks of poorly sourced biofuels, NRDC noted, but are unable to determine whether their biofuels are produced sustainably. Third-party certification systems can provide this service, but vary significantly in stringency and protectiveness. A sound certification system should check each stage for effects on water quality, soil, biodiversity, air quality, land use, and waste, NRDC said. It also should check for the social impacts on economic issues, human rights, food security, and workforce safety.

To help stakeholders, the report examines seven leading programs that certify biofuel production practices for sustainability. NRDC ranked the Roundtable on Sustainable Biomaterials (Geneva, Switzerland) as the best certification system for helping to ensure economic, environmental, and social sustainability of biofuels production practices.

The report is available at http://tinyurl.com/NRDC-report. ■

Brominated vegetable oil will soon be removed from many soft drinks produced by global beverage producers, including Coca-Cola and PepsiCo. "Industry sources estimate that some 800 million pounds of BVO is produced from soybean oil, but that represents all uses," said Richard Galloway, an oil industry expert who consults with United Soybean Board (USB; Chesterfield, Missouri, USA) farmer-leaders, in a news release. The companies cite pressure from consumer advocates as the primary reason for removing the ingredient, which serves to help soft drinks stay properly mixed.

■■■

China has now published official dietary reference intakes for two omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), according to a report by NutraIngredients (http://tinyurl.com/NutraIngredients-China). A recent study in the *British Medical Journal* (http://dx.doi.org/10.1136/bmj.g2272) reports the average person in China consumes 37 mg of long-chain omega-3 fatty acids a day—far lower than the 250 mg to 2,000 mg recommended by the Chinese Nutrition Society. The World Health Organization estimates 188,000 people in China died in 2010 from low omega-3 intake.

■■■

The percentage of US consumers saying they avoid eating fat has been slowly decreased from 64% to 56% over the past ten years. But according to a recent Gallup survey, fat-avoiders still outnumber those who avoid carbohydrates two to one. "Avoidance of fats is lower than it was a decade ago, perhaps reflecting new scientific research that is calling into question the supposed insalubrious effects of fat," writes Gallup's Andrew Dugan. "Individuals who say they are seriously trying to lose weight are more likely than other Americans to say they avoid both fats and carbohydrates, though fats are clearly the more pressing priority [to dieters] to exclude." See all the results of the Gallup Consumption Habits survey at http://tinyurl.com/Gallup-Survey-2014. ■

FOOD, HEALTH & NUTRITION

A panel of medical researchers make the case that a high-fat, low-carbohydrate diet should be the first approach to treating diabetes.

Diabetes: The case for the low-carb, high-fat diet

Dietary guidelines for diabetics are all wrong, according to a panel of 26 medical experts and researchers in a report in the journal of *Nutrition* (http://dx.doi.org/10.1016/j.nut.2014.06.011, 2014). Current recommendations, which call for a high-carbohydrate, low-fat diet in conjunction with medications, have failed to control the diabetes epidemic, while "the benefits of carbohydrate restriction in diabetes are immediate and well-documented," the researchers write.

The panel presents 12 points of evidence from the research literature supporting the recommendation of a high-fat, low-carbohydrate diet as the first approach to treating diabetes. Since hyperglycemia is the most salient feature of diabetes, it makes sense that restricting carbohydrates will have the greatest effect on decreasing blood glucose levels. Studies show high-fat, low-carbohydrate diets can help patients with type 1 diabetes reduce the amount of medication required to control the disease, and in patients with type 2 diabetes, medication can often be reduced or even eliminated. By lowering their glucose levels through dietary carbohydrate restriction, patients can be spared the side effects that come with intensive pharmacologic treatment.

Critics have raised concerns that elevated fat intake will lead to an increased risk of cardiovascular disease, but the researchers point out that several large clinical studies "have failed to show an association between dietary lipids and cardiovascular risk." The researchers state their goal in presenting

CONTINUED ON NEXT PAGE

this case for the low-carbohydrate diet for diabetics is to help promote dialogue between researchers in the field, the medical community, and the organizations creating dietary guidelines. "The severity of the diabetes epidemic warrants careful and renewed consideration of our assumptions about the diet for diabetes," they write.

Modified protein mimics taste and texture of fat

Proteins may soon replace fat in food products without compromising taste, thanks to the work of UK scientists. The team, led by Steve Euston, senior lecturer in the school of life sciences at Herriot-Watt University in Scotland, found a modified protein easily breaks down into micro-particles, thereby mimicking the behavior of fats in food manufacture. Although previous protein-for-fat substitution efforts have succeeded in yogurt products, they have had limited success in applications such as cheeses and cakes. The new effort focuses on using proteins to replace eggs, which would open the door for use in bakery items, creating low-fat options in a food group that is typically high in fat.

Moving forward, the researchers will develop a computer model that will allow manufacturers to determine the optimum levels for replacing fat with protein in various food products, according to a statement from the Engineering and Physical Sciences Research Council, which funded the study. The research on the fat-mimicking protein will be taken forward by project partner Nandi Proteins, who will help incorporate the modified proteins into products that could reach the shelves within two years. Nandi Proteins is based in Edinburgh, Scotland, UK.

In another study, led by University of Massachusetts food scientist David Julian McClements, researchers found microparticulated whey protein could help create reduced-calorie emulsion-based foods, such as sauces and dressing. The team showed the protein microparticles, in combination with polysaccharides, can be used to create "reduced calorie food emulsions with an appearance and consistency similar to those of commercial full fat products," according to a report in *Food Navigator* (http://tinyurl.com/protein-microparticles). To see the full study, which was published in *Food Research International* in August 2014, visit http://dx.doi.org/10.1016/j.foodres.2014.07.034.

Brown fat plus cold temperatures may protect against diabetes and obesity

When exposed to mildly cold temperatures, people with higher levels of a certain type of fat known as brown fat are better able to regulate blood sugar, according to a study published in the journal *Diabetes* in late July 2014 (http://dx.doi.org/10.2337/db14-0746).

The majority of fat in the human body is composed "white fat" cells that serve as a reserve energy supply but which, in excess, can contribute to diabetes and other illnesses. The primary function of the lesser-known "brown fat" is to burn energy to generate body heat. Brown fat, also known as brown adipose tissue, is most abundant in newborn babies and hibernating animals. In adults, brown fat is found primarily in the shoulders and neck, although the role of brown fat in human metabolism—and whether it could play a role in weight loss—remains unclear.

The researchers, led by University of Texas Professor Labros Sidossis, compared seven men with high brown fat levels with five men who had low brown fat levels who were otherwise similar in age, body mass index, and adiposity. They found the men with higher levels of brown fat, when exposed to mildly cold temperatures, had higher insulin sensitivity and better metabolism for burning stored fat.

"These results demonstrate a physiologically significant role of [brown fat] in whole-body energy expenditure, glucose homeostasis, and insulin sensitivity in humans," the researchers wrote, "and support the notion that [brown fat] may function as an antidiabetic tissue in humans." If confirmed, these results suggest that an ambient room temperature of about 70°F, or 21°C, could help with blood glucose regulation, Sidossis told Medscape Medical News (see http://tinyurl.com/brown-fat-diabetes).

In another study, published in *Proceedings of the National Academy of Science,* researchers led by The Scripps Research Institute's Professor Anastasia Kralli shed light on the complex intracellular pathways that regulate brown fat's response to cold temperatures (http://dx.doi.org/10.1073/pnas.1406638111). The report explains how the proteins that activate brown fat, some of which were previously unknown, work together to jump start the calorie-burning process known as brown-fat thermogenesis. The results may "provide new avenues for the stimulation of energy expenditure," the authors write.

Mounting evidence for fish oil during pregnancy for diabetics

Babies born to diabetic mothers are at greater risk of developing diabetes themselves. A study published in *Diabetic Medicine* offers hope that fish oil supplementation for diabetic mothers during pregnancy can boost the levels of crucial long-chain omega-3 fatty acids in the babies' blood, which may serve a protective role against diabetes (http://dx.doi.org/10.1111/dme.12524, 2014).

Previous studies show pregnant women with diabetes have almost 40% less docosahexaenoic acid (DHA), an omega-3 fatty acid found in fish oil, than healthy moms-to-be, and they passed the deficit on to their children, which could explain why children born to diabetic mothers have a greater risk of blood sugar regulation later in life. The new study—a randomized controlled trial—involved 88 pregnant women with type 2 diabetes and 85 healthy pregnant women. Starting in the first trimester, half of each of the groups of women were given a DHA-enhanced fish oil (containing 600 mg of DHA), while the rest of the women were given a placebo pill filled with high oleic acid sunflower oil. The article did not indicate whether the DHA was in the triglyceride or esterified form, and neither group knew which pill they had received. By the time the babies were born, both the diabetic mothers and their babies who took the DHA pills had significantly higher levels of serum DHA compared to the control group.

"If you give omega-3 fatty acids it changes the composition of cell membranes and it is feasible this may make the cells more sensitive to insulin," Kebreab Ghebremeskel, one of the study's authors, told London's *Daily Express* newspaper.

American Society of Nutrition: Processed foods integral to diet

Are processed foods an essential part of the diet? The American Society of Nutrition (ASN) thinks so. The ASN issued a scientific statement in July, published in the *American Journal of Clinical Nutrition* (http://dx.doi.org/10.3945/ajcn.114.089284, 2014), stating that although processed foods can be harmful "when consumed inappropriately or at inordinately high proportions of a total diet," they have nevertheless provided individuals with several beneficial nutrients, including dietary fiber, iron, and folate. The authors use a definition of processed foods adopted from the International Food Information Council (IFIC, Washington, DC, USA), which ranges from washed and packaged produce to "ready-to-eat" cereals, crackers, and cookies, and urged food processors to develop new technologies to improve the nutrition of their products. IFIC is a nonprofit organization whose goal is to effectively communicate science-based information about food safety and nutrition and support research on consumer attitudes about food and nutrition issues.

Some nutritionists expressed disappointment over the statement. Although some foods, like frozen fruits and vegetables, are minimally processed and retain much of their nutritional value, other processed foods "all but glow in the dark," writes David Katz, director of Yale's Prevention Research Center in *MedPage Today* (see http://tinyurl.com/Katz-Processed-Foods). But the reality is that processed foods are a source of nutrients in the current American diet, so "there is a rational argument here that we should do the best we can with the food supply we've got, and not make perfect the enemy of good," he writes.

Famous 1970s fish oil study criticized

In 1971, Jørn Dyerberg and coworkers at Aalborg Hospital North in Denmark published a paper in *The Lancet* reporting lower cholesterol and triglyceride levels in Greenlandic Inuits compared with Danish people, the Inuit's diet being rich in animal fat, primarily from fish (http://dx.doi.org/10.1016/S0140-6736(71)91658-8). Their study was motivated by epidemiological data that showed Inuits had low rates of acute myocardial infarction.

That study has recently come under attack by researchers led by George J. Fodor, researchers at the University of Ottawa Heart Institute, who published a review article in the *Canadian Journal of Cardiology* (http://dx.doi.org/10.1016/j.cjca.2014.04.007, 2014) claiming the data presented by Dyerberg *et al.* do not make a strong case for the cardioprotective effect of the "Eskimo diet." The disagreement over the validity of this famous fish oil study will be the focus of in-depth coverage in a future issue of *Inform*. ■

ysis of Fats and Oils

FROM AOCS TECHNICAL SERVICES

Ensure your laboratory's integrity with AOCS Methods, the most current and widely-recognized methods for testing fats and oils.

The *Official Methods and Recommended Practices of the AOCS* contains currently recognized methodology required for proficiency testing in the Laboratory Proficiency Program (LPP). Additionally, *AOCS Methods* are internationally recognized for trade, and several are listed by the Codex Alimentarius Commission. Worldwide acceptance has made *AOCS Methods* a requirement wherever fats and oils are analyzed.

PRINT

***Official Methods and Recommended Practices of the AOCS*, 6th Edition, 3rd Printing**

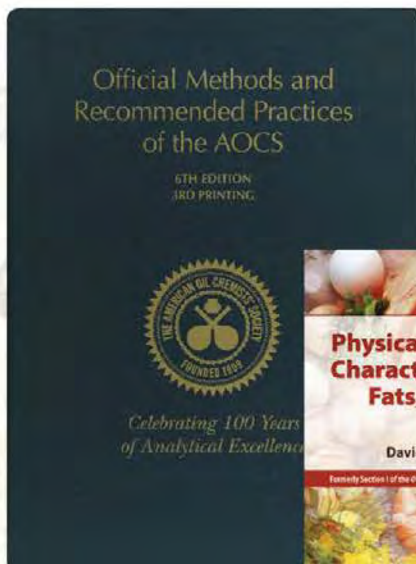
Edited by David Firestone. Product code METH09

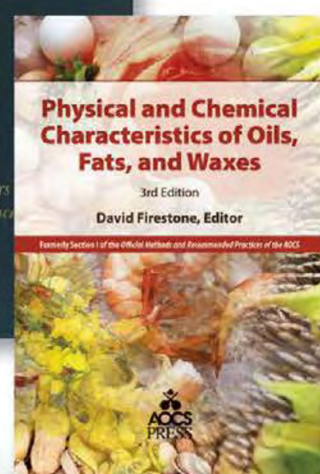
Additions and Revisions to the Official Methods and Recommended Practices of the AOCS

2011–2012 Additions and Revisions • Product Code 11AR
2013–2014 Additions and Revisions • Product Code 13AR
2011–12 and 2013–14 Additions and Revisions • Product Code AR_SET

ELECTRONIC

- Online individual *Methods*: www.aocs.org/tech/onlinemethods.
- *Methods* can also be licensed individually for your company's marketing purposes. For licensing information, contact AOCS Technical Services by phone: +1 217-693-4810, or email: technical@aocs.org.
- Tailored to your company's needs, AOCS offers individual intranet application or multiuser/multi-site access to a web-based library of *AOCS Methods*.





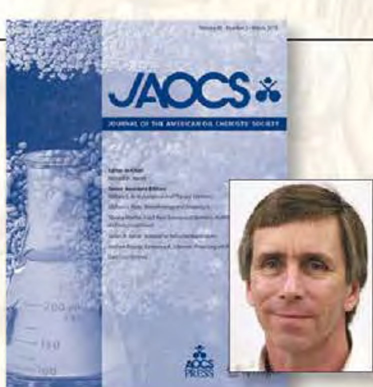
TECHNICAL SERVICES AOCS

***Physical and Chemical Characteristics of Oils, Fats, and Waxes*, 3rd Edition**

Edited by David Firestone. Product code mi99-3
List: $150 • AOCS Member: $120

The third edition of *Physical and Chemical Characteristics of Oils, Fats, and Waxes* includes updated material as well as 25% more new content. This is an essential reference tool for professionals interested in the quality, trade, and authenticity of oils and fats. Values for significant properties and important low-level constituents of nearly 500 fats and oils are provided including the following parameters where available: Specific Gravity, Refractive Index, Iodine and Saponification Value, Titer, and Fatty Acid, Tocopherol, Tocotrienol, Sterol, and Triglyceride Composition.

FROM AOCS JOURNALS



JAOCS, publishing articles for over 90 years, continues to be the leading source for original research articles on the science and technology of fats, oils, oilseed proteins, and related materials. Submit your original research, letter to the editor, or review to JAOCS today!

http://mc.manuscriptcentral.com/jaocs

Editor-in-Chief Richard W. Hartel

Richard W. Hartel has been the editor-in-chief of JAOCS since 2006. He is a professor of food engineering at the University of Wisconsin-Madison, where his research focuses on phase transitions in foods.

2015 AOCS Your Global Fats and Oils Connection

Membership Application

15INF

P.O. Box 17190, Urbana, IL 61803-7190 USA
P: +1 217-693-4813 | F: +1 217-693-4857 | membership@aocs.org | www.aocs.org

Please print or type.

▶ ***Encouraged to join by*** ______________________________

❑ Dr. ❑ Mr. ❑ Ms. ❑ Mrs. ❑ Prof.

Last Name/Family Name ____________________ First Name ____________________ Middle Initial ______

Firm/Institution ______________________________

Position/Title ______________________________

Business Address (Number, Street) ______________________________

City, State/Province ______________________________

Postal Code, Country ______________________________ Birthdate ____________ (mm/dd/yyyy)

Business Phone ______________ Fax ______________ Email ______________

(Expected) Graduation Date ____________________

MEMBERSHIP DUES

$__________

	U.S./Non-U.S. Surface Mail	Non-U.S. Airmail
❑ Active	❑ $175	❑ $265
❑ Corporate (Bronze)	❑ $850	❑ $850
❑ Student*	❑ $ 0	❑ N/A

Active membership is "individual" and is not transferable. Membership year is from January 1 through December 31, 2015.
*Complimentary student membership includes free access to online *Inform* only. Student membership applies to full-time graduate students working no more than 50% time in professional work, excluding academic assistantships/fellowships.

OPTIONAL TECHNICAL PUBLICATIONS

$__________

❑ *JAOCS* — $180 | ❑ *Lipids* — $180 | ❑ *Journal of Surfactants and Detergents* — $180

These prices apply only with membership and include print and online versions and shipping/handling.

DIVISIONS AND SECTIONS DUES (Division memberships are free for students.)

$__________

Divisions	Dues/Year	Divisions	Dues/Year	Sections	Dues/Year	Sections	Dues/Year
❑ Agricultural Microscopy	$16	❑ Lipid Oxidation and Quality	$10	❑ Asian	$15	❑ India	$10
❑ Analytical	$15	❑ Phospholipid	$20	❑ Australasian	$25	❑ Latin American	$15
❑ Biotechnology	$20	❑ Processing	$10	❑ Canadian	$15	❑ USA	FREE
❑ Edible Applications Technology	$20	❑ Protein and Co-Products	$12	❑ European	$25		
❑ Health and Nutrition	$20	❑ Surfactants and Detergents	$30				
❑ Industrial Oil Products	$15						

MEMBERSHIP PRODUCTS

$__________

❑ Membership Certificate: $25 | ❑ AOCS Lapel Pin: $10 | ❑ AOCS Directory: $17
❑ Membership Certificate and AOCS Lapel Pin: $30

PREFERRED METHOD OF PAYMENT

Total Remittance $ ____________

❑ Check or money order is enclosed, payable to AOCS in U.S. funds drawn on a U.S. bank.

❑ Send bank transfers to: Busey Bank, 100 W. University, Champaign, IL 61820 USA. Account number 111150-836-1. Reference: 15INF. Routing number 071102568. Fax bank transfer details and application to AOCS.

❑ Send an invoice for payment. (Memberships are not active until payment is received.)

❑ To pay by credit card, please use our online application (www.aocs.org/join) or contact Doreen Berning at +1 217-693-4813.

Dues are not deductible for charitable contributions for income tax purposes; however, dues may be considered ordinary and necessary business expenses.

AOCS: Your international forum for fats, oils, proteins, surfactants, and detergents.

This Code has been adopted by AOCS to define the rules of professional conduct for its members.

AOCS Code of Ethics • Chemistry and its application by scientists, engineers, and technologists have for their prime objective the advancement of science and benefit of mankind. Accordingly, the Society expects each member: 1) to be familiar with the purpose and objectives of the Society as expressed in its articles of incorporation; to promote its aim actively; and to strive for self-improvement in said member's profession; 2) to present conduct that at all times reflects dignity upon the profession of chemistry and engineering; 3) to use every honorable means to elevate the standards of the profession and extend its sphere of usefulness; 4) to keep inviolate any confidence that may be entrusted to said member in such member's professional capacity; 5) to refuse participation in questionable enterprises and to refuse to engage in any occupation that is contrary to law or the public welfare; 6) to guard against unwarranted insinuations that reflect upon the character or integrity of other chemists and engineers.

The National Research Council plans to conduct a broad review of information on genetically engineered (GE) crops. The operating arm of the National Academy of Sciences explained on its website that "there is a need for an independent, objective study that examines what has been learned about GE crops, assesses whether initial concerns and promises were realized since their introduction, and investigates new concerns and recent claims." The study is projected to be completed in early 2016 and will be available to download for free at www.nap.edu.

■■■

The US Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) has released the final environmental impact statement (EIS) for genetically engineered (GE) corn and soybean plants that are resistant to several herbicides, including 2,4-dichlorophenoxyacetic acid (2,4-D), which is used to control broadleaf weeds. The statement is part of the USDA's review to determine whether to regulate the crops. Visit www.aphis.usda.gov/biotechnology/news to find links to the final EIS and APHIS' plant pest risk assessment (PPRA).

■■■

At a meeting in Washington, DC, in August, the American Soybean Association and the Illinois Soybean Association gathered together more than 100 farmers, researchers, and leaders of agricultural organizations to "communicate the need to accelerate government approval processes for biotech seed for soybeans and other crops," according to a report in *Farm Futures.* The "DC Biotechnology Roundtable" featured a presentation by Robert Paarlberg, a professor at Wellesley College and Harvard University (Cambridge, MA, USA), who is also an author and adviser to food and agricultural organizations around the world. Paarlberg noted that "opposition to biotechnology comes from environmental and antiglobalization groups in more affluent countries, particularly the European Union," and explained that "the current state of worldwide regulation deprives people of food by preventing use of biotechnology by farmers in poorer countries." Access the full agenda for the meeting at www.dcbiotechroundtable.com. ■

BIOTECHNOLOGY

A new strain of genetically engineered cotton contains two different genes encoding proteins that render it resistant to two major cotton pests: cotton bollworm and *Spodoptera litera*.

A new strain of pest-resistant cotton

A new strain of genetically engineered (GE) cotton, which is resistant to two major cotton insects, could make it more difficult for insects to acquire resistance, according to a report in *Acta Physiologiae Plantarium* (http://dx.doi.org/10.1007/s11738-014-1642-5, 2014).

Prior to the advent of pest-resistant crops in the 1990s, it was not uncommon for an outbreak of insects, such as the cotton bollworm that is common in China, to wipe out an entire field. Since then, GE crops have enabled farmers to avoid severe loss during outbreaks. But, many insects have evolved resistance to the first-generation GE cotton strains, which carried a single gene encoding a toxin known as the Bt toxin because it is naturally produced by the bacterium *Bacillus thuringiensis*. Researchers have long known that to inhibit or delay the development of pest resistance to toxic proteins, it is best if a single plant expresses multiple different toxins with unique modes of action.

The team, led by researchers Lebin Li and Yi Zhu from Huazhon Agricultural University in China, used a method known as gene stacking to create the new cotton strain that is resistant to both cotton bollworm and *Spodoptera litura.* The new crop was the result of cross-breeding two GE plants each containing a single pest-resistance gene. To test the feasibility of the gene-stacking strategy, the researchers performed numerous analyses, including molecular characterization,

CONTINUED ON NEXT PAGE

measurements of Bt toxin levels, bioassays with insects, and heredity tests. The team found the progeny had similar levels of toxins as the parent plants.

Mexican judge bans use of genetically modified soybean

In the Mexican state of Yucatán, a district judge has overturned a permit issued to Monsanto (St. Louis, Missouri, USA) that would have allowed farmers to plant Roundup-ready soybeans, according to a report in London's *The Guardian*. The plant is resistant to the herbicide glyphosate, the active ingredient in Roundup.

The judge cited evidence that the genetically modified (GM) soybean crops posed a threat to honey production on the peninsula, and that co-existence was not possible. As the world's sixth largest producer of honey, about 25,000 families in Yucatán depend on honey production. Opponents of the GM crops argued that if the pollen from GM soybean crops were to contaminate the honey, sales could be jeopardized in Europe, where foods containing more than 0.9% of GM pollen would not be allowed to be marketed as an organic product, or would be banned altogether.

Hope for "genetically edited" foods

Genome-editing tools may one day allow scientists to create plants that are "genetically edited" and less prone to public rejection than genetically modified organisms (GMOs), according to the authors of a review article published in *Trends in Biotechnology* (http://dx.doi.org/10.1016/j.tibtech.2014.07.003, 2014). These so-called genetically edited organisms (GEOs)—which would contain modifications to existing genes but be free of foreign DNA—would be made with the help of gene-editing tools such as zinc-finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and clustered regularly interspaced short palindromic repeats (CRISPRs). These tools would allow researchers to modify DNA by inserting, deleting, or altering genes in a way that increases or decreases levels of natural ingredients that the plants already make, resulting in fruits that produce higher levels of important vitamins, for example.

Researchers have yet to create genetically edited fruit crops. However, the many recent developments involving gene-editing techniques for biomedical applications, coupled with the increasing availability of genome sequences for many fruit crops, give the authors hope that "GEOs will surge as a 'natural' strategy to use biotechnology for a sustainable agricultural future."

A sweet new tool lays the groundwork for renewable fuels

The sugars stored within plant biomass could serve as an environmentally friendly energy source if only they could be harvested in an economical way. One way to improve yields of the biomass-to-fuel conversion process would involve genetically engineering fuel crops to express high levels of sugars. But before this is possible, scientists need to better understand how the enzymes that transport sugars in plants—known as nucleotide sugar transporters (NSTs)—function within plant cells.

A study led by Carsten Pautengarten and Berit Ebert of Lawrence Berkeley National Laboratory, California, USA, helps shed light on the sugar transport process in Arabidopsis, a relative of mustard that serves as a model plant for biofuels research (http://dx.doi.org/10.1073/pnas.1406073111, 2014). As described in the *Proceedings of the National Academy of Sciences*, the team developed an assay for isolating and analyzing a family of six NSTs, which has never been done before in plants. The researchers found the NSTs, which play a critical role in the biosynthesis of plant cell walls, have a surprising level of specificity for structurally similar sugar substrates. "We are already using this information . . . to improve biomass sugar composition for biofuel production," said Henrik Scheller, one of the study's authors, in a press release. The team has already applied the assay to characterize 20 other transporters, which will be published in a subsequent paper.

American Soybean Association urges EU to action

The American Soybean Association (ASA) sent letters to the European Commission and the US Trade Representative (USTR) in August 2014, urging the European Union (EU) to take action on nine biotech products awaiting final import authorization. The products include genetically engineered varieties of soy, maize (corn), rapeseed and cotton. Eighteen other associations, including farm, commodity, grain processing, grain trade, and biotechnology associations in the United States, joined the ASA in sending the letter, which encouraged the USTR to ask the EU to make timely regulatory decisions on new biotechnology applications.

"The time required for EU decisions on new biotech crops has only lengthened in recent years and no authorizations have been issued since November 2013," the groups stated. "Some of the products have been before the European Commission since the end of 2013 and were submitted to EFSA more than five years ago."

ASA is a trade association based in Chesterfield, Missouri, USA. The Office of the USTR is part of the Executive Office of the US President that helps develop and coordinate US international trade, among other responsibilities.

A-maize-ing glance at ancient DNA

The results of a new study on the genetic composition of maize (corn) as it existed 10 million years ago could lead to improvements in modern-day crops. Using tools for genetic analysis, researchers led by Oxford University's Steven Kelly report in the journal *Genome Research* that the ancient maize crop duplicated its entire genome and then used the extra copies of their genes to handle the pressures of domestication, which began roughly 12,000 years ago (http://dx.doi.org/10.1101/gr.172684.114, 2014). The duplicate genes allowed farmers to develop maize into a high-yield crop by optimizing the process of photosynthesis in the plant's leaves.

"Although whole genome duplication events are widespread in plants, finding evidence of exactly how plants use this new 'toolbox' of copied genes is very difficult," said Kelly in a new release.

The trick to the study's success was the availability of genetic data from the plant we now know as sorghum. In contrast to maize, sorghum evolved from a plant that was a close relative of maize, but sorghum never did duplicate its genome. The team compared the genetic data from the "duplicated" and "nonduplicated" descendants of ancient maize to arrive at their conclusions about the process by which they evolved over time.

"Whole genome duplication events are key in allowing plants to evolve new abilities," Kelly said. "Understanding the complete trajectory of duplication and how copied genes can transform a plant is relevant for current efforts to increase the photosynthetic efficiency of crops," adding that the key to creating high-yield crops is optimizing photosynthesis. ■

CLASSIFIED

AOCS MEETING WATCH

November 17–18, 2014. Fundamentals of Oilseed and Edible Oil Processing and Refining Short Course, Crowne Plaza Shanghai Pudong, Shanghai, China. http://meetings.aocs.org/EdibleOil

November 19–20, 2014. AOCS–CCOA Joint Symposium on Functional Lipids, Crowne Plaza Shanghai Pudong, Shanghai, China. http://meetings.aocs.org/FunctionalLipids

May 3–6, 2015. 106th AOCS Annual Meeting and Industry Showcases, Rosen Shingle Creek, Orlando, Florida, USA. http://annualmeeting.aocs.org

October 27–30, 2015. SODEOPEC 2015, Hyatt Regency Miami, Florida, USA.

For in-depth details on these and other upcoming meetings, visit http://aocs.org/meetings or contact the AOCS Meetings Department (email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865).

Also, be sure to visit AOCS' online listing of industry events and meetings at http://tinyurl.com/industry-calendar. Sponsoring organizations can submit information about their events to the web-based calendar by clicking a link and completing a web form. Submission is free. No third-party submissions, please. If you have any questions or comments, please contact Valorie Deichman at valoried@aocs.org.

BRIEFS

Solazyme and AkzoNobel announced on July 31, 2014, that they have expanded their partnership in surface chemistry. The agreement covers joint product development and principal terms of a multi-year supply agreement targeting annual supply of up to 10,000 metric tons of algal oil for surfactant production. The parties said in a statement that they expect the algal oil could replace both petroleum- and palm oil-derived chemicals. The target product has been designed to have improved functional and environmental performance, as well as a lower overall cost to AkzoNobel. Solazyme is a renewable oils company based in So. San Francisco, California, USA; AkzoNobel is a specialty chemicals producer based in Amsterdam.

■■■

China has abolished the requirement for animal testing for most cosmetics manufactured in the country, including shampoo, makeup, many skin-care products, and perfume, according to the London-based Organic Monitor consultancy. Animal testing is still required, however, for "special cosmetics" such as skin whitening products, hair dyes, deodorants, and sun cream.

■■■

P2 Science Inc., a renewable chemical company with headquarters in Cambridge, Massachusetts, USA, has partnered with flavors and fragrance (F&F) firm Symrise AG of Holzminden, Germany, to jointly develop and commercialize renewable F&F cosmetics ingredients. "The F&F industry is reportedly increasingly looking to renewable ingredients as a key platform for growth," writes Doris DeGuzman on her greenchemicals.com blog. "Products of immediate commercial interest to both companies are expected to be scaled up to production for commercial supply within a 12-month timeframe. Brand new molecules will be assessed for toxicology, performance, and economics. Selected products will be moved through the commercializa-

CONTINUED ON PAGE 583

HOME & PERSONAL CARE

Review finds no adverse environmental impacts of detergent ingredients

A comprehensive review of five decades of research suggests that high-volume use of major detergent ingredients has had no adverse environmental impacts to waterways and river sediments, according to a paper co-authored by the American Cleaning Institute (ACI). ACI is a trade association based in Washington, DC.

"Surfactants are the key workhorse ingredients in many detergents and cleaning products," said ACI in a news release. "Over the past 50 years, ACI and its members have spent at least $30 million on the assessment and reporting of the environmental safety of the major surfactants."

The review article, "Environmental safety of the use of major surfactant classes in North America," examines more than 250 published and unpublished studies on the environmental properties, fate, and toxicity of the four major, high-volume surfactant classes and relevant feedstocks: alcohol sulfate, alcohol ethoxysulfate, linear alkylbenzene sulfonate, alcohol ethoxylate, and long-chain alcohol.

"We looked at the surfactants' physical and chemical properties, environmental fate properties such as biodegradation and sorption, monitoring studies through sewers, wastewater treatment plants and eventual release to the environment, aquatic and sediment toxicity, and bioaccumulation information," said Kathleen Stanton, ACI director of technical and regulatory affairs and one of the paper's co-authors.

Though the surfactants studied are used in very high volumes and are widely released to the aquatic environment, the review paper reports that prospective and retrospective risk assessments demonstrate that "they have no adverse impact on the aquatic or sediment environments."

The paper's authors include: Lead author Christina Cowan-Ellsberry (CE^2 Consulting), Scott Belanger (Procter & Gamble), Philip Dorn (Shell Health Americas), Scott Dyer (Procter & Gamble), Drew McAvoy (University of Cincinnati), Hans Sanderson (Aarhus University), Donald Versteeg (Procter & Gamble), and Darci Ferrer and Kathleen Stanton (ACI).

More than 70 of the research articles cited in the paper are available on ACI's science website, www.ACIscience.org. The review article was published in *Critical Reviews in Environmental Science and Technology* (see http://tinyurl.com/ACI-Surf-Review, 2014).

In related news, ACI recently commented on a research study on triclosan and triclocarban that was presented at the August 2014 National Meeting of the American Chemical Society. The study reported that trace elements of these antibacterial ingredients were detected in the urine of pregnant women, as well as some umbilical cord blood samples.

"We looked at the exposure of pregnant women and their fetuses to triclosan and triclocarban, two of the most commonly used germ-killers in soaps and other everyday products," said Benny Pycke, a research scientist at Arizona State University (ASU; Tempe, USA). "We found triclosan in all of the urine samples from the pregnant women that we screened. We also detected it in about half of the umbilical cord blood samples we took, which means it transfers to fetuses. Triclocarban was also in many of the samples."

The problem with this, according to Pycke, is that there is a growing body of evidence suggesting the compounds can lead to developmental and reproductive problems in animals and potentially in humans. Also, some research suggests that the additives could contribute to antibiotic resistance, a growing public health problem.

Although the human body is efficient at flushing out triclosan and triclocarban, a person's exposure to them can potentially be constant.

"If you cut off the source of exposure, eventually triclosan and triclocarban would quickly be diluted out, but the truth is that we have universal use of these chemicals, and therefore also universal exposure," said Rolf Halden, the lead investigator of the study.

The compounds are used in more than 2,000 everyday products marketed as antimicrobial, including toothpastes, soaps, detergents, carpets, paints, school supplies, and toys, the researchers said.

Halden and Pycke's colleague, Laura Geer, of the State University of New York, noted that the study yielded a link between women with higher levels of another ubiquitous antimicrobial, butylparaben, which is commonly used in cosmetics, and shorter newborn lengths. The long-term consequences of this are not clear, but Geer added that if this finding is confirmed in larger studies, it could mean that widespread exposure to these compounds could cause a subtle but large-scale shift in birth sizes.

State policymakers, the US Food and Drug Administration (FDA), and industry have taken notice of research on triclosan. Minnesota became the first state to ban the use of the antimicrobial in certain products, beginning in January 2017. Some companies, such as Johnson & Johnson and Procter & Gamble, have announced that they are phasing out the compound from some products. At the federal level, the FDA and Environmental Protection Agency are reviewing the use and effects of the compounds.

In response, ACI said that some of the researchers' public comments—and well as news media headlines about the research—may mislead the public about the safety of the ingredients.

"The levels of these ingredients they found are extremely small and are excreted from the body," said Paul DeLeo, ACI associate vice president of environmental safety. "There's a wide margin of safety between these levels and the levels deemed unsafe based on standard safety evaluation.

"The weight of evidence supports the conclusion that these ingredients are not causing adverse effects on the endocrine system," DeLeo added. "The continued 'suggestions' that the presence of these substances are leading to health risks are not borne out by the data and years of safe use by consumers."

Exploring biodiversity to produce sustainable cosmetics and agrochemicals

AGROCOS—a project funded under the European Union's Horizon 2020 program—is using modern scientific techniques to explore the diversity of nature to develop new products for the agrochemical and cosmetics industries.

By searching through nature's molecules to discover the essential building blocks for a new generation of ingredients, the project is expected to pave the way for products that are not only innovative and effective but also more environmentally friendly than existing synthetic compounds.

At the heart of the AGROCOS project are molecules extracted from 1,800 plant species harvested in "biodiversity hotspots" in Africa, Europe, Latin America, and the Asia-Pacific region. The compounds are being tested for qualities that would benefit the agrochemical sector, such as anti-fungal, herbicidal, or insecticidal effects. For the cosmetics industry, the key characteristics of interest include ultraviolet protection and anti-aging properties. The AGROCOS researchers aim to identify the five most promising compounds from among the 1,800 extracted to date.

In addition to these final five ingredients, project scientists will create an extensive library of compounds that will be made available for future use by researchers or commercial enterprises.

As the AGROCOS project coordinator, Leandros Skaltsounis of the National and Kapodistrian University of Athens, explains: "This is an important breakthrough for the technique of 'bio-prospecting,' or deriving materials from nature. Plants have been used since antiquity to meet people's needs," he adds. This technique of bio-prospecting, which was revived in recent decades, has led to the discovery of novel bioactive products and enabled the production of important anticancer and antimicrobial drugs.

For KORRES, a Greek company that develops "natural" cosmetic products, there is no doubt about the significance of the project. "This is the biggest piece of research in natural ingredients in recent years," says Lena Korres, the company's brand development director.

"For us, this will be fantastic because it will provide us not only with the five specific ingredients but also with an extensive library of ingredients detailing the benefits of each and how they can help us in cosmetics."

For more information about the project, visit http://www.agrocos.eu or contact Leandros Skaltsounis at skaltsounis@pharm.uoa.gr. ■

BRIEFS (cont.)

tion process for use in certain Symrise end markets and potential sale to other F&F companies."

■■■

Kao Corp. (Tokyo, Japan) announced in August 2014 that it has identified some strains of the algal genus *Nannochloropsis* that contain a large number of C12–C14 fatty acids. These medium-chain fatty acids are raw materials for oleo-based surfactants and detergents and are normally sourced from palm kernel and coconut oils. Further, Kao said it has found a novel acyl-acyl carrier protein thioesterase in *Nannochloropsis* with high specificity toward medium-chain fatty acids. The company expects that these findings will dramatically accelerate the breeding development of algae for large-scale production of medium-chain fatty acids. These results were reported at the 1st Asian Conference on Oleo Science, September 8–10, 2014, in Sapporo, Japan, which was organized by the Japan Oil Chemists' Society. ■

PATENTS

Non-dispersive process for insoluble oil recovery from aqueous slurries

Kipp, P.B., *et al.,* Board of Regents, The University of Texas System; Organic Fuels Algae Technologies, US8617396, December 31, 2013

The development and application of a novel non-polar oil recovery process utilizing a non-dispersive solvent extraction method to coalesce and recover oil from a bio-cellular aqueous slurry is described herein. The process could apply to recovery of algal oil from a lysed or non-lysed algae slurry, recovery of omega fatty acids from a bio-cellular aqueous feed, recovery of β-carotene from a bio-cellular aqueous feed, and for the removal from produced water in oil production and similar type applications. The technique of the present invention utilizes a microporous hollow fiber (MHF) membrane contactor. The non-polar oil recovery process described herein can be coupled to a collecting fluid (a non-polar solvent such as heptane, a biodiesel mixture or the previously extracted oil) that is circulated through the hollow fiber membrane. In cases where the biodiesel mixture or the previously extracted oil is used, the solvent recovery step (e.g., distillation) can be eliminated.

Robust multi-enzyme preparation for the synthesis of fatty acid alkyl esters

Basheer, S., *et al.,* Transbiodiesel Ltd., US8617866, December 31, 2013

Disclosed is an enzymatic process for the preparation of fatty acid alkyl esters, particularly fatty acid methyl esters (biodiesel), in a solvent-free microaqueous system, from a fatty acid source and an alcohol or alcohol donor, employing a robust lipase preparation that comprises at least two lipases separately or jointly immobilized on a suitable support, where one of the lipases has increased affinity to partial glycerides, another is *sn*-1,3 positional specific, and an optional third lipase has high selectivity toward the *sn*-2 position of the glycerol backbone of the fatty acid source.

Compositions for removing lead from metal surfaces

Hunt, D., and G. Kuhlmann, Stone Chemical Co., US8618038, December 31, 2013

The invention provides an aqueous composition that includes a hydroxy-substituted mono-, di-, or tricarboxylic acid; phosphoric acid; a surfactant; and water. The invention further provides a method for removing lead from the surface of metal; the method includes contacting a metal surface with an aqueous composition that includes a hydroxy-substituted mono-, di-, or tricarboxylic acid; phosphoric acid; a surfactant; and water; to provide a metal surface with a reduced amount of leachable lead. The leachable lead on the surface of the metal can be reduced to below 1 ppb by using the composition described herein.

Lipid preparation for enhancing mineral absorption

Shulman, A., *et al.,* Enzymotec Ltd., US8618050, December 31, 2013

Disclosed is a dietary ingredient comprising at least one edible lipid that does not inhibit mineral absorption, enhances mineral absorption and intake, particularly a chemically or enzymatically synthesized synthetic oil, particularly glyceride-based lipid with high levels of mono- or polyunsaturated fatty acids at positions *sn*-1 and *sn*-3 of the glycerol backbone, vegetable- and plant-derived oil, such as flax and canola oils, short- and medium-chain lipids, preferably medium-chain triglycerides, and an oil mimicking the triglyceride composition of human mother's milk fat and its various uses. The dietary ingredient is particularly intended for use in enhancing calcium absorption and in the prevention and/or treatment of disorders associated with depletion of bone calcium and bone density, prevention and treatment of osteoporosis, for the enhancement of bone formation and bone mass maximization, and for the enhancement of bone formation in infants and young children.

Chocolate products containing amorphous solids and methods of producing same

Hanselmann, W., The Hershey Co., US8617635, December 31, 2013

The invention relates to novel food, confectionery, and chocolate compositions and methods of producing them. In one embodiment, an amorphous sugar, such as a corn syrup solid, wholly or partially replaces crystalline sugar in the chocolate composition. In a second embodiment, an amorphous sugar is combined with cocoa solids, milk solids, and/or fruit purees and incorporated into a chocolate product or composition. In a further embodiment, the invention relates to a chocolate composition comprising amorphous sugar and crystallized sugar wherein the ratio of amorphous sugar to crystallized sugar is such that the combination of amorphous sugar and crystallized sugar has a glass transition temperature of at least room temperature and amorphous sugar is detectable in the final product or composition.

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@adm.com.

EXTRACTS & DISTILLATES

Alteration of gut bacteria and metabolomes after glucaro-1,4-lactone treatment contributes to the prevention of hypercholesterolemia

Xie, B., *et al.*, *J. Agric. Food Chem. 62*: 7444–7451, 2014, http://dx.doi: 10.1021/jf501744d.

D-Glucaro-1,4-lactone (1,4-GL) has been shown to have a hypocholesterolemic effect in rats and human subjects. However, little information is known concerning the alteration of metabolome associated with the effect. Here, we show that 1,4-GL delays the development of hypercholesterolemia with the coadministration of a high-fat, high-cholesterol diet (HFHC) in rats. Metabonomic results based on proton nuclear magnetic resonance indicate that urinary trimethylamine *N*-oxide, trimethylamine, lactate, acetate, formate, and creatinine are significantly altered after 1,4-GL and HFHC treatments. Colonic flora test results reveal that the quantity of Bifidobacterium and Lactobacillus in the intestines respectively increase by about 1.7- and 4.2-fold in rats treated with 1,4-GL compared with those in the control group. Rats that were coadministered with HFHC and 1,4-GL exhibit normal levels of lactate and acetate in serum and display urinary excretions of lactate and acetate that are 2 to 3 times higher compared with those treated with HFHC alone. The results imply that the increased probiotic quantities and urinary excretion of breakdown products of fat/cholesterol after 1,4-GL treatment contribute to the prevention of hypercholesterolemia. Our study offers insights into the model of action for 1,4-GL in preventing hypercholesterolemia.

Effects of heat treatment and moisture contents on interactions between lauric acid and starch granules

Chang, F., *et al.*, *J. Agric. Food Chem. 62*: 7862–7868, 2014, http://dx.doi: 10.1021/jf501606w.

This study aimed to understand the effects of the moisture content of granular normal cornstarch (NC), heat treatment at 80 °C, and order of adding lauric acid (LA) to starch before or after the heat treatment on the physicochemical properties and digestibility of the starch. LA was added to NC priority heated with different moisture contents (10, 20, 30, 40, and 50%) or added to dried NC and then heated with different moisture contents. The hydrothermal/LA treatments increased the pasting temperature but decreased the peak viscosity of the NC. Light and scanning electron microscopy revealed that the addition of LA retarded gelatinization. The hydrothermal/LA treatments changed the X-ray pattern of the NC to a mixture of A- and V-type patterns. The thermal property and digestibility analysis showed that 40% was the optimum moisture content for the formation of the amylose–LA complex and adding LA prior to heating the NC favored the formation of slowly digestible starch.

CONTINUED ON PAGE 598

Journal of the American Oil Chemists' Society (September)

- Effect of palm oil enzymatic interesterification on physicochemical and structural properties of mixed fat blends, Danthine, S., E. Lefébure, H.N. Trinh, and C. Blecker
- Intrinsic fluorescence excitation–emission matrix spectral features of cottonseed protein fractions and the effects of denaturants 1, He, Z., M. Uchimiya, and H. Cao H.
- Biodiesel synthesis in a solvent-free system by recombinant *Rhizopus oryzae* lipase. Study of the catalytic reaction progress, Canet, A., M. Dolors Benaiges, and F. Valero
- Optimization of physiological growth conditions for maximal gamma-linolenic acid production by *Cunninghamella blakesleeana*-JSK2, Sukrutha, S.K., Z. Adamechova, K. Rachana, J. Savitha J., and M. Certik
- Toxin content of commercial castor cultivars, McKeon, T.A., D. Auld, D.L. Brandon, S. Leviatov, and X. He
- Effects of different oil sources and residues on biomass and metabolite production by *Yarrowia lipolytica* YB 423-12, Saygün, A., N. S¸ahin-Yes¸ilçubuk, and N. Aran
- Antioxidant and anti-inflammation activities of Ocotea, Copaiba and Blue Cypress essential oils *in vitro* and *in vivo*, Amilia Destryana, *et al.*
- Antioxidant activity of soybean oil containing 4-vinylsyringol obtained from decarboxylated sinapic acid, Wang, X.-Y., *et al.*
- Effects of phosphatidylcholine on interaction of α-tocopherol and β-carotene in photosensitized oxidation of emulsions, Lee, Y., E. Lee E., and E. Choe
- The effect of different cold storage conditions on the compositions of extra virgin olive oil, Li, X., H. Zhu, C.F. Shoemaker, and S.C. Wang
- Sterol and fatty acid compositions of olive oil as an indicator of cultivar and growing area, Noorali, M., M. Barzegar, and M.A. Sahari
- Antioxidant activity of amaranth protein hydrolysate against thermal oxidation of vegetable oils, Tironi, V.A. and M.C. Añón
- Polyphenols of pistachio (*Pistacia vera* L.) oil samples and geographical differentiation by principal component analysis, Saitta, M., G.L. La Torre, A.G. Potortì, G. Di Bella, and G. Dugo
- Optimization of a colorimetric test method for quantifying glycerol in aqueous solution, Bompelly, R. and D.W. Skaf
- Antioxidants in fish oil production for improved quality, Carvajal, A.K., R. Mozuraityte, I.B. Standal, I. Storrø, and M. Aursand
- Improved solubility and emulsification of wet-milled corn germ protein recovered by ultrafiltration–diafiltration, Hojilla-Evangelista, M.P.
- Gas-assisted oilseed pressing on an industrial scale, Müller, M. and R. Eggers
- Catalytic production of 1-octadecanol from octadecanoic acid by hydrotreating in a plug flow reactor, Potts, T.M., K. Durant K., J. Hestekin, R. Beitle, and M. Ackerson

Journal of Surfactants and Detergents (September)

- Fate of Triton X-100 applications on water and soil environments: a review, Abu-Ghunmi, L., M. Badawi, and M. Fayyad
- Investigation of color instability in a liquid laundry detergent, Missler, S.R., D.J. Vredeveld, E.D. Westrate, P.G. Sliva, and S.J. Brouwer
- Dissolution of soap scum by surfactant Part I: effects of chelant and type of soap scum, Itsadanont, S., J.F. Scamehorn, S. Soontravanich, D.A. Sabatini, and S. Chavadej
- Dissolution of soap scum by surfactant. Part II: effects of NaCl and added chelant on equilibrium solubility and dissolution rate of calcium soap scum in amphoteric surfactant solutions, Itsadanont, S., D. Ratanalert, S. Soontravanich, J.F. Scamehorn, D.A. Sabatini, and S. Chavadej
- Synthesis of poly(maleic anhydride-co-taurine) as a biodegradable detergent builder, Pan, L., J. Guo, and D. Zhu
- Characterization of phosphate-free detergent powders incorporated with palm C16 methyl ester sulfonate (C16MES) and linear alkyl benzene sulfonic acid (LABSA), Siwayanan, P., R. Aziz, N.A. Bakar, H. Ya, R. Jokiman, and S. Chelliapan
- Interaction between cationic and anionic surfactants: detergency and foaming properties of mixed systems, Wang, R., Yunling Li, and Yan Li
- Purification and characterization of highly alkaline lipase from *Bacillus licheniformis* MTCC 2465: and study of its detergent compatibility and applicability, Bora, L.
- The removal of thermally aged films of triacylglycerides by surfactant solutions, Dunstan, T.S. and P.D.I. Fletcher
- Effects of pH and surfactant precipitation on surface tension and CMC determination of aqueous sodium *n*-alkyl carboxylate solutions, Jackson, L.P., R. Andrade, I. Pleasent, and B.P. Grady

- Optimization of microwave-assisted extraction of tea saponin and its application
  on cleaning of historic silks, He, J., Z. Wu, S. Zhang, Y. Zhou, F. Zhao, Z. Peng, and Z. Hu
- Gemini pyridinium surfactants: synthesis and their surface-active properties, Patial, P., A. Shaheen, and I. Ahmad
- A new anionic oxalamide lauryl succinate sodium sulfonate Gemini surfactant: microwave-assisted synthesis and surface activities, Chen, H. and B. Zhu
- Synthesis, surface property, and antimicrobial activity of cationic Gemini surfactants containing adamantine and amide groups, Zhong, X., J. Guo, S. Fu, D. Zhu, and J. Peng
- Gemini surfactants foam formation ability and foam stability depends on spacer length, Kuliszewska, E. and L. Brecker
- Structural and interfacial properties of hyperbranched-linear polymer surfactant, Qiang, T., Q. Bu, Z. Huang, and X. Wang
- Synthesis and surface-active behavior of new fluorinated hyperbranched polymer, Zhang, Y., Y. Wang, H. Zhang, X. Wang, Y. Zhao, J. Liu, and F. Wang
- Interfacial and demulsifying behavior of novel fluorinated hyperbranched polymers, Li, Y., X. Wang, H. Zhang, Y. Wang, Y. Yan, Y. Zhang, and Y. Zhao
- Evaluation of Rheological and Thermal Properties of a New Fluorocarbon
- Surfactant–polymer system for EOR applications in high-temperature and high-salinity oil reservoirs, Kamal M.S., A.S. Sultan, U.A. Al-Mubaiyedh, I.A. Hussien, and M. Pabon M.
- Research and application of recyclable nitrogen foam horizontal well drilling technology in the Daniudi gas field, Tang, M., S. He, J. Xiong, and F. Zheng
- Decolorization of *Sapindus* pericarp extract by hydrogen peroxide and a comparison of basic characteristics before and after decolorization, Wang, N., H. Wang, Z. Weng, C. Zhang, H. Wu, Y. Guo, Z. Sun, and W. Yao
- Synthesis, characterization, and investigation of different properties of three novel thiourea-based nonionic surfactants, Ullah, I., A. Shah, A. Badshah, U.A. Rana, I. Shakir, A.M. Khan, S.Z. Khan, and Zia-ur-Rehman
- Undecanoic and 10-undecenoic acid-based amidobetaines and amidoamine oxides, Akula, S., R.R. Nayak, and S. Kanjilal
- The Effect of inorganic ions on dodecylbenzenesulfonate adsorption onto hematite: an ATR-FTIR study, Potapova, E., R. Jolstera, A. Holmgren, and M. Grahn
- Synergistic effect on wettability of mixtures of amine oxides, alkylpolyglucosides, and ethoxylated fatty alcohols, Garcı´a Martı´n, J.F., O. Herrera-Ma´rquez, J.M. Vicaria, and E. Jurado
- Influence of nonionic rosin surfactants on surface activity of silica particles and stability of oil-in-water emulsions, Atta, A.M. and H.A. Al-Lohedan
- Reversibility of thermal transitions in dilute dioctadecyl-dimethyl-ammonium bromide vesicles, Feitosa, E. and R.D. Adati

Lipids

Lipids (September)

- Tocotrienol-rich fraction reverses age-related deficits in spatial learning and memory in aged rats, Taridi, N.M., N. Abd Rani, A. Abd Latiff, W.Z. Wan Ngah, and M. Mazlan
- CLA supplementation and aerobic exercise lower blood triacylglycerol, but have no effect on peak oxygen uptake or cardiorespiratory fatigue thresholds, Jenkins N.D.M., S.L. Buckner, K.C. Cochrane, H.C. Bergstrom, J.A. Goldsmith, *et al*.
- Dietary lipid intake only partially influences variance in serum phospholipid fatty acid composition in adolescents: impact of other dietary factors, Vyncke, K., I. Huybrechts, M. Van Winckel, M. Cuenca Garcia, I. Labayen, F., *et al.*
- An interesterified palm olein test meal decreases early-phase postprandial lipemia compared to palm olein: a randomized controlled trial, Hall, W.L., M. Fiuza Brito J. Huang, L.V. Wood, A. Filippou, *et al.*
- Distribution of glycolipid and unsaturated fatty acids in human hair, Takahashi, and S. Yoshida
- Distinctive lipid composition of the copepod *Limnocalanus macrurus* with a high abundance of polyunsaturated fatty acids, Hiltunen, M., U. Strandberg, M. Keinänen, S. Taipale, and P. Kankaala
- Unique odd-chain polyenoic phospholipid fatty acids present in Chytrid fungi, Akinwole, P.O., E. Lefevre, M.J. Powell, and R.H. Findlay
- MALDI-TOF fingerprinting of seminal plasma lipids in the study of human male infertility, Camargo, M., P. Intasqui, C. Bruna de Lima, D.A. Montani, M. Nichi, *et al.*
- Hyaluronidase alters the lipid profile of cumulus cells as detected by MALDI-TOF MS and multivariate analysis, Montani, D.A., T. Regiani, A.B. Victorino, J. Camillo J., E.J. Pilau, *et al.*

Professional Pathways

Professional Pathways is a regular Inform *column in which AOCS members discuss their professional experiences and share advice with young professionals who are establishing their own careers in oils and fats-related fields.*

Rich Wilson served the US Department of Agriculture–Agricultural Research Service (USDA–ARS) for 32 years, is a professor emeritus at North Carolina State University, and a past president of AOCS. His research dealt with the biochemical and genetic regulation of soybean seed composition. He retired from USDA in 2007, and is now a consultant based in Raleigh, North Carolina.

Why did you join AOCS?

My graduate studies at the University of Illinois focused on lipid biochemistry and the biological regulation of linolenic acid in soybean. One of my mentors, Dr. Evelyn Weber, had encouraged me to join AOCS. However, all the stars fell in line one evening when my wife Pam came home with news that she had just been hired to typeset JAOCS and Lipids. I even volunteered to help sweep the floors at the office on 6th Street. The staff took us into its family; Pam and I still regard AOCS as home, and always will.

Describe your career path.

When I received my Ph.D., I overheard my professors discussing who would help the USDA–ARS geneticist at North Carolina State University continue their collaborative research to breed high-oleic low-linolenic soybeans. The solution seemed obvious to me, but it eventually became clear to them that I was available. Pam and I moved from Champaign, Illinois (-15 ˚F) to Raleigh, North Carolina (+55 ˚F) in December 1975; and, with exception of a few years as national program leader for USDA–ARS oilseed research in Beltsville, Maryland, we have been in Raleigh ever since. With support from the US soybean industry, the work we did in Raleigh contributed to the commercial launch of high-oleic soybeans by Pioneer and Monsanto. I am a consultant now, and an original member of the QUALISOY Board.

What do you love about your job?

Many have helped me throughout my professional career. There is no way to adequately express my gratitude or return their kindness; but I can help others succeed. It gives me great satisfaction to facilitate efforts that help individuals at every career stage achieve solutions to problems that would be difficult to attain on their own.

How do you see the industry changing in the next five years?

The biggest change will be the transition of the US oilseed market to include major supplies of high-oleic soybean oil and meal. US production on of high-oleic soybeans is expected to reach 18 million acres by 2023. These new commodities will provide a cost-effective and sustainable high-quality solution for trans-fat replacement, and should be a game-changer for vegetable-proteins in food and feed applications.

Describe a memorable job experience.

One icy morning in Raleigh, my ARS area director called to solicit a volunteer to represent the ARS administrator (Dean Plowman) at the 100th anniversary celebration of North Carolina A&T State University. He was quite persuasive; so I gathered my cap & gown had drove to the event in Greensboro, North Carolina. Along the way, radio reports kept emphasizing airport closures due to ice all along the east coast, including Washington, DC. When I arrived and took my place in the procession, there was an obvious vacancy. Under Secretary Hess, who was on the program to speak, was nowhere to be found; it was likely that he was stranded by the weather. It also occurred to me that Dr. Plowman may have been assigned to represent Dr. Hess. In any case, I was certain he would step in to save embarrassment and, doomed or not, I was next in line. So, I took Dr. Hess' seat on the stage, delivered a heart-felt speech on his behalf, turned to leave the podium, and then stood face-to-face with the next speaker who had just arrived: Under Secretary Hess. The revelation conjured images of spending the rest of my USDA career at some cold and dreary outpost. However, Dr. Hess took it in stride, gave his speech on behalf of Secretary Yeutter, took my original seat on the back row, and when it was all over asked me, "Who the #### are you anyway?" I was tempted to say, "Dr. Gary List," (my best friend at the USDA lab in Peoria IL), but I 'fessed up. Then a miracle happened. John Jacobs, head of the Urban League, came to us, shook my hand vigorously, and proclaimed to me: "Mr. Under Secretary, you gave the best speech of the day!" Thankfully, Dr. Hess had a sense of humor; I was spared a transfer to USDA purgatory, but have never worn my cap & gown since then.

Please describe a course, seminar, book, mentor, or speaker that has inspired you in ways that have helped you advance your career.

Two undergraduate courses come to mind. One was based on the book, Plant Physiology, by Salisbury & Ross, which opened my senses, curiosity, and desire for understanding biological mechanisms that sustain life. That experience effectively caused me to turn down a scholarship for graduate study in soil science/geology at the University of Missouri-Columbia, and "walk-on" the campus at the University of Illinois in hopes that someone in the Agronomy Department would take me in. Dr. Bill Rinne in the USDA Regional Soybean Lab gave me a chance, and that was the beginning of my professional career. The other undergraduate course had more impact on how I learned to think. It was based on the book, Plant Growth & Development by A.C. Leopold, which was filled with mind-benders. Each chapter masterfully outlined a rational approach, analysis and indisputable conclusion from research on a given topic. However, alternating chapters elaborately documented in elegant detail research on the same topic that had led to a diametrically opposite conclusion. It was an unforgettable lesson to keep an open mind.

Do you have any advice for young professionals who are trying to develop an effective network of other professionals?

Yes, stick with AOCS. Where else is there opportunity to engage key members of the so many different businesses, research disciplines, policy makers, and consumer interest groups in the global oilseed community on a personal level? I believe the recent innovations in AOCS social media will facilitate making these connections and keeping current on issues and technologies.

If you were starting your career again, what would you do differently?

Other than buying a pile of gold at $35/ounce, there are too many alternative timelines to ponder. I am quite content to play out the hand that was dealt to me.

What are the opportunities for advancement in your career/field and how can someone qualify for such advancements?

If an interview is granted, project a sense of commitment as well as ability. The last thing a prospective employer wants to hear from a job candidate is, 'What's in it for me?" Of course, one would like to know that, but why hurt one's chances to find out?

How would you describe the culture in your field, and how has it developed?

Changes in US social and work culture during my time have been, are, and will continue to be profound. I often listen to transcripts of radio programs from the 1940's and 1950's to remind myself that the "good old days" are here and now. The most progressive aspect of this continual transition has been the number of women in the workforce, in business, research, policy, you name it. We all are better off for it, so all I can say is BRAVO!

What is your opinion toward the value of obtaining or possessing a graduate degree during a challenging economy?

I believe the answer here is: Be the best you can be at whatever you do. ■

Using palm oil mill effluent to produce **single-cell protein**

- **Palm oil production requires tons of water and generates vast waste streams.**

- **The anaerobic pond systems typically used to treat palm oil mill effluent are low cost and easy to operate; but they also involve long treatment times, emit biogas, and monopolize sizeable areas of land. Digestion of organic material is often incomplete, which can have a detrimental impact on local groundwater and soil.**

- **Recent laboratory studies show that a process presently used to produce single-cell protein from effluents in the food and beverage industries can be applied to palm oil mill effluent, and that integrating an aerobic treatment system along with single-cell protein production into existing and planned palm oil mills has potential to mitigate environmental issues while creating a new revenue stream.**

Tracy Yates and Leo Gingras

Palm oil production has continued to increase in recent years, driven by global demand for edible oils, and currently stands at approximately 54 million metric tons (MMT) annually. Roughly 85% of world palm oil production comes from Indonesia and Malaysia, which together produce about 45 MMT of crude palm oil annually.

Concomitant with the production of palm oil is the generation of vast quantities of palm oil mill effluent (POME). An estimated 5.0–7.5 metric tons (MT) of water is used to extract and process 1 MT of the palm fruit. About half of this water becomes POME, a waste stream that contains high concentrations of total solids, oil and grease, and readily degradable organic matter (Table 1). On average, the chemical oxygen demand (COD) is 50,000 mg/L, and the biological oxygen demand (BOD) is 25,000 mg/L. These represent very high levels of organic material, roughly 100 times that of municipal wastewater.

The large volumes and high organic content of POME present a significant water treatment issue for palm oil producers. The majority of palm oil mills in Indonesia and Malaysia use anaerobic pond systems for treatment of POME because they are

low cost and easy to operate. However, anaerobic pond systems have a number of disadvantages including long treatment times, greenhouse gas (GHG) implications from emitting biogas, and the large land area required. Also, the digestion of organic material is often incomplete, resulting in water with high levels of COD that is discharged to nearby fields. If the discharge water enters local waterways it may become a source of aquatic pollution by depleting dissolved oxygen. Land application may also be harmful to soils due to the low pH and substantial concentration of fine cellulosic materials and oils. For these reasons there is real need for the development of sustainable alternative treatment options for palm oil mill effluent.

One such approach, which addresses the issue of sustainability in addition to generating a value-added product, is the production of single-cell protein (SCP) in conjunction with an aerobic water treatment process in place of anaerobic ponds. SCP refers to protein derived from unicellular microorganisms that can be used as an animal or human food additive or as fertilizer. Low-cost feedstocks or waste streams are used to grow bacteria, yeast, or algae, and the biomass produced is the resulting protein product. Typically, SCP production has been accomplished through expensive industrial fermentation processes. The process described here is quite different in that it can be economically integrated into standard aerobic wastewater treatment systems.

Our company, Nutrinsic Corp. (Aurora, Colorado, USA), has developed and patented a straightforward and economical process to produce SCP using effluent from the food and beverage industry (Fig. 1). This process technology has already been demonstrated with large-scale pilots at several commercial breweries. In addition, a large number of effluents from other food industries have been successfully used at bench scale in the laboratory.

The basis of the technology entails modification of the aerobic wastewater treatment process to augment protein production by the heterotrophic bacteria responsible for wastewater treatment. This is accomplished by providing naturally occurring bacteria with additional nitrogen and micronutrients to supplement wastewater nutrients to produce large amounts of protein efficiently. This level of nutrient supplementation is not typical in traditional aerobic water treatment and is one feature that makes our process unique. Another key aspect of the technology is to limit the mean cell retention time in the aerated basins to promote rapid cell growth and turnover and thus a “harvesting” of young cells at peak protein levels.

Harvesting of SCP is a straightforward process of concentrating, drying, sterilizing, and packaging. Recent research in our laboratory has demonstrated that our technology can also be successfully applied to POME. Bench-scale bioreactors that simulate an aerobic activated sludge treatment process were used to treat POME. Food/beverage plant wastewater is pumped from a storage reservoir into an aerated basin where bacteria rapidly consume dissolved organic carbon. As the microorganisms grow and multiply they form flocs, that is, aggregated masses of bacteria. These flocs from the aeration basin flow into the clarifier tank, where they settle into a thick layer on

CONTINUED ON NEXT PAGE

TABLE 1. Characteristics of palm oil mill effluent[a]

Parameter	Average value
pH	4.5
BOD	25,000 mg/L
COD	50,000 mg/L
Total solids	40,500 mg/L
Total suspended solids	18,000 mg/L
Oil and grease	4,000 mg/L
Ammonia nitrogen	35 mg/L
Total Kjeldahl nitrogen	750 mg/L

[a]BOD, biological oxygen demand; COD, chemical oxygen demand.

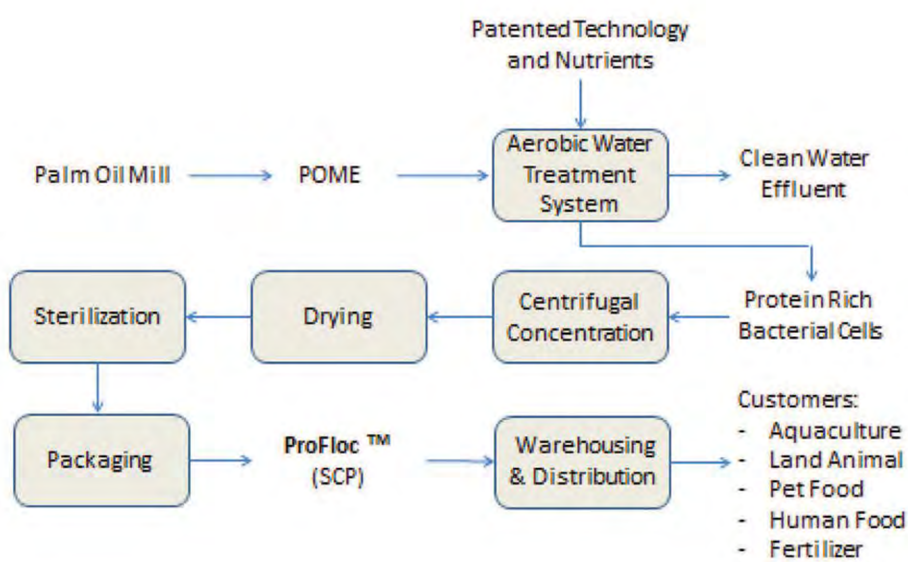


FIG. 1. Process flow diagram for Nutrinsic Corp. single-cell protein (SCP) production from palm oil mill effluent (POME).

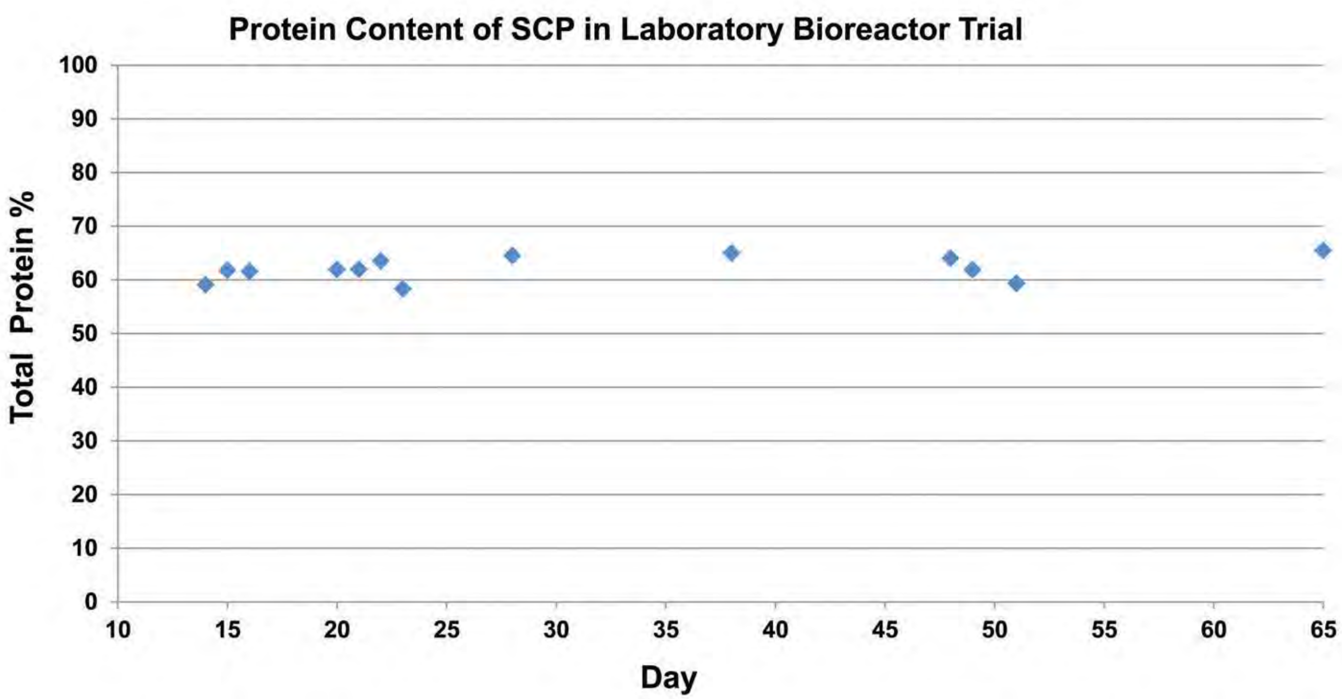


FIG. 2. Percentage of protein (dry weight basis) in SCP product during 65 days of continuous operation of laboratory bioreactors treating POME. For abbreviations see Figure 1.

the bottom. As the flocs settle, clear treated water flows from the top of the clarifier and is discharged. A portion of the flocculated bacteria from the bottom of the clarifier is recycled back into the aeration basin as inoculum for a continuous culture, and the rest is removed from the system as biosolids.

When our company's process is implemented, what was once waste sludge becomes a protein-rich material that has significant value in the food, feed, and fertilizer markets. Therefore, by adding nutrients at the head-end of the process, the waste sludge that is typically a disposal problem for most treatment facilities can be converted into SCP and sold into protein markets.

POME was processed for 65 days of continuous operation in our laboratory bioreactors. Bacterial cells were harvested regularly and dried to produce our proprietary SCP product, ProFloc™ (Table 2). Protein content was measured using a LECO protein analyzer. As shown in Figure 2, protein levels in ProFloc produced from POME were consistently above 60% of the total dry biomass. The percentage of protein in these samples meets or exceeds levels achieved with our process when using other food and beverage process effluents, demonstrating that POME is a viable feedstock for the production of high-quality SCP. Furthermore, the relatively high COD of POME means more food for bacterial growth, which in turn means greater potential for the production of SCP.

TABLE 2. Typical proximate analysis for ProFloc™ single-cell protein

Fraction	Percentage
Protein	63
Oil	4
Carbohydrate	17
Ash	12
Moisture	4

Key metrics for the successful treatment of POME are significant reductions in the levels of nitrogen, phosphorus, and COD. These water-quality treatment parameters were monitored over the course of 65 days of continuous operation of our laboratory reactor. In this experiment we demonstrated continuously effective water treatment (Fig. 3), averaging 79% COD removal from the influent. Likewise, phosphate removal was substantial, with removal rates averaging 88% over the course of the experiment. Operation of laboratory reactors was not tailored for removal of nitrogen, which was added in vast excess in order to ensure nutrient sufficiency. Therefore, the potential for nitrogen removal from POME was not demonstrated well in this particular experiment, averaging around 50%. We are confident that nitrogen addition at the large scale can be fined-tuned such that greater than 90% removal is possible in practice. Our process shows great promise as an alternative treatment method for POME that will greatly reduce discharge levels for key aquatic pollutants while mitigating emissions of GHG to the atmosphere.

CONTINUED ON PAGE 594

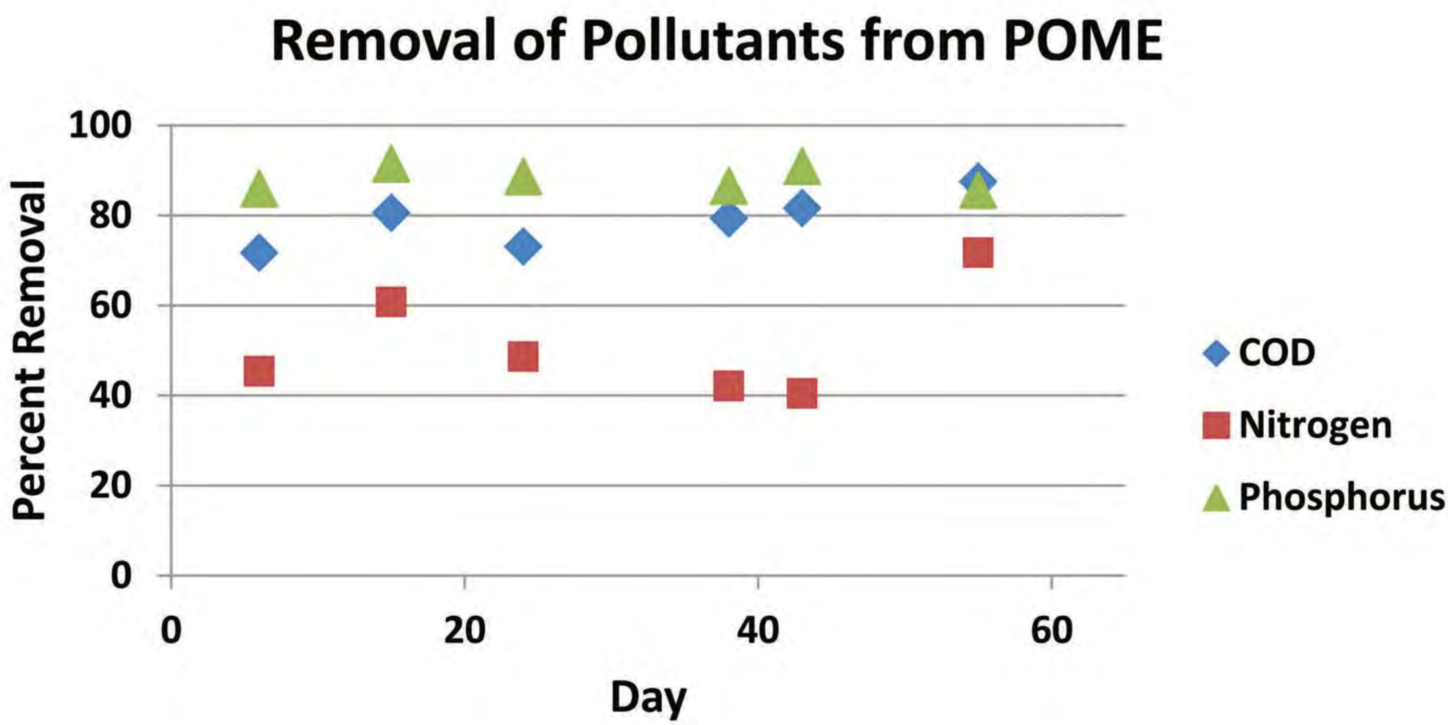


FIG. 3. Reduction of key pollutants: chemical oxygen demand (COD), nitrogen, and phosphorus during 65 days of continuous operation of laboratory bioreactors treating palm oil mill effluent (POME).

REDUCING DISCHARGE LEVELS FOR KEY AQUATIC POLLUTANTS IS CRITICAL

If the organic material in palm oil mill effluent is not completely digested before being discharged into local fields, it could potentially enter and pollute local waterways.

In an article published in the *Journal of Geophysical Research: Biogeosciences* (http://doi: 10.1002/2013JG002516, 2014), researchers from Stanford University and the University of Minnesota warned that land clearing, plantation management, and the processing of oil palm fruits to make crude palm can all send sediment, nutrients, and other harmful substances into streams that run through plantations. When the researchers compared small streams flowing through oil palm plantations, smallholder agriculture, and forests in and around Gunung Palung National Park, Indonesia, they discovered that streams dominated by oil palm plantation agriculture had warmer stream temperatures, increased suspended sediment concentration and yield, and reduced oxygen saturation. Such "significantly eroded" water quality, the team concluded, threatens freshwater streams that millions of people depend on for drinking, water, food, and livelihoods.

The study's co-author and team leader Professor Lisa Curran of Stanford was quoted by *Food Navigator.com* as saying "we were stunned by how these oil palm plantations profoundly alter freshwater ecosystems for decades."

The most dramatic alterations were in streams draining recently cleared plantations, where temperatures were almost 7 ˚ F (4 ˚ C) warmer than forest streams and a spike in stream metabolism (the rate at which a stream consumes oxygen and an important measure of a stream's health) was observed. Curran expressed concern that extensive land conversion to plantations could lead to a "perfect storm" that "could cause collapse of freshwater ecosystems and significant social and economic hardships in a region."

TABLE 3. Estimated potential annual production of SCP from palm oil mill effluent

Country	SCP production[a]
Malaysia	1.0
Indonesia	0.7
All other	0.3
Total world	2.0

[a]SCP, single-cell protein, expressed as million metric tons per year.

Integration of an aerobic treatment process along with SCP production into existing and planned palm oil mills has potential to provide numerous benefits to the palm oil industry. Aerobic systems provide effective water treatment and allow effluent water to be utilized in irrigation or safely discharged to local water bodies. Combining aerobic treatment with the production and sale of SCP results in an economically viable option. Thus, treatment of POME using the process described here presents the opportunity to mitigate environmental issues while simultaneously creating a revenue stream. As the demand for both edible oils and protein continues to grow, we hope that our technology will provide a sustainable alternative to traditional methods for treatment of POME.

By our calculations, up to 2.0 MMT of SCP could be produced annually from POME (Table 3). Using current fish meal prices as a guide (SCP is similar in composition and quality to fish meal) we foresee a potential global market value for SCP produced from POME in the vicinity of $ 3.6 billion.

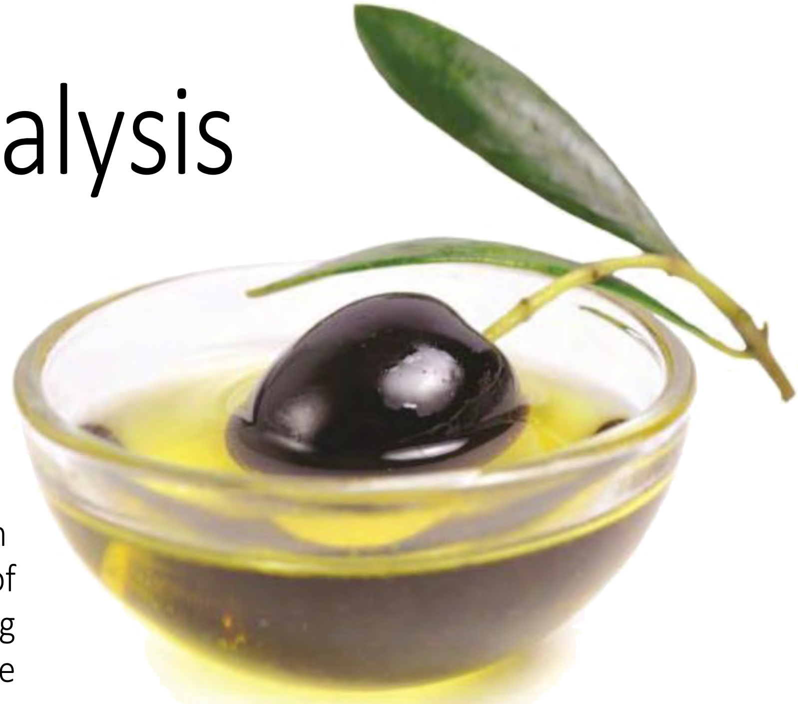
In summary, application of our technology to POME may provide significant benefits to the palm oil industry as well as the environment. These include:

- Cleaner effluent water for use in irrigation or discharge to local waters
- Production of single-cell protein for sale to animal, human, and plant nutrition markets
- Improved economics for palm oil mills
- Mitigation of greenhouse gases discharged to atmosphere

Tracy Yates is a senior scientist at Nutrinsic Corp. (Aurora, Colorado, USA) She received her Ph.D. in biochemistry from the University of Oregon (Eugene, USA), and since then her career has woven together numerous aspects of microbial ecology from microalgae to wastewater microbiology. She can be contacted at Tracy.Yates@gonutrinsic.com.

Leo Gingras is the chief executive officer of Nutrinsic Corp. His career spans more than 30 years working in various technical and management capacities in the human and animal nutrition industry. He can be contacted at Leo.Gingras@gonutrinsic.com.

Automated analysis of **edible oils**



Gary Jackoway and Craig Kunitsky

Determining the quality, purity, and health benefits of edible oils requires a number of evaluations, one of the most important being fatty acid analysis. Since some fatty acids have more health benefits than others, it is essential to know the full fatty acid makeup of an oil. Currently, skilled technicians determine the fatty acid profile by injecting a derivatized sample onto a gas chromatograph (GC) or gas chromatograph–mass spectrometer (GC–MS) and then using the results to calculate the fatty acid composition. Current AOCS methods for analysis standardize the analytical process while still giving the technician some flexibility as to instruments, materials, and techniques of data processing. Requirements for analysis include: verifiable system suitability for the analysis; repeatability of analyses within a laboratory; and reproducibility across laboratories. MIDI, Inc. (Newark, Delaware, USA) has developed a fully automated system that meets these requirements, providing precise analysis, accurate naming of compounds, correction for instrument and column variables, as well as labor-saving calculations that would otherwise be done post-analysis. The software is designed to meet AOCS standards for such analyses.

AUTOMATION, PRECISION OF ANALYSIS, AND SOFTWARE FLEXIBILITY

MIDI software automatically analyzes the results from the GC and calculates the fatty acid profile for an oil sample without time-consuming and potentially error-prone human intervention. An example of a fatty acid profile is shown in Table 1, page 596.

The software is able to accurately name fatty acids by using a calibration standard containing a mixture of saturated fatty acids—having chain lengths of 4–25 carbon atoms—with each batch of samples; these known fatty acids 'act as a series of "fence posts" yielding a series of small naming windows', allowing

CONTINUED ON NEXT PAGE

This article describes a fully automated gas chromatographic system that:

- **names more than 100 fatty acids automatically;**
- **provides accurate quantification for a specific instrument based on a composite calibration standard;**
- **calculates complex metrics and determines sample relationships.**

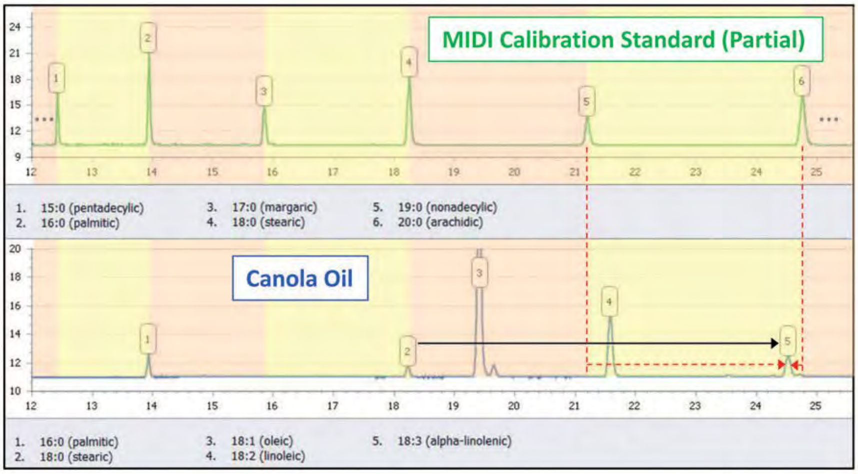


FIG. 1. An external calibration standard creates small naming windows (colored bars). Fatty acids are identified by interpolation between the calibration peak at the beginning and end of each window (e.g., 18:3 in the canola oil samples is identified using the 19:0 and 20:0 calibration peaks—dashed red arrows). In contrast, relative retention time identifies fatty acids by extrapolation from a fixed internal standard (e.g., 18:0, black arrow).

precise determination of the expected times of all fatty acids for a batch of samples run on this particular GC. This method is superior to using an internal standard and calculating relative retention times from a single fixed point. Figure 1 demonstrates the advantage of multiple calibration points for discerning peak location. Accuracy in peak positioning is especially crucial for distinguishing trans fatty acids from the equivalent cis form and for determining the position of double bonds in unsaturated fatty acids.

The software detects any peak "drift" by tracking systematic variations in peak positions of saturated fatty acids in the samples. It triggers automatic recalibration if the drift exceeds a pre-set limit, thereby allowing unattended operation.

FLEXIBILITY OF THE SOFTWARE

Although only the GC-flame ionization detection (FID) software is discussed here, the same software algorithms have been applied to both GC–MS and high-performance liquid chromatography (HPLC) instruments.

When used for identification of bacteria, both GC-FID and HPLC methods have succeeded in large interlaboratory studies accepted by the US Food and Drug Administration and the Association of Analytical Communities (AOAC INTERNATIONAL).

TABLE 1. Fatty acid analysis of extra virgin olive oil[a] (EVOO)

Time (min)	Peak Area	Peak name	Percentage
3.4046	2272	Palmitoleic acid	1.08
3.5082	24331	Palmitic acid	11.51
4.6745	11442	Linoleic acid	5.35
4.7085	162811	Oleic acid	76.15
4.7438	5494	Vaccenic acid	2.57
4.8658	5590	Stearic acid	2.61
6.1737	690	Gondoic acid	0.32
6.3437	848	Arachidic acid	0.40

[a]Sample ID: EVOO-A-59. Total response: 213478.

ANALYSIS

A number of critical measures of edible oil quality can be derived from the fatty acid profile; the software can automatically generate some of these key parameters such as iodine value and saponification value.

IODINE VALUE

The iodine value is a measure of the amount of unsaturation present in the fatty acids in the sample. It is automatically calculated by the software according to AOCS Method Cd 1c-85 (Table 2, page 598). The value is the sum of the percentage of each unsaturated fatty acid in the sample, multiplied by a pre-defined "Fatty Acid Factor" for that fatty acid (based on its level of unsaturation and its molecular weight).

SAPONIFICATION VALUE

The saponification value is a measure of the difficulty to saponify an oil and is based upon the mean molecular weight (MMW) of all the fatty acids present in the sample. The software automatically calculates the MMW for each sample; by using the formula from AOCS Method Cd 3a-94, the saponification value is computed (Table 3, page 598).

OTHER POST-ANALYSIS CALCULATIONS

The software can be configured to automatically calculate any fatty acid combination (or ratio) with each sample report. For some types ofoils, such as marine oils, the percentage of all long-chain omega-3 fatty acids or the ratio of omega-6 to omega-3 fatty acids may be useful. In other applications, it is desirable to know the ratio of monounsaturated fatty acids to polyunsaturated fatty acids; this ratio can also be automatically calculated.

VISUALIZATION

Tools are available that use the fatty acid information to visualize relationships among oil samples. A two-dimensional (2D) plot is a cluster analysis tool that is most useful for finding relationships among large numbers of samples or for finding outliers in a group of

CONTINUED ON PAGE 598

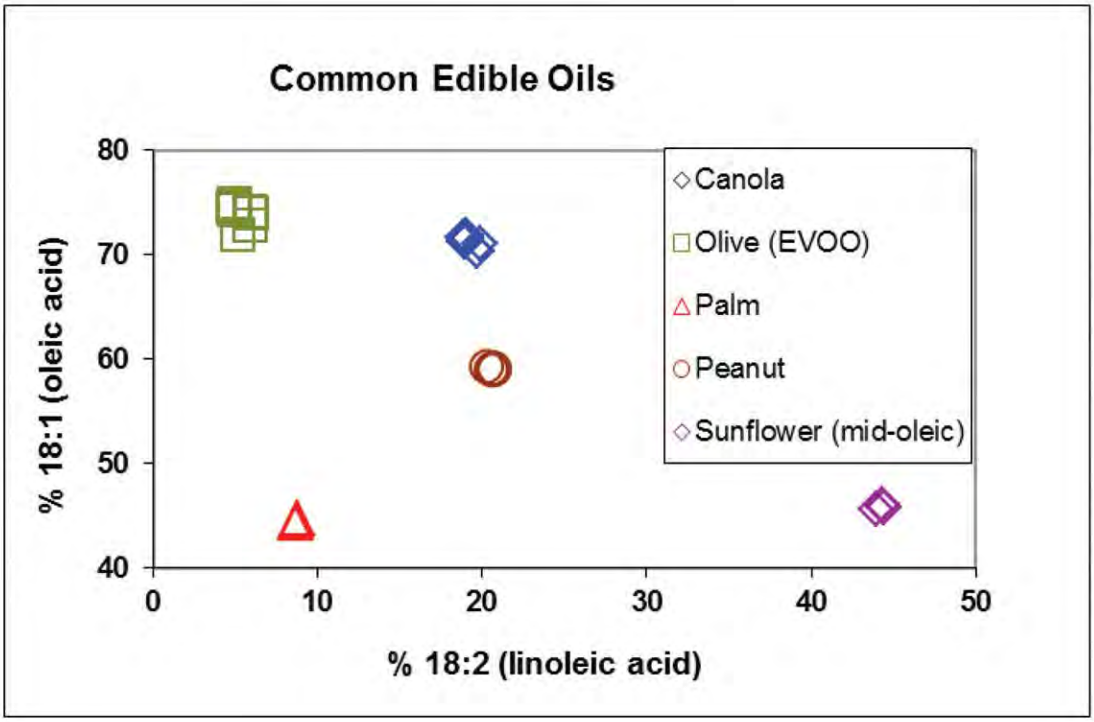


FIG. 2. Two dimensional (2D) plot for common edible oils. EVOO, extra virgin olive oil.

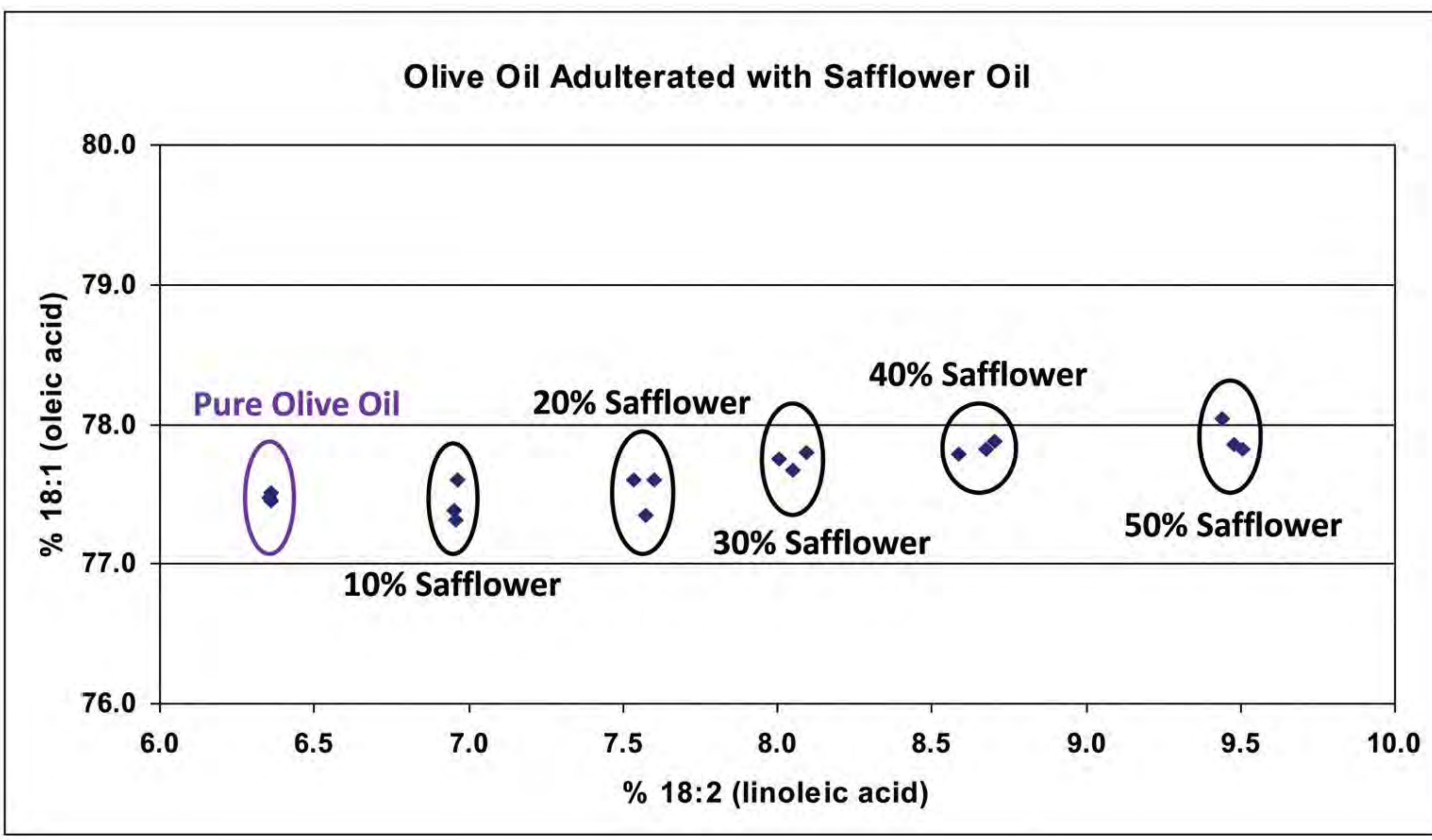


FIG. 3. 2D plot for extra virgin olive oil adulterated with varying amounts of safflower oil.

TABLE 2. Iodine value calculation[a]

Peak Area	Peak name
108	Palmitoleic acid
969	Linoleic acid
6842	Oleic acid
231	Vaccenic acid
27	Gondoic acid

[a]Sample ID: EVOO-A-59. Total response: 8175. **Iodine value: 81.75**

TABLE 3. Saponification value calculation[a]

Peak Area Area	Peak name
274	Palmitoleic acid
2952	Palmitic acid
1501	Linoleic acid
21512	Oleic acid
726	Vaccenic acid
744	Stearic acid
101	Gondoic acid
125	Arachidic acid

[a]Sample ID: EVOO-A-59. Total response: 27934. Mean molecular weight: 279.34. **Saponification value: 192.1.**

closely related samples. One way a 2D plot can be used for fatty acid analysis is to plot individual fatty acids against each other.

In Figure 2 (page 597), a 2D plot was used to compare five major edible oil types by charting the percentage of linoleic acid against the percentage of oleic acid. Each type of oil grouped well with similar samples and was clearly separated from the other oils. Three to ten replicate runs of the same oils demonstrate excellent reproducibility.

OLIVE OIL ADULTERATION

Olive oil is often adulterated with other, low-cost oils. Determining whether olive oil is pure or adulterated is important in ascertaining the healthful properties of the oil. In Figure 3 (page 597), a 2D plot was created of olive oil adulterated with varying levels of safflower oil. As shown, the software system can easily distinguish pure olive oil from these adulterated combinations and can determine the approximate level of adulteration. Work is ongoing to resolve the adulteration problem using different extraction techniques.

OTHER CAPABILITIES

As well as 2D plots, the software visualization tools available include dendrograms, neighbor-joining trees, and histograms. Further, the software includes data export capabilities that allow information to be exported to standard database, spreadsheet, mathematical analysis, and drawing tools.

Fatty acid profiles give detailed information concerning the quality and purity of edible oils. The use of automated peak naming with calculated response factors yields a reproducible, objective measure of the fatty acid profile in oils. These profiles may then be used to calculate key chemical factors for the samples or for visualization of relationships among samples.

Work is ongoing to apply this same software to other chemical information within oils, such as sterol, triterpene, and tocopherol contents.

Gary Jackoway is vice president of MIDI, Inc. and is responsible for research and development.

Craig Kunitsky is chief marketing officer of MIDI, Inc. and is responsible for Sales and Marketing. Both can be reached at oils@midi-inc.com.

EXTRACTS & DISTILLATES (cont. from page 585)

An overview on the presence of cyclopropane fatty acids in milk and dairy products

Caligiani, A., *et al.*, *J. Agric. Food Chem. 62*: 7828–7832, 2014, http://dx.doi: 10.1021/jf4057204.

A survey was carried out to determine the presence of cyclopropane fatty acids (CPFA) in various dairy products. CPFA such as lactobacillic acid and dihydrosterculic acid are components of bacterial membranes and have been recently detected in milk from cows fed with maize silage. In this paper about 200 dairy samples comprising cow, sheep, and goat milk, cheese, yogurt/fermented milk, and butter were analyzed. Results showed that cow milks were generally positive to CPFA (0.014–0.105% of total fatty acids), while goat, yak, and sheep milks were negative. Experimental yogurt and fermented milks showed the same CPFA content of the starting milk. Positive to CPFA were also the majority of samples of commercial butter and cheeses, except some PDO cheeses as Parmigiano-Reggiano and Fontina, cheeses from mountain regions, and goat and sheep cheeses. These data suggest that the presence of CPFA in dairy products could be used as a marker of silage feeding.

More Extracts & Distillates can be found in this issue's supplement (digital and mobile editions only).

2014–2015 AOCS Approved Chemists

The AOCS Approved Chemist Program recognizes the most accomplished participants in the Laboratory Proficiency Program (LPP). Certification is based on performance during the previous LPP year. Approved Chemists must work in an independent or industrial laboratory, hold AOCS membership in good standing, and establish analytical competency through the LPP. For more information about either program, contact Dawn Shepard at AOCS Technical Services (phone: +1 217-693-4810; fax +1 217-693-4855; email: dawns@aocs.org).

A & L Plains Lab
8201 Gary Ave.
Lubbock, Texas 79423
USA
+1 806-763-4278
Tami Brown: Aflatoxin in Corn Meal (test kit), Cottonseed Oil

AAK
2520 7th St. Rd.
Louisville, Kentucky 40208
USA
+1 502-636-1321
James Houghton: Edible Fat, Trace Metals in Oil
Doug Powell: Edible Fat
Jack M. Stearns: Edible Fat, Gas Chromatography, *trans* Fatty Acid Content

Adams Vegetable Oils Inc.
7301 John Galt Way
Arbuckle, California 95912
USA
+1 530-668-2072
Abdul Bath: Gas Chromatography

Admiral Testing Services, Inc.
12111 River Rd.
Luling, Louisiana 70070
USA
+1 985-785-8302
Renato M. Ramos: Oilseed Meal, Unground Soybean Meal, Soybean, Soybean Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit)

Advance Mycotoxin Laboratory
16070 Wildwood Rd.
Wasco, California 93280
+1 661-758-7790
Elizabeth Sanchez: Aflatoxin in Peanut Paste

Algood Food Company
7401 Trade Port Dr.
Louisville, Kentucky 40258
USA
+1 502-736-3720
Algood QA Group: Aflatoxin in Peanut Paste (test kit)

Ana Gida IHTIYAC Mad. San ve Tlc. A.S.
Canakkale Izmir Karayolu
Kozak Yol Ayrimi
Balikesir, Gomec
Turkey
+90 530 387 19 10
Aysun Stenvik: Olive Oil Chemistry Part A, B and C

Areej Vegetable Oils and Derivatives
Old Nizwa Rd., PO Box 22
Rusayl 124
Sultanate of Oman
+96 82444 8019
Abraham Thomas: Solid Fat Content by NMR

ATC Scientific
312 N. Hemlock St.
North Little Rock, Arkansas 72114
USA
+1 501-771-4255
Michael White, Brian Eskridge: Oilseed Meal, Unground Soybean Meal, Soybean Oil, Cottonseed Oil, Phosphorus in Oil. Aflatoxin in Corn Meal (test kit)

Bachoco Baijo
Carretera Panamericana
Km 267.5
Celaya Guanajuato
Mexico
+461 61 45625
Leticia Yazmin Garcia: Unground Soybean Meal

Bakels Edible Oils Ltd.
5 Hutton Place
Mount Maunganui 3116
New Zealand
+64 7 9272443
Laboratory: Gas Chromatograhy

Barrow-Agee Laboratories, Inc.
1555 Three Place
Memphis, Tennessee 38116
USA
+1 901-332-1590
Michael Hawkins: Oilseed Meal

Bayer CropScience
Site 600 Box 117 RR #6
Saskatoon, Saskatchewan S7K 3J9
Canada
+1 306-477-9443
Rudy Fulawka: Gas Chromatography

Biodiagnostics
507 Highland Dr.
River Falls, Wisconsin 54022
USA
+1 715-426-0246
Joseph Zalusky: Gas Chromatography

CONTINUED ON NEXT PAGE

Donna Dean-Zavala

Product Scientist, Blue Diamond Growers, Sacramento, California, USA

Donna Dean-Zavala has worked at Blue Diamond Growers for seven years, and has been an AOCS Approved Chemist since 2008. Blue Diamond Growers initially participated in the LPP program voluntarily, but participation is being considered as a requirement by the Almond Board of California for the *Detection of Aflatoxin in Almonds Laboratory Approval Program.*

"Blue Diamond Growers participates in two proficiency test series from AOCS for Aflatoxin analysis. Two samples are received and analyzed for each series quarterly." Dean-Zavala says. Test results and Z-scores are often reviewed during customer and regulatory audits. "Demonstrating a high level of performance in the AOCS proficiency program gives our customers confidence that we are producing reliable analytical results", she says.

Blue Diamond Growers
1802 C St.
Sacramento, California
95814
USA
+1 916-329-3361
Donna Dean-Zavala: Aflatoxin in Almond

Bunge Oils
725 N. Kinzie
Bradley, Illinois 60915
USA
+1 815-523-8148
Bunge Analytical Team: Gas Chromatography

Canadian Food Inspection Agency
960 Carling Ave.,
Bldg #22 CEF
Ottawa, Ontario K1A 0C6
Canada
+1 613-759-1269
Angela Sheridan: Gas Chromatography

Canadian Grain Commission
303 Main St.
Winnipeg, Manitoba R3C 3G8
Canada
+1 204-983-3354
Oilseed Lab: Gas Chromatography, Oilseed Meal, Soybean

Carolina Analytical Services, LLC
17570 N.C. Hwy 902
Bear Creek, North Carolina
27207
USA
+1 919-837-2021
Brad N. Beavers, Jennie B. Stewart: Oilseed Meal

Certispec Services, Inc.
2813 Murray St.
Port Moody, British Columbia V3H 1X3
Canada
+1 604-469-9180
Cipriano Cruz: NIOP Fats and Oils

Ceway Chemical Services
105 Morris St., Ste. 222
Sebastapol, California
95472
USA
+1 707-373-7129
Wayne Britton: Olive Oil Part A

Chemiservice SRL
Via Vecchio Ospedale Str.
Priv 11
Monopoli 70043
Italy
+39 080-742 777
Giorgio Cardone: Olive Oil (Parts A, B and C), Olive Oil Sensory Analysis

Conagra Foods
1351 Williams Ave.
Memphis, Tennessee
38104
USA
+1 901-729-5636
Richard Carl Whitney: Gas Chromatography, Soybean Oil, Cottonseed Oil, Vegetable Oil (color only), *trans* Fatty Acid Content, Solid Fat Content by NMR, Edible Fat

Cumberland Valley Analytical Services
14515 Industry Drive
Hagerstown, Maryland
21742
USA
+1 301-790-1980
Sharon Weaver: Oilseed Meal

Dallas Group of America
1402 Fabricon Blvd.
Jeffersonville, Indiana
47130
USA
+1 812-283-6675
Melanie Greer: Vegetable Oil for Color Only, NIOP Fats and Oils
George Hicks: Vegetable Oil for Color Only, NIOP Fats and Oils

Darling Analytical Laboratories
2665 SE Oak Tree Ct.
Suite 106
Ankeny, Iowa 50021
USA
+1 515-289-3718
Shirley Elliott: Tallow and Grease, Gas Chromatography

Diversified Laboratories
4150 Lafayette Center Court, Ste. 600
Chantilly, Virginia 20151
USA
+1 703-222-8700
Thomas Scott: Tallow and Grease

Enzymotec Ltd.
Sagi 2000 Industrial Zone
Kfar Baruch 36584
Israel
+972 54-332-1322
Gregory Blinder: AOCS/GOED Nutraceutical Oils

Eurofins Central Analytical Laboratory, Inc.
2219 Lakeshore Dr.
Suite 500
New Orleans, Louisiana 70122
USA
+1 504-297-3420
John Reuther:: Oilseed Meal, Unground Soybean Meal, Soybean, Trace Metals in Oil, Fish Meal, AOCS/GOED Nutraceutical Oils, Marine Oil, Marine Oil FAP, Palm Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal, Aflatoxin in Corn Meal (test kit), Aflatoxin in Almond and Pistachio, Soybean Oil

Eurofins Scientific
2200 Rittenhouse St.
Suite 150
Des Moines, Iowa 50321
USA
+1 515-265-1461
Ardin Backous: Oilseed Meal, Unground Soybean Meal, Soybean, Fish Meal, Soybean Oil , Aflatoxin in Corn Meal (test kit), Nutritional Labeling
Kent Karsjens: Oilseed Meal, Unground Soybean Meal, Soybean, Fish Meal, Aflatoxin in Corn Meal (test kit), Nutritional Labeling, Soybean Oil
Keith Persons: Edible Fat, Tallow and Grease, Cholesterol, AOCS/GOED Nutraceutical Oils, Marine Oil, Marine Oil Fatty Acid Profile, *trans* Fatty Acid Content, Nutritional Labeling
Anders Thomsen: Edible Fat, Tallow and Grease, Oilseed Meal, Unground Soybean Meal, Soybean, Cholesterol, Fish Meal, AOCS/GOED Nutraceutical Oils, Marine Oil Fatty Acid Profile, Soybean Oil, Aflatoxin in Corn Meal (test kit), Nutritional Labeling

Fieldale Farms Corp.
565 Broiler Blvd.
Baldwin, Georgia 30511
USA
+1 706-778-5100
Janet Smith: Oilseed Meal, Aflatoxin in Corn Meal (test kit)

Fuji Vegetable Oil, Inc.
120 Brampton Rd.
Savannah, Georgia 31408
USA
+1 912-433-5331
Gregg Newman: *trans* Fatty Acid Content, Edible Fat

GC Rieber Omega-3 Concentrates AS
Teistholmsundet 6
Kristiansund N 6512
Norway
+47 48134957
Analytical Team: AOCS/GOED Nutraceutical Oils

Grupo Agroindustrial Numar S.A.
Barrio Cuba
St 22-24 Ave 12
San Jose 3657-1000
Costa Rica
+506 2284-1000
Ricardo Arevalo: Gas Chromatography, *trans* Fatty Acid Content

Hahn Laboratories, Inc.
1111 Flora St.
Columbia, South Carolina 29201
USA
+1 803-799-1614
Frank Hahn: Oilseed Meal, Unground Soybean Meal, Soybean Oil, Aflatoxin in Corn Meal (test kit)

Illinois Crop Improvement Association
3105 Research Rd.
Champaign, Illinois 61822
USA
+1 217-359-4053
Sandra K. Harrison: Oilseed Meal

Imperial Western Products
86-600 Avenue 54
Coachella, California 92236
USA
+1 760-398-0815
Joe Boyd: Aflatoxin in Cottonseed Meal

In Con Processing
970 Douglas Rd.
Batavia, Illinois 60510
USA

CONTINUED ON NEXT PAGE

Karen Letourneau

Technical Programs Manager, POS Bio-Sciences, Saskatoon, Saskatchewan, Canada

Karen Letourneau has worked at POS Bio-Sciences for 24 years and has been an AOCS Approved Chemist since 2011. “Being part of the certification program really improves the quality of our testing,” she says.

She explains that although POS Bio-Sciences had been performing marine oil lab testing for years, the laboratory initially didn’t do well in that particular series of proficiency testing. “Comparing our data to other labs’ data helped us improve, and we used the check samples obtained through AOCS to train our technicians,” she says. “The next year we placed first in the AOCS marine oil series.”

Michael Hawkins

Owner, Barrow-Agee Laboratories, Memphis, Tennessee, USA

Michael Hawkins is an AOCS Approved Chemist in oilseed meal 100% crude fiber, oilseed meal 100% nitrogen Ba 4e-93 method, oilseed meal overall, and soybean oil testing. Hawkins says that AOCS certification has led to more work for him and the lab as a whole.

"Certification shows that you're efficient and competent," he says. "One of the first questions some customers ask is, 'Are you AOCS approved?' They understand that if you can't pass the check sample series, you can't do the work."

+1 630-761-1180
Christopher Stefan:
Marine Oil Fatty Acid Profile

INOLASA
Barranca Puntarenas,
Contiguo a la Zona Franca
Puntarenas 6651-1000
Costa Rica
+506 2663-0323
***Jesus Gomez Salgado*:**
Edible Fat, Unground Soybean Meal, *trans* Fatty Acid Content, Soybean

Inspectorate America
12622 Highway 3
Webster, Texas 77598
USA
+1 713-451-2192
Mumtaz Haider:
Tallow and Grease, Oilseed Meal, Soybean, Gas Chromatography, Soybean Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit)

International Analytical Services S.A.C.
Av. La Marina 3035,
San Miguel
Lima 32
Peru
+511 6165200
***Carmen Catter de Bueno*:**
Fish Meal

Intertek Agri Services
1286 Channel Ave.
Memphis, Tennessee 38113
USA
+1 901-947-9900
***Sandra Holloway*:**
Oilseed Meal, Soybean Oil, Aflatoxin in Corn Meal (test kit), Gas Chromatography

Intertek Agri Services
160 East James Dr.
Suite 200
St. Rose, Louisiana 70087
USA
+1 504-602-2100
***Tuyen Mai*:** Oilseed Meal, Gas Chromatography, Soybean Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit)

Intertek Agri Services
115 Chernomorskogo Kazachestva Str.
Office 507
Odessa 65003
Ukraine
+38 0487202475
Irina Kushnir: Palm Oil

Isotek, LLC
5225 NW 5th St.
Oklahoma City, Oklahoma 73127
USA
+1 405 948 8889
***R. Bruce Kerr, George Ducsay*:** Tallow and Grease, Oilseed Meal

Jacob Stern & Son
2104 75th St.
Houston, Texas 77261
USA
+1 713-926-8386
***Robert Poullard, Jr.*:**
Tallow and Grease

Kalamata Olive Oil Taste Laboratory
Technological Educational Institute of Peloponnese
Kalamata 24100
Greece
+30 6944675764
Vasilis Demopoulos: Olive Oil Sensory Analysis

K-Testing Laboratory
1555 Three Place, Suite A
Memphis, Tennessee 38116
USA
+1 901-525-0519
***Edgar Tenent*:** Oilseed Meal

La Nogalera S.A de C.V
Enrique Pinocelli
9381 Col Puento Alto Cd. Juarez, Chihuahua 32695
Mexico
+52 656 8435052
Dulcinea Mendoza:
Specialty Oils

Lipid Analytical Labs
150 Research Lane
University of Guelph, Research Park Centre
Guelph, Ontario N1G 4T2
Canada
+1 519-766-1510
***Jerry Piekarski*:**
Cholesterol, AOCS/GOED Nutraceutical Oils

Lysi hf
Fiskislod 5-9
Reykjavik 101
Iceland
+354 5258140
***Arnar Halldorsson*:** AOCS/GOED Nutraceutical Oils, Marine Oil, Marine Oil Fatty Acid Profile

Malaysian Palm Oil Board, AOTD
Lot 9 & 11 Jalan P 10/14
Seksyen 10
Bandar Baru Bangi
Selangor 43000
Malaysia
+60 3-89256055
***Dr. Hazimah Abu Hassan, Mrs. Hajar Musa*:** Palm Oil, Gas Chromatography, *trans* Fatty Acid Content

Mid Continent Laboratories
300 Buckeye Rd.
Greenwood, Mississippi38930
USA
+1 662-453-2388
***Garlon Beckwith*:** Oilseed Meal

Mid Continent Laboratories
1279 Jackson Ave.
Memphis, Tennessee

38107
USA
+1 901-725-1722
***Donald Britton*:**
Oilseed Meal, Soybean, Cottonseed Oil, Soybean Oil

Minnesota Valley Testing Lab
2 North German St.
New Ulm, Minnesota 56073
USA
+1 507-233-7171
***Joel Sieh*:** Oilseed Meal

Modern Olives Laboratory Services
95 Broderick Rd.
Lara, VIC 3212
Australia
+61-352729500
***Claudia Guillaume*:** Olive Oil (Parts A, B and C), Olive Oil Sensory Analysis

National Beef
2000 East Trail St.
Dodge City, Kansas 67801
USA
+1 620-338-4250
***Mike Clayton*:** Tallow and Grease

National Beef Packing Company
1501 East 8th St.
Liberal, Kansas 67801
USA
+1 620-626-0646
***Sherry Robertson*:** Tallow and Grease

New Jersey Feed Lab, Inc.
1686 Fifth St.
Trenton, New Jersey 08638
USA
+1 609 882 6800
***Pete Cartwright*:** Oilseed Meal, Gas Chromatography, Fish Meal, AOCS/GOED Nutraceutical Oils, Marine Oil, Marine Oil Fatty Acid Profile

NSW Department of Primary Industries
Pine Gully Rd.
Wagga Wagga, NSW 2650
Australia
+61 02-69381-818
***Jamie Ayton*:** Gas Chromatography, Olive Oil (Part A, B and C), *trans* Fatty Acid Content

Nu-Mega Ingredients Pty. Ltd.
31 Pinnacle Rd.
Altona North, VIC 3025
Australia
+61 3-8369-2100
***Nathaniel Irving*:** Marine Oil Fatty Acid Profile

Nutreco Canada Shur Gain
8175 Rue Duplessis
St. Hyacinthe, Québec J2R 1S5
Canada
+1 450-796-2555
***Jana Pogacnik*:** Oilseed Meal, Cholesterol, Nutritional Labeling, Marine Oil

Olam Food Ingredients UK, LTD
Brittania Way
Goole East Riding of Yorkshire DN14 6ES
United Kingdom
+44 1405 767776
Analysts Olam Food Ingredients: Gas Chromatography

Omega Protein, Inc.
243 Menhaden Rd.
Reedville, Virginia 22539
USA
+1 804-453-3830
***Otelia Robertson*:** Marine Oil

Omega Protein, Inc.—Health and Science Center
243 Menhaden Rd.
Reedville, Virginia 22539
USA
+1 804-453-3830
***Nancy Roman*:** Marine Oil
Melissa V. Thrift: Marine Oil

Owensboro Grain Edible Oils
1145 Ewing Rd.
Owensboro, Kentucky 42301
USA
+1 270-686-6628
***OGEO Lab*:** Gas Chromatography, Soybean Oil, *trans* Fatty Acid Content

Pompeian Inc.
4201 Pulaski Hwy.
Baltimore, Maryland 21224
USA
+1 410-276-6900
***Maria Garzon*:** Olive Oil Parts (A, B and C), Olive Oil Sensory Analysis

POS Bio Sciences
118 Veterinary Rd.
Saskatoon, Saskatchewan S7J 3B6
Canada
+1 306-978-2826
***Angie Johnson*:** Oilseed Meal, Cholesterol, Marine Oil, Marine Oil Fatty Acid Profile, *trans* Fatty Acid Content, Phosphorus in Oil

CONTINUED ON NEXT PAGE

Ricardo Arevalo
Quality assurance manager, Grupo Agroindustrial Numar S.A., San Jose, Costa Rica

Grupo Agroindustrial Numar S.A. receives daily samples of vegetable fats, specifically palm oils. Quality assurance manager Ricardo Arevalo—an AOCS Approved Chemist who has been recognized for excellence in solid fat content by NMR testing—says that being involved with the program allows him to compare his results with those of other labs in Latin America and abroad, which leads to improved test quality and more accurate results.

"Customs regulations are very strict in my country, and we have to do a lot of paperwork to get samples out," he says. "At first we had to send the results by email or fax, but now it's all done through the internet. It's very fast and smooth program."

2014–2015 AOCS Certified Laboratories

The Laboratory Certification Program is sponsored by AOCS and the National Oilseed Processors Association (NOPA). Certification entitles a laboratory to serve as a NOPA referee for soybean meal analyses, and publication in the annual edition of the *NOPA Rule Book*.

Admiral Testing Services, Inc.
12111 River Rd.
Luling, Louisiana 70070
USA
+1-504-734-5201
Renato M. Ramos

ATC Scientific
312 North Hemlock
North Little Rock, Arkansas 72114
USA
+1-501-771-4255
Mike White, Brian Eskridge

Barrow-Agee Laboratories, Inc.
1555 Three Place
Memphis, Tennessee 38116
USA
+1-901-332-1590
Michael Hawkins

Carolina Analytical Services LLC
17570 NC Hwy 902
Bear Creek, North Carolina 27207
USA
+1-919-837-2021
Jennie Stewart, Brad Beavers

Cumberland Valley Analytical
14515 Industry Drive
Hagerstown, Maryland 21742
USA
+1-301-790-1980
Sharon Weaver

Eurofins Scientific
2200 Rittenhouse St.
Suite 150
Des Moines, Iowa 50321
USA
+1-515-265-1461
Ardin Backous, Kent Karsjens. Anders Thomsen, Keith Persons

Hahn Laboratories, Inc.
1111 Flora St.
Columbia, South Carolina 29201
USA
+1-803-799-1614
Frank M. Hahn

Intertek Agri Services
160 East James Dr. Suite 200
St. Rose, Louisiana 70087
USA
+1-504-602-2100
Tuyen Mai

K-Testing Laboratory, Inc.
1555 Three Place Suite A
Memphis, Tennessee 38116
USA
+1-901-525-0519
Edgar Tenent

SGS North America
151 James Dr. W.
Saint Rose, Louisiana 70087
USA
+1-504-463-3320
William Spence

Thionville Laboratories, Inc.
5440 Pepsi St.
Harahan, Louisiana 70123
USA
+1-504-733-9603
Paul Thionville, Boyce Butler, Andre Thionville, Kristopher Williams

Whitbeck Laboratories, Inc.
1000 Backus Ave.
Springdale, Arkansas 72764 USA
+1-479-756-1270
Gordon Whitbeck, John Dillard

PT Musim Mas
Jl. K. L. Yos Sudarso Km 7.8
Tanjung Malia
Medan
North Sumatra 20241
Indonesia
+62 616871123
Goh Tiam Huat: Gas Chromatography, Trace Metals in Oil, Palm Oil, NIOP Fats and Oils, *trans* Fatty Acid Content

Russell Marine Group–PNW, LLC
2580 NW Upshur St.
Portland, Oregon 97210
USA
+1 503 224 9325
Robert Carr: Oilseed Meal, Soybean

Sanimax-ACI, Inc.
2001 Ave. De La Rotonde
Charny, PQ G6X 3R4
Canada
+1 418-832-4641
Jean-Francois Harvey: Tallow and Grease

Sanimax USA, Inc.
2099 Badgerland Dr.
Green Bay, Wisconsin 54303
USA
+1 920-494-5233
Green Bay Analytical Team: Tallow and Grease

SDK Laboratories
1000 Corey Rd.
Hutchinson, Kansas 67501
USA
+1 620-665-5661
Dennis Hogan: Tallow and Grease (MIU, FFA), Aflatoxin in Corn Meal (test kit)

Ser-Agro S.A.
Kilometro 138 Carretera a Corinto
Chinandega
Nicaragua
+505 2340-3493
Norma Hernandez: Peanut

SGS Canada
Suite B 3260 Production Way
Burnaby, British Columbia
V5A 4W4
Canada
+1 604-638-2349
Cathy Sun: Oilseed Meal, Soybean Oil

SGS North America
151 James Dr. West
St. Rose, Louisiana 70087
USA

+1 504-471-6489
William Spence: Oilseed Meal, Cholesterol, Olive Oil (Parts B & C), NIOP Fats and Oils

Silliker Canada Co.
90 Gough Rd.
Unit #4
Markham, Ontario L3R 5V5
Canada
+1 905-479-5255
Jocelyn Alfieri: Cholesterol, Gas Chromatography, *trans* Fatty Acid Content, Aflatoxin in Peanut Paste (test kit), Marine Oil Fatty Acid Profile, Specialty Oils, Nutritional Labeling

Southern Acids (M) Bhd. Industries Sdn. Bhd.
Golconda Estate, 10th Mile
Kapar Rd.
Klang, Selangor 42200
Malaysia
+603 32508723
Tan Pei Fong: Gas Chromatography

Sovena Oilseeds Laboratory
Rua Dr António Loureiro Borges
No 2 Ed Arquiparque
Lisboa 1495-131
Portugal
+351 21-2949000
Sovena Oilseeds Laboratory: Unground Soybean Meal, Soybean, Gas Chromatography, Phosphorus in Oil, Trace Metals in Oil

Stratas Foods–RDI Center
7970 Stage Hills Blvd.
Bartlett, Tennessee 38133
USA
+1 901-387-2237
Eddie L. Baldwin, Helen Cianciolo: Gas Chromatography, *trans* Fatty Acid Content, Solid Fat Content by NMR, Edible Fat

Testing Services (Sabah) Sdn. Bhd.
1st Floor, Lot 1, BLK N
Bandar Ramai
Sandakan Sabah 90712
Malaysia
+60 89-210431
Kong Khim Chong: Palm Oil

Thai Vegetable Oil
149 Ratchadapisek Rd. (Thapra-Taksin)
Bukkhalow Thonburi
Bangkok, 10600
Thailand
+662 4779020
Piyanut Boriboonwiggai: Unground Soybean Meal

Thionville Laboratories, Inc.
5440 Pepsi St.
Harahan, Louisiana 70123
USA
+1 504-733-9603
Paul C. Thionville, Andre Thionville, Kristopher Williams, Boyce H. Butler: Tallow and Grease, Oilseed Meal, Soybean, Gas Chromatography, Trace Metals in Oil, Fish Meal, Soybean Oil, Cottonseed Oil, NIOP Fats and Oils, *trans* Fatty Acid Content, Aflatoxin in Corn Meal, Aflatoxin in Corn Meal (test kit)

Twin Rivers Technologies
780 Washington St.
Quincy, Massachusetts 02169
USA
+1 617-745-4229
Glenn Craig: Gas Chromatography

University of Missouri–Columbia
AESCL, Office of the State Chemist
Rm. 4 Agriculture Bldg.
Columbia, Missouri 65211
USA
+1 573-882-2608
Thomas P. Mawhinney: Cholesterol, Gas Chromatography, Oilseed Meal, Nutritional Labeling

University of Stirling
Institute of Aquaculture Nutrition Group
Stirling, FK9 4LA
United Kingdom
+44 1786 467996
Douglas Tocher: Marine Oil Fatty Acid Profile

Viterra Canola Processing
386 Industrial Park Road
Winnipeg, Manitoba R0G 1Y0
Canada
+1 877-822-2565
Mike Adelino: Gas Chromatography, Trace Metals in Oil, *trans* Fatty Acid Content, Phosphorus in Oil

Whitbeck Laboratories, Inc.
1000 Backus
Springdale, Arizona 72764
USA
+1 479-756-9696
John Dillard and Gordon Whitbeck: Tallow and Grease (MIU only), Unground Soybean Meal, Aflatoxin in Corn Meal (test kit), Oilseed Meal

Reactive seed crushing of castor seeds to produce **methyl ester**

Jean-Luc Dubois

Arkema, headquartered in Colombes, France, is one of the largest consumers in the world of castor seed oil for the production of polyamide-11 and sebacic acid. Polyamide-11, commercialized for more than 50 years with the trade name of Rilsan®, is produced in a multistep process starting from castor oil. Sebacic acid is used to produce Polyamide 10.10 and other copolyamides.

Today, most castor seed oil production originates from India. Castor seeds are nonedible and can grow in very difficult conditions where many other crops would not survive, which makes castor an interesting crop in the current food vs. fuels debate. However, castor seeds are highly toxic, as they contain the powerful toxic protein ricin and an allergen: CB-1A. Castor oil is a little more expensive than food-grade vegetable oils, but mainly its price suffers from variation in local climatic conditions since most of the production is concentrated in the same region of the world.

Castor oil could potentially be considered for biodiesel or jet fuel production since the average oil yield per hectare would be competitive with many other crops.

However, castor production suffers from high processing costs, requires high investment cost, and generates a toxic waste in the form of the seed meal, which is either burned or used as a natural fertilizer even though it still contains ricin and CB-1A.

Jatropha is another tropical oilseed crop that has been investigated for biodiesel production since it is also nonedible. Much like castor, it contains a toxic protein called curcin, but it also contains phorbol esters, which are tumor-promoting agents. Since both crops are nonedible they require dedicated processing units to avoid contamination. The objective of the development of a new technology for castor and jatropha, called reactive seed crushing, was to reduce the capital cost of oil production, in order to facilitate the implementation of these crops in new regions of the world while bringing a solution to detoxify the meal.

CURRENT PROCESS FOR PRODUCING POLYAMIDE-11 FROM CASTOR SEEDS

Castor is the only crop that can be used so far for the production of Rilsan-11® - Arkema's trade name for Polyamide-11, a fully renewable technical polymer used in many applications—such as low-pressure gas pipes and oil transportation—since castor oil is the sole source of ricinoleic acid.

Currently, the production of Polyamide-11 requires the following steps starting from castor seeds: seed crushing and oil solvent extraction; transesterification to produce methyl ricinoleate; thermal cleavage to produce methyl 10-undecenoate; hydrolysis to 10-undecenoic acid; hydrobromination to 11-bromoundecanoic acid; ammoniation (substitution of Br by ammonia) to lead to the monomeric 11-aminoundecanoic acid; and finally polymerization.

The production of methyl ricinoleate has also been proposed for the production of biodiesel. However, castor oil would make a very bad biodiesel for two main reasons: the high viscosity of the esters, which generates large droplets in the combustion chamber and a poor combustion, and the low cetane number of the methyl ester. This is mainly due to the high content (85 %) in ricinoleic acid in the oil – an hydroxy fatty acid—which is also the reason why castor oil is so attractive for other applications such as lubricants, polyurethane, and chemicals synthesis. If the methyl ricinoleate is diluted in other vegetable oils or in diesel fuel, then the main disadvantages are limited, but in order to access the fuel market, the castor oil methyl ester should become more economically accessible. It should also be noticed that once thermally cleaved the products obtained—methylundecylenate and the blend of non-ricinoleate methyl esters—are excellent components for biodiesel.

A MORE SUSTAINABLE TECHNOLOGY

To promote sustainable castor production a new process called reactive seed crushing has been developed. In this process, once the seeds have been flattened to produce flakes, they are directly reacted with methanol, which is also used as

CONTINUED ON NEXT PAGE

- **Oil from seeds of the castor oil plant has potential as a feedstock for biodiesel and jet fuel production, as the plant grows under harsh conditions where food-yielding plants cannot, and the average oil yield per hectare for castor is competitive with that of many other oilseed crops.**
- **Unfortunately, castor oil production suffers from high processing costs and generates toxic waste in the form of the seed meal.**
- **In this article, a scientist from Arkema, one of the largest consumers of castor seed oil for the production of polyamide-11 and sebacic acid, describes a process called "reactive seed crushing" that his company developed to promote sustainable castor production.**

TABLE 1. Effect of the reactive seed crushing process on the extraction–transesterification of castor seeds

Process conditions (at 50°C)	
Weight of methanol	700 g
Weight ratio methanol/seed flakes	2
Weight of NaOH (catalyst) used	1.1 g (0.3 wt % relative to flakes)
Methyl ester yield	87.1 %
Fat lost in the defatted seed cake	2.6 %
Loss of esters: (Theoretical weight of esters)–(weight of esters produced)–(potential weight of esters in the final seed cake)	10.3 %
Methyl esters recovered	
Acid number (mg KOH/g)	0.46
Methyl C16:0 content (palmitate)	0.85 %
Methyl C18:2 content (linoleate)	2.90 %
Methyl C18:1 content (oleate)	3.46 %
Methyl C19:0 content (stearate)	0.96 %
Methyl C18:1, OH content (ricinoleate)	90.65 %
Monoglyceride content	1.19 %
Diglyceride content	Not detected
Triglyceride content	Not detected

INFORMATION

- Dubois, J.L., J. Magne, J. Barbier, and A. Piccirilli, Procede de trituration reactive des graines de ricin, French Patent FR 2940804, July 9, 2010; WO10076527.
- Dubois, J.-L., J. Magne, and A. Piccirilli, Method for reactively crusing jatropha seeds, US Patent Application 2013052328.
- Dubois, J.-L., A. Piccirilli, J. Magne, and X. He, Detoxification of castor meal through reactive seed crusing, *Ind. Crops Prod. 43*:194–199, 2013.
- Piccirilli, A., J. Barbier, J. Magne, and J.-L. Dubois, Method for obtaining a fraction enriched with functionalized fatty acid esters from seeds of oleaginous plants, US Patent Application 2012077999.

an extraction solvent, in the presence of a basic catalyst. In this process sodium hydroxide can be used. There are several possible process configurations, such as having the flakes in trays of a solvent extraction unit, continuously washed by the caustic methanol solution. The flakes are finally dried to recover remaining solvent (Table 1 , page 607). The methyl ester is separated from the glycerine and excess methanol and recovered.

Through this process, a high-quality methyl ester is produced, together with glycerine and a detoxified seed meal. The quality of the methyl ester is equivalent to the ester that can be obtained through the conventional process of castor oil transesterification. The castor meal detoxification has been assessed by ricin quantification, by animal testing, and also by allergenicity testing (Dubois *et al.*, 2013).

This new technology requires significantly less equipment, does not require refining (since the chemistry is done directly on the seeds), and should enable the processing of seeds from a smaller footprint, allowing production to start in new cultivation areas. Several pieces of processing equipment can be omitted in this new configuration such as the seed-crushing unit (cold or hot press), the oil-refining unit, and the transesterification unit. The main advantage of the new process is the detoxification of the castor cake, as proven by the reduction of the ricin content.

A variation of this technology has also been developed for jatropha.The objective has been to bring down the phorbol esters in the meal to the value observed in the so-called nontoxic variety of jatropha. It was necessary to use a combination of solvents (hexane and methanol) to achieve both a high and fast extraction rate and detoxification.

The work done by Arkema has been aimed at developing a new technology to produce methyl ricinoleate more readily, through process intensification, and to detoxify the seed meal. As for most vegetable oils, the value of the co-products is the key for a successful development. In the case of castor oil, it is also essential to develop solutions that can give higher values to the seed meal as well as to reduce the number of steps (key equipment). New products will also be essential for the development of a new economy based on the nonedible castor crop.

Jean-Luc Dubois is a researcher at Arkema in Colombes, France. He can be reached at jean-luc.dubois@arkema.com.

The French ADEME (Agency for Development and Energy Conservation) is acknowledged for its financial support. Antoine Piccirilli and Julien Magne from Valagro, Poitiers,France, are acknowledge for their scientific and technical support. Xiaohua He (Western Regional Research Center, US Department of Agriculture, Albany, California) carried out tests to confirm the reduction in ricin content.

FRENCH

U.S.A.

Your Partner in Processing

FRENCH® OILSEED POCESSING EQUIPMENT AND SYSTEMS

THE INDUSTRY STANDARD

Cracking Mill

French understands the importance equipment reliability has on oilseed preparation system performance. Our proprietary line of precisely engineered and durable Cracking Mills, Flaking Mills, Conditioners and Screw Presses have a worldwide reputation for years of reliable operation.

Flaking Mill

Since 1900, we have supplied thousands of pieces of long lasting oilseed preparation equipment and hundreds of successful complete oilseed equipment systems for nearly all commercial oilseeds food and industrial uses. Our process solutions meet and exceed industry standards of high quality crude oil, meal and oil extraction efficiencies.

Conditioner

Looking to develop or improve your process? Utilize French's Innovation Center by conducting performance trials on your seed. Our team of experienced engineers will work with you to test a variety of processing elements and methods to achieve your optimal oil recovery while reducing heat degradation of the crude oil and cake. Confidentiality agreements are available.

Achiever Screw Press

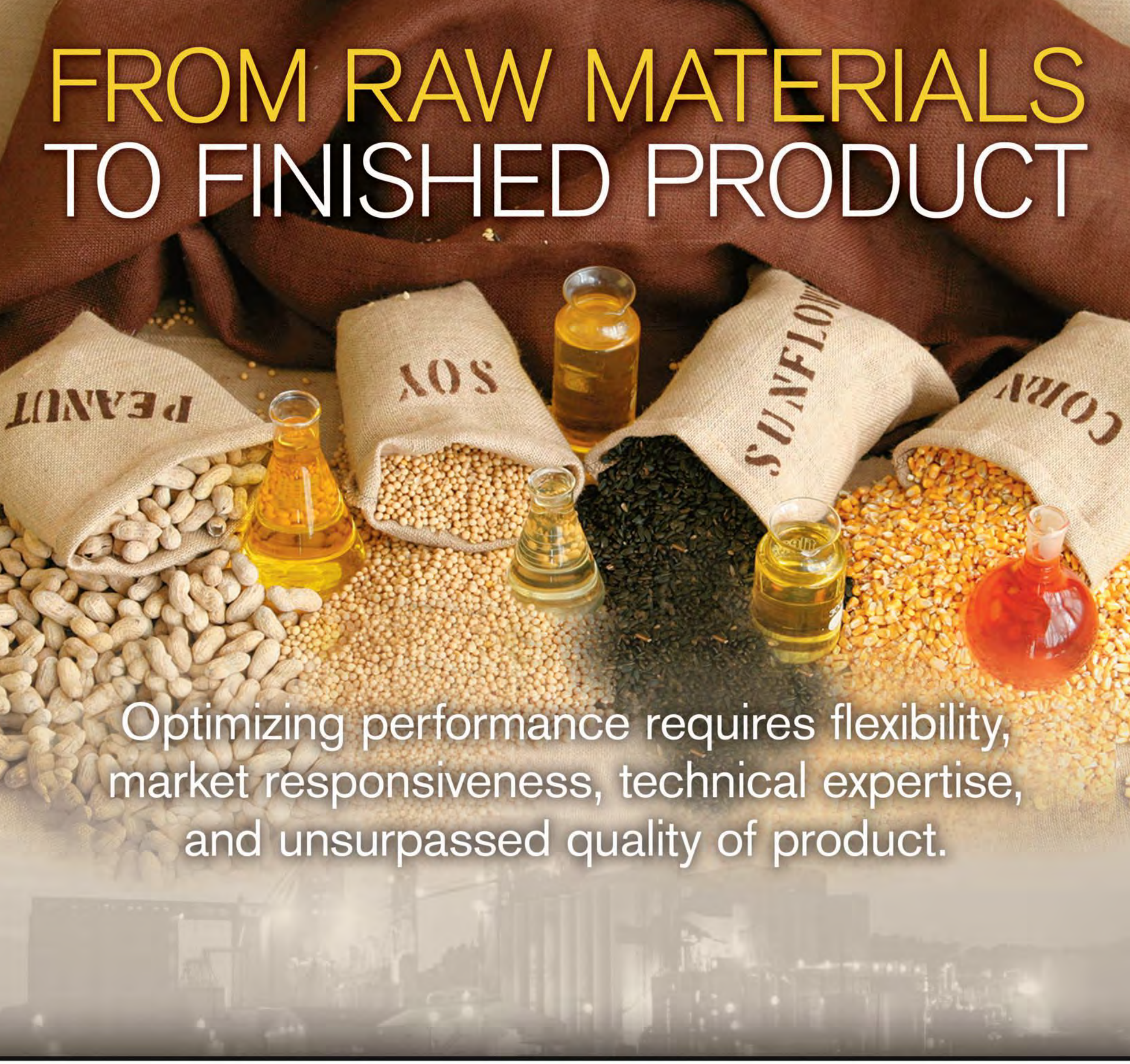
Let us share with you the benefits of becoming ***Your Partner in Processing.***

CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001:2008 ANAB DNV

French Oil Mill Machinery Co.

Piqua, Ohio, U.S.A. · 937-773-3420

www.frenchoil.com/oilseed-equipment

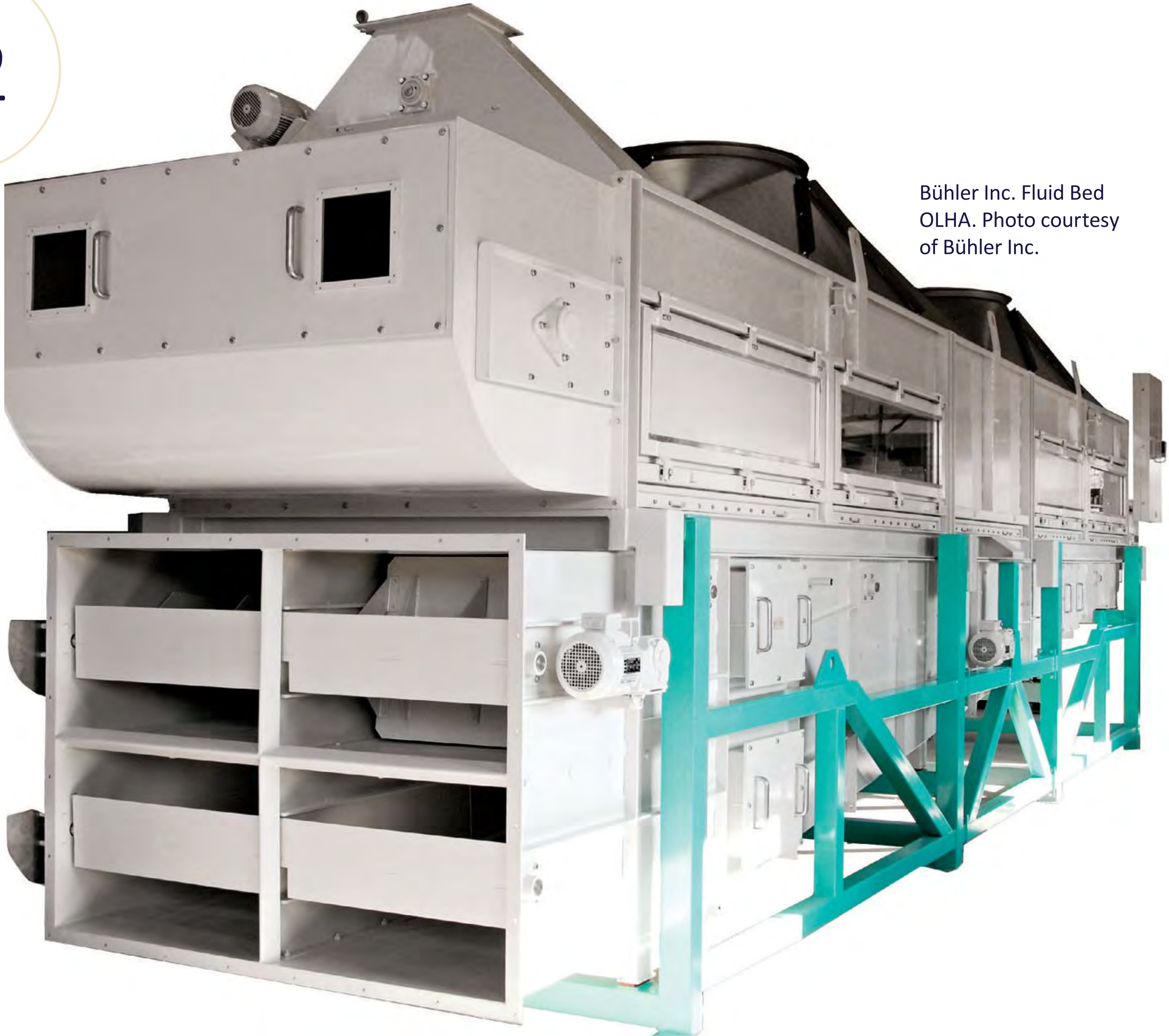

FROM RAW MATERIALS
TO FINISHED PRODUCT
Optimizing performance requires flexibility, market responsiveness, technical expertise, and unsurpassed quality of product.

October 2014

INFORM

International News on Fats, Oils, and Related Materials

SUPPLEMENT



Bühler Inc. Fluid Bed OLHA. Photo courtesy of Bühler Inc.

UNDERSTANDING the art of SOYBEAN PROCESSING: DEHULLING

Frank Boling

Operating a successful production process must include identification and management of the range of variables that are inherent in all forms of work. Processing soybeans—or any oilseed, for that matter—is a job rife with variable conditions.

The following is a list of some of the factors that can affect soybeans as presented to the plant receiving operation:

- Whole bean oil and protein content
- Geographical location of farm
- Weather conditions during crop season
- Weed and insect control methodology
- Harvest practices
- Harvest conditions
- Onsite storage history
- Transportation methods

The product attributes presented here are normally out of the range of control of the processing plant and cannot be changed. However, they should be recognized and compensated for by the processing techniques used at the plant.

As a matter of necessity, many large processing facilities receive soybeans from a wide geographical crop production area. They may or may not have the luxury of being able to segregate these receipts based on bean conditions.

Almost all modern plants produce high protein (47–50%) soy meal. Assuming good oil extraction, effective hull removal becomes the pivotal operation that affects the final commercial analysis. Some of the in-plant processing variables that affect good hull removal are:

- History of the stock to be processed (bean moisture, bean size, hull, and protein content)
- Type and state of repair of in-plant conveying systems
- Type of preparation system (conventional, hot, or warm dehulling)
- Specific size and corrugation of cracking mills
- Specific size and type of hull separation equipment
- Flaker size and state of repair
- Operator experience
- Operator supervision
- Expanders, if used in the process
- Expander repair status
- Drying/conveying after expanders
- Extractor feed conveying
- Plant-specific equipment control technology
- Scheduled plant downtime
- Unscheduled plant downtime
- Merchandizing quotas

DEALING WITH THE VARIABLES

The oil and protein content of whole soybeans received in-plant are variables that cannot be changed in the process. These values are dependent on the variety of the seed, moisture, and the amount of sunlight available during the growing season. However, in large plants today, beans with lower protein or oil content may be slowly blended with standard-quality beans so that the resulting meal and quantity of oil produced is not severely impacted by the deficiencies.

The geographic location of the soybean's origin certainly influences the above-mentioned variables. It also becomes an important factor when the growing area is sandy. In fact, processing whole soybeans, which are extremely abrasive themselves, becomes almost unmanageable when quantities of fine silica sand are present.

Maintenance on material-handling as well as the process equipment must be accelerated when this condition exists and is not minimized. Most processors that experience sandy conditions have gone to great lengths to remove the sand before presenting the beans for processing. Unfortunately, maintenance is high on the cleaning equipment but with the available abrasion-resistant materials, wear and tear can be controlled.

Good cleaning should remove all the sand, dirt, loose hulls, fiber, and other trash. The removed fiber can be separated from other contaminants and either be blended back into the finished meal or added to the processed hull stream of the mill run.

DEHULLING SYSTEMS

With very few exceptions, modern plant prep rooms fall into three general categories based primarily on the type of dehulling system employed: conventional, hot, or warm.

CONTINUED ON NEXT PAGE

- **Dehulling is an important step in processing oilseeds in general and soybeans in particular.**
- **All types of dehulling equipment attempt to remove as many hulls as possible, to reduce the moisture content to 10% or less, and to present conditioned soybean meats to the flaking mills at between 140°F and 160°F.**
- **Warm dehulling equipment represents more than one-half of all soybean dehulling systems being sold internationally today and virtually 100% of the systems being installed in China and Brazil.**

To better understand the mechanics of dehulling, we need to understand that the soybean is made up of three components. First is the very hard, dense hull that forms an armor-like, sealed barrier around the bean. Next is a layer of natural glue that causes the hull to stick to the bean meat. Finally, there is the meat itself. Defeating this system that nature has provided to protect the bean seed is the object of dehulling.

Conventional dehulling. The older system known as "conventional dehulling" is no longer being installed in new facilities because it cannot compete in operating cost with hot and warm dehulling. It has been in service in some form since high-protein meal began being produced in the late 1960s.

Conventional dehulling begins with effective thermal treatment of the beans, reducing the storage moisture from around 14% to 10%. Some of the smaller facilities accomplish this with the receiving drier. Others have a dedicated process bean drier. In either case, due to the inefficiencies of this type of moisture reduction, it is necessary to hold the dried beans for up to 72 hours to allow temperature and moisture equalization.

Experience has shown that even in very dry growing seasons when low-moisture beans are received at the plant, this thermal input to the beans is necessary for adequate hull release from the meat of the bean. Studies have determined that the tight bond between hull and meat must be broken by rapidly driving moisture inside to outside through the hull. Failure to do this will cause small pieces of hull to remain stuck to the meats even after passing through the cracking mills, thus allowing higher fiber in the finished meal.

Several other variables have caused problems with effective hull removal. Beans that are harvested too early are difficult to process. The hulls are hard to remove and even with normal drying, the meat remains soft. These beans will not crack properly and are merely squashed by the corrugated rolls. If possible, this type of bean should be isolated in storage and blended back with normal beans at a slow rate.

Hot dehulling. One example of hot dehulling is the fluid-bed system, introduced into the industry in the early 1980s in an attempt to reduce the thermal energy of a conventional system and improve the quality of hull removal. In this scheme, pre-cleaned beans at storage moisture of about 14% or less are fed into a large rectangular vessel that is heavily aerated from the bottom, causing the volume of beans up to 48 inches deep to act as a fluid mass. Inside the bed are steam-heated pipes strategically spaced to allow continuous flow from inlet to outlet and to provide very efficient heat transfer to the beans. Typical residence time in this vessel is four to six minutes.

With this high mass transfer rate, moisture more or less explodes from the beans, effectively breaking the hull-to-meat bond. Specially corrugated high-speed cracking rolls reduce the hot beans (180°F or 82°C) to a size the flaking mills will accept. Impact mills assure a good release of any hulls remaining stuck to the meats and then multi-aspirators

This Crown Jet Dryer (Model 3051) has a rotary feeder on the right and the main drive and discharge on the left. Photo courtesy of Crown Iron Works Co.

separate meats from hulls in a two-step system. Cracked beans arrive at the flaking mills at a controllable temperature between 140°F and 160°F in a softened, conditioned state with about 10% moisture.

State-of-the-art hot dehulling. A different approach to the hot dehulling prep room was introduced to the soybean processing industry in the 1990s. It employs a two-step heating system for preparing the feed material for solvent extraction.

The first step of this process utilizes a vertical bin appropriately sized to give the feed material adequate hold-up time to reach about 140°F by employing internal heating media. In some plants, the thermal input is furnished by low-pressure steam. Material continuously passes through this preheater so that at the exit, the internal bean moisture has been driven to the surface and begins to loosen the hulls. The flow is then elevated and distributed to separate lines of vertically arranged equipment.

The next principal heating unit employs an enclosed vessel with a woven metal mesh belt and high-velocity air jets fixed between the upper and lower runs of the continuous belt. These jets blow high-temperature air under the passing thin bed of beans, causing partial fluidization. The rapid temperature shock causes the hulls to loosen from the bean meats and reduces the moisture.

After spouting from the belt drier, the beans go to a proprietary roller mill that treats the beans between two sets of rolls and loosens the hulls. From this operation, the beans are fed to a specially designed counter-current cascade aspirating drier fitted with heating tubes. These units remove a large volume of hulls.

After this step, a conventional two-high cracking mill reduces the whole beans to a particle-size distribution suitable to feed the flaking mills. An aspirating cascade conditioner removes the last bit of hulls remaining in the stream and at the same time the temperature of the cracked beans is reduced to 140°F. The exhaust air from the belt driers is cleaned by high-efficiency cyclones, after which high-moisture air is exhausted to the atmosphere and a portion is recycled back to the belt drier through an air heater.

The air from the heated cascade driers is cleaned by cyclones and part is exhausted to the atmosphere and part is recycled back to the unit. Some make-up air is introduced to the cleaned recycled air via an air heater. Air from the cascade conditioners is also partially exhausted to the atmosphere and the rest is recycled. This system is also equipped to draw in make-up air.

The belt-type hot dehulling system offers good thermal economy, especially when compared to a conventional head-end dehulling prep room. Many of the variables are reduced and future expansion of the system is possible by adding another line of equipment. It may also be fitted with automated controls for excellent management of the flakes going to the solvent extraction plant.

Warm dehulling. Another category of dehulling that is growing in importance is warm dehulling. This system, which

CONTINUED ON NEXT PAGE

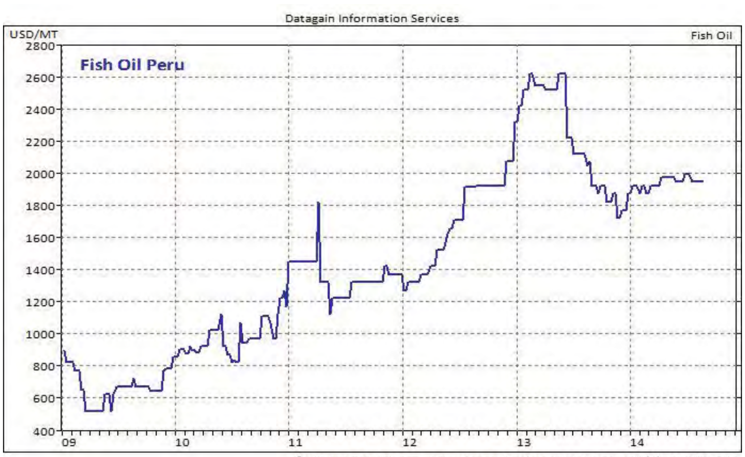
STATISTICAL ANALYSIS FROM MINTEC

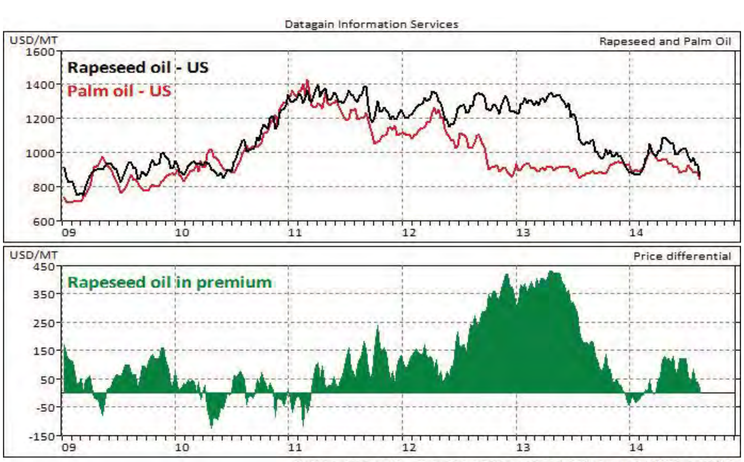
Yuliya Nam-Wright

In 2013, a sharp reduction in the size of the fish quota from the top producer, Peru, tightened global supply and caused fish oil prices to reach record-high levels in the first half of 2013. Since then, the quotas were increased and production rebounded, causing prices to fall throughout 2013. Since the beginning of 2014, ongoing speculation of a strong El Niño event later in the year has driven fish oil prices up by 5%. Poor catches of anchoveta and Jack mackerel have been reported so far in 2014 due to warmer sea temperatures off the coast of South America.

Global production of fish meal, of which fish oil is a by-product, is estimated to increase only marginally to 2.4 MMT during the period from April to September 2014, as recovering production in Chile was offset by the shortfall in Peruvian production. Production of fish oil is set to decline as latest reports from Peru indicate falling oil yields that are typically associated with an El Niño event.

Rapeseed (canola) oil prices fell sharply in throughout July and August, weighed down by good global supply. Global rapeseed production in 2014/15 is forecast at 70.4 MMTs, down 1% year-on-year following the record production in 2013/14. Although there is higher production from the European Union and Russia (up 7% and 8% year-on-year, respectively), a fall in production from Canada outweighed the increase from these regions. This significant fall in rapeseed oil prices reduced rapeseed oil's premium over palm oil. Palm oil prices were more resilient to downward pressure due to concerns about dry weather in Malaysia, the world's second largest producer of palm oil.





Mintec Limited Mintec is the principal independent source of global pricing information for commodities and raw materials. Mintec has a suite of unique procurement tools and training courses designed to assist supply chain professionals in their daily tasks of reporting, analyzing, and interpreting market information. Mintec supports sales and purchasing professionals in their commodity decisions, by improving efficiency, minimizing commodity risk and ultimately gaining a commercial advantage. Mintec Ltd., 9 The Courtyard, Glory Park, Wooburn Green, High Wycombe, Buckinghamshire HP10 0DG, United Kingdom; Tel: +44 (0)1628 851313; Fax: +44 (0)1628 851321; Email: support@mintec.ltd.uk; Web: www.mintecglobal.com

was developed in the late 1990s, is used mainly by facilities that process imported soybeans. Imported soybeans are two to three months past harvest and thus have been tempered during shipment. Therefore, they will allow for easier and more complete dehulling than recently harvested soybeans. This dehulling method provides cost savings, both in terms of capital expense and energy.

Warm dehulling systems represent over half of all soybean dehulling systems being sold today, according Crown Iron Works Co. (Minneapolis, Minnesota, USA). Virtually all soybean dehulling systems in China and Brazil use warm dehulling. In most cases, the modular design of dehulling equipment will allow facilities to upgrade to a hot dehulling system in the future if dehulling needs change.

Where soybean conditions or markets allow less aggressive hull removal, warm dehulling offers processing advantages over other forms of soybean preparation, said Bill Morphew, product sales manager at Crown.

"Going forward, we are going to need a lot more flexibility in what we process and how we process it," he noted. "Warm dehulling is one more tool that producers should be aware of as a great intermediate solution."

Each of the above systems has pros and cons in the areas of efficiency, maintenance, and capital investment. Each system is capable of reducing the variables and more or less standardizing the feed material, greatly enhancing the ease of oil extraction.

SUMMARY

All dehulling systems in use today are effective in producing prepared material that will yield market-standard oil and protein. In the last 30 years, the industry has almost completely embraced hot dehulling in one form or another as the new standard for use with freshly harvested soybeans or beans with low protein content.

Each of these prep methods has its list of pros and cons. However, ever-escalating energy and labor costs have led oilseed plants to invest in the more efficient and controllable hot and warm dehulling equipment available. It will be interesting to see how the next decades of market demands and processing costs impact the technology as processors move more and more into what can best be termed mega-plant production.

Frank Boling retired from H. Hunt Moore & Assoc., Inc. in 2009, and can be reached at oeulmuelle@aol.com.

BOOK REVIEW

Conjugated Linoleic Acids and Conjugated Vegetable Oils

Edited by Bert Seels and An Philippaerts
RSC Publishing
http://pubs.rsc.org/
ISBN 978-1-84973-900-9. 247 pages.
Hardback. £145

Reviewed by Andrew Proctor

Conjugated Linoleic Acids and Conjugated Vegetable Oils is a short book (247 pages) reviewing the bio-production, catalytic production, animal feed uses, human nutrition, industrial uses, and chromatographic analysis of conjugated linoleic acid (CLA). The material is generally well-presented, but there is no detailed information on important areas such as CLA lipid oxidation chemistry or food science and cosmetic science applications.

The opening chapters describe CLA biosynthesis in ruminants and humans, followed by CLA's use in animal feed and its human health benefits. These chapters are well presented. They are followed by a short chapter on commercial production and use of CLA that focuses on the production of non-food materials and drying oils. The subsequent two chapters, "Microbial and enzymatic CLA production" and "CLA production by metal catalysis," are good summaries of the current knowledge. The final chapter on CLA and other fatty acid analysis provides an excellent review of chromatographic separation, analysis, and practices, with mentions of ultraviolet, infrared, and mass spectroscopy detection. An additional chapter dedicated to spectroscopy would have been appropriate. For example, the use of Diels Alder derivitization to determine CLA positional isomerism by MS and FTIR/chemometric quantification would have been informative.

Nevertheless, *Conjugated Linoleic Acids and Conjugated Vegetable Oils* is a reasonable first edition and introduction to the topic. However, CLA production, technology, analysis, and applications is a broad and rapidly developing multidisciplinary arena. Therefore, a larger and more comprehensive second edition should be anticipated. This may include sections containing multiple chapters on CLA production and engineering; CLA in animal production; CLA lipid analysis and characterization; CLA reactivity and industrial materials; CLA oxidation and stabilization; CLA nutrition and human health; CLA in food systems, nutraceuticals, and food product development; and CLA in cosmetics and personal care products.

Andrew Proctor is a University Professor of Food Science at the University of Arkansas where he conducts basic and applied lipid science research. He is an AOCS Fellow, Fellow of the Royal Society of Chemistry and can be contacted at aproctor@uark.edu.

EXTRACTS & DISTILLATES

Discriminating eggs from different poultry species by fatty acids and volatiles profiling: Comparison of SPME-GC/MS, electronic nose, and principal component analysis method

Wang, Q., *et al.*, *Eur. J. Lipid Sci.Technol. 116*: 1044–1053, 2014, http://dx.doi: 10.1002/ejlt.201400016.

Fatty acid profiles and volatile composition in the yolks of conventional eggs from seven different species (duck, free-range chicken, silky chicken, quail, pigeon, goose, and chicken) were compared using GC–MS and electronic nose (E-nose). The results showed that there were significant differences among the fatty acid profiles of the seven avian eggs. Goose eggs contained the highest contents of saturated and monounsaturated fatty acids but the lowest content of polyunsaturated fatty acids (PUFA), and the differences were significant ($p<0.05$). The PUFA proportion was the highest in the free-range chicken eggs of all the tested avian eggs. The ω-3 PUFA content and the ω-6/ω-3 ratio were significantly ($p<0.05$) higher in the yolks of goose and silky chicken. The volatile compositions of egg yolks are esters, alcohols, alkenes, and nitrogenous compounds, and the major compounds that contributed to discrimination of different species of eggs were ethyl acetate, pathalic acid butyl isohexyl ester, *O*-methylisourea hydrogen sulfate, 1-butanol, and *N*-isopropylbenzamide. In addition, seven different species of eggs were distinguished from each other through principal component analysis of E-nose data, suggesting that the E-nose may be a potential technology for discriminating different species of eggs.

Identification and phytotoxicity of a new glucosinolate breakdown product from meadowfoam (*Limnanthes alba*) seed meal

Intanon, S., *et al.*, *J. Agric. Food Chem.* 62: 7423–7429, 2014, http://dx.doi: 10.1021/jf5018687.

Meadowfoam (*Limnanthes alba* Hartw. ex Benth.) is an oilseed crop grown in the Willamette Valley of Oregon. Meadowfoam seed meal (MSM), a byproduct after oil extraction, contains 2–4% glucosinolate (glucolimnanthin). Activated MSM, produced by adding freshly ground myrosinase-active meadowfoam seeds to MSM, facilitates myrosinase-mediated formation of glucosinolate-derived degradation products with herbicidal activity. In the activated MSM, glucolimnanthin was converted into 3-methoxybenzyl isothiocyanate (“isothiocyanate”) within 24 h and was degraded by day three. 3-Methoxyphenylacetonitrile (“nitrile”) persisted for at least 6 days. Methoxyphenylacetic acid (MPAA), a previously unknown metabolite of glucolimnanthin, appeared at day three. Its identity was confirmed by LC-UV and high resolution LC-MS/MS comparisons with a standard of MPAA. Isothiocyanate inhibited lettuce germination 8.5- and 14.4-fold more effectively than MPAA and nitrile, respectively. Activated MSM inhibited lettuce germination by 58% and growth by 72% compared with the control. Results of the study suggest that MSM has potential uses as a pre-emergence bioherbicide.

Laboratory-scale optimization of olive oil extraction: Simultaneous addition of enzymes and microtalc improves the yield

Peres, R., *et al.*, *Eur. J. Lipid Sci.Technol. 116*: 1054–1062, 2014, http://dx.doi: 10.1002/ejlt.201400060.

The aim of this work was to optimize olive oil extraction, at laboratory-scale (Abencor system), from fruits of “Cobrançosa” and “Galega Vulgar” Portuguese cultivars, either in the absence or in the presence of enzymes and natural microtalc. Using a Placket–Burman design to select significant variables followed by a central composite rotatable design (CCRD), Abencor operation conditions were optimized: no water addition in 30 min malaxation and 14% w/w water addition at 50°C in centrifugation. The combined effects of the concentrations of natural microtalc (MT: 0.04–0.46 w-%) and enzyme preparation (E: 0.003–0.117 w-%) added at the beginning of malaxation, on quality criteria, total phenols and chlorophyll pigments concentrations, and on oil extraction yield, were investigated using a CCRD. The results showed that the addition of both an enzyme preparation and natural microtalc could enhance olive oil yield (up to 34% for 0.4–0.5% of microtalc and 0.1% of enzymes for “Galega Vulgar”) without any effect on quality of the obtained virgin olive oil.

Vitamin A is rapidly degraded in retinyl palmitate-fortified soybean oil stored under household conditions

Pignitter, M., *et al.* , *J. Agric. Food Chem. 62* : 7559–7566, 2014, http://dx.doi: 10.1021/jf502109j.

Oil fortification with retinyl palmitate is intended to lower the prevalence of vitamin A deficiency in populations at risk. Although the stability of vitamin A in vegetable oil has been shown to depend on environmental factors, very little information is known about the stability of vitamin A in preoxidized vegetable oils. The present study investigated the stability of retinyl palmitate in mildly oxidized (peroxide value < 2 mequiv O_2/kg) and highly oxidized (peroxide value > 10 mequiv O_2/kg) soybean oil stored under domestic and retail conditions. Soybean oil was filled in transparent bottles, which were exposed to cold fluorescent light at 22 or 32 °C for 56 days. Periodic oil sampling increased the headspace, thereby mimicking consumer handling. Loss of retinyl palmitate in soybean oil by a maximum of 84.8 ± 5.76% was accompanied by a decrease of vitamin E by 53.3 ± 0.87% and by an increase of the peroxide value from 1.20 ± 0.004 to 24.3 ± 0.02 mequiv O_2/kg. Fortification of highly oxidized oil with 31.6 IU/g retinyl palmitate led to a doubling of the average decrease of retinol per day compared to fortification of mildly oxidized oil. In conclusion, oil fortification programs need to consider the oxidative status of the oil used for retinyl palmitate fortification.

Consumer attitudes and understanding of cholesterol-lowering claims on food: randomize mock-package experiments with plant sterol and oat fiber claims

Wong, C.L., *et al.*, *Eur. J. Clin. Nutr. 68*: 946–952; 2014, http://dx.doi: 10.1038/ejcn.2014.107.

Few studies have examined consumer acceptability or comprehension of cholesterol-lowering claims on food labels. Our objective was to assess consumer attitudes and understanding of cholesterol-lowering claims regarding plant sterols (PS) and oat fiber (OF). We conducted two studies on: (1) PS claims and (2) OF claims. Both studies involved a randomized mock-packaged experiment within an online survey administered to Canadian consumers. In the PS study (*n*=721), we tested three PS-related claims (disease risk reduction claim, function claim and nutrient content claim) and a 'tastes great' claim (control) on identical margarine containers. Similarly, in the OF study (*n*=710), we tested three claims related to OF and a "taste great" claim on identical cereal boxes. In both studies, participants answered the same set of questions on attitudes and understanding of claims after seeing each mock package. All claims that mentioned either PS or OF resulted in more positive attitudes than the taste control claim (P<0.0001), despite all products within each study having the same nutrition profile. How consumers responded to the nutrition claims between the two studies was influenced by contextual factors such as familiarity with the functional food/component and the food product that carried the claim. Permitted nutrition claims are approved based on physiological evidence and are allowed on any food product as long as it meets the associated nutrient criteria. However, it is difficult to generalize attitudes and understanding of claims when they are so highly dependent on contextual factors.

Replacing with whole grains and legumes reduces Lp-PLA2 activities in plasma and PBMCs in patients with prediabetes or T2D1

Kim, M., *et al.*, *J. Lipid Res.* 55: 1762–1771, 2014, http://dx.doi: 10.1194/jlr.M044834.

To determine dietary effects on circulating lipoprotein-associated phospholipase A_2 (Lp-PLA$_2$) activity and enzyme activity in peripheral blood mononuclear cells (PBMCs), 99 patients with impaired fasting glucose, impaired glucose tolerance, or newly-diagnosed T2D were randomly assigned to either a control group (usual diet with refined rice) or the whole grain and legume group. Substitution of whole grains and legumes for refined rice was associated with the replacement of 7% of energy from carbohydrates with energy from protein (about 4%) and fat. After 12 weeks, the whole grain and legume group showed a significant decrease in fasting glucose, insulin, homeostasis model assessment-insulin resistance, hemoglobin A_{1c}, malondialdehyde, plasma Lp-PLA$_2$ activity, and oxidized LDL (ox-LDL), and an increase in LDL particle size. The changes (Δs) in these variables in the whole grain and legume group were significantly different from those in controls after adjustment for the baseline levels. When all subjects were considered, Δ plasma Lp-PLA$_2$ positively correlated with Δ glucose, Δ PBMC Lp-PLA$_2$, Δ ox-LDL, and Δ urinary 8-epi-prostaglandin $F_{2\alpha}$ after being adjusted for confounding factors. The Δ PBMC Lp-PLA$_2$ correlated positively with Δ glucose and Δ ox-LDL, and negatively with Δ LDL particle size and baseline PBMC Lp-PLA$_2$. The substitution of whole grains and legumes for refined rice resulted in a reduction in Lp-PLA$_2$ activities in plasma and PBMCs partly through improved glycemic control, increased consumption of protein relative to carbohydrate, and reduced lipid peroxides.

Is low docosahexaenoic acid associated with disturbed rhythms and neurodevelopment in offsprings of diabetic mothers?

Zornoza-Moreno, M., *et al.*, *Eur. J. Clin. Nutr. 68*: 931–937, 2014, http://dx.doi: 10.1038/ejcn.2014.104.

The objective was to evaluate the relation between docosahexaenoic acid (DHA) status and neurodevelopment in the offsprings of gestational diabetic mothers (ODMs). A prospective cohort study was performed. The offspring of 63 pregnant women (23 controls, 21 diet-controlled gestational diabetes mellitus (GDM) and 19 insulin-treated GDM) were recruited. Maternal and venous cord plasma DHA percentages were analyzed. Skin temperature and activity in children were recorded for 72 h at 3 and 6 months of life. Neurodevelopment was assessed using the Bayley Scale of Infant Development II (BSID II) at 6 and 12 months of age.

CONTINUED ON NEXT PAGE

Cord plasma DHA percentage was significantly lower in the ODMs compared with that in the controls (Control 6.43 [5.04–7.82][a]; GDM+diet 5.65 [4.44–6.86][ab]; GDM+insulin 5.53 [4.45–6.61][b]). Both mental (Control 102.71 [97.61–107.81][a]; GDM+diet 100.39 [91.43–109.35][a]; GDM+insulin 93.94 [88.31–99.57][b]) and psychomotor (Control 91.52 [81.82–101.22][a]; GDM+diet 81.67 [73.95–89.39][b]; GDM+insulin 81.89 [71.96–91.85][b]) scores evaluated by the BSID II were significantly lower at 6 months in ODMs, even after adjusting for confounding factors such as breastfeeding, maternal educational level and gender. Cord plasma DHA percentage correlated with the psychomotor score from BSID II (r=0.27; P=0.049) and with the intra-daily variability in activity (r=−0.24; P=0.043) at 6 months. Maternal DHA was correlated with several sleep rhythm maturation parameters at 6 months. Lower DHA levels in cord plasma of ODMs could affect their neurodevelopment. Maternal DHA status was also associated with higher values in the sleep rhythm maturation parameters of children.

High-throughput analysis of lipid hydroperoxides in edible oils and fats using the fluorescent reagent diphenyl-1-pyrenylphosphine

Santas, J., *et al.*, *Food Chem.* *162*: 235–241, 2014, http://dx.doi: 10.1016/j.foodchem.2014.04.059.

A fluorometric method for the determination of hydroperoxides (HP) in edible oils and fats using the reagent dipheny1-1-pyrenylphosphine (DPPP) was developed and validated. Two solvent media containing 100% butanol or a mixture of chloroform/methanol (2:1, v/v) can be used to solubilise lipid samples. Regardless of the solvent used to solubilise the sample, the DPPP method was precise, accurate, sensitive and easy to perform. The HP content of 43 oil and fat samples was determined and the results were compared with those obtained by means of the AOCS Official Method for the determination of peroxide value (PV) and the ferrous oxidation-xylenol orange (FOX) method. The proposed method not only correlates well with the PV and FOX methods, but also presents some advantages such as requiring low sample and solvent amounts and being suitable for high-throughput sample analysis.

Isotope-labeling studies on the formation pathway of acrolein during heat processing of oils

Ewert, A., *et al.*, *J. Agric. Food Chem.* 62: 8524–8529, 2014, http://dx.doi: 10.1021/jf501527u.

Acrolein (2-propenal) is classified as a foodborne toxicant and was shown to be present in significant amounts in heated edible oils. Up to now, its formation was mainly suggested to be from the glycerol part of triacylglycerides, although a clear influence of the unsaturation of the fatty acid moiety was also obvious in previous studies. To unequivocally clarify the role of the glycerol and the fatty acid parts in acrolein formation, two series of labeled triacylglycerides were synthesized: [$^{13}C_3$]-triacylglycerides of stearic, oleic, linoleic, and linolenic acid and [$^{13}C_{54}$]-triacylglycerides with labeled stearic, oleic, and linoleic acid, but with unlabeled glycerol. Heating of each of the seven intermediates singly in silicon oil and measurement of the formed amounts of labeled and unlabeled acrolein clearly proved the fatty acid backbone as the key precursor structure. Enzymatically synthesized pure linoleic acid and linolenic acid hydroperoxides were shown to be the key intermediates in acrolein formation, thus allowing the discussion of a radical-induced reaction pathway leading to the formation of the aldehyde. Surprisingly, although several oils contained high amounts of acrolein after heating, deep-fried foods themselves, such as donuts or French fries, were low in the aldehyde.

Lipases in wheat breadmaking: analysis and functional effects of lipid reaction products

Schaffarczyk, M., *et al.*, *J. Agric. Food Chem.* *62*: 8229–8237, 2014, http://dx.doi: 10.1021/jf5022434.

The baking activity of two different lipases was evaluated by a microbaking test on a 10 g flour basis, and the altered lipid composition of lipase-treated wheat lipids was quantitated. To identify and quantitate the various lipid classes, pure glycolipids and phospholipids were isolated from a wheat flour lipid extract by a silica gel batch procedure and silica gel column chromatography. These reference compounds were used to establish a high-performance liquid chromatographic method with evaporative light scattering detection, which was able to separate all of the wheat lipid classes and lipase reaction products. Wheat lipids, dough lipids, and dough lipids after lipase addition were quantitated using cholesterol as an internal standard. Especially digalactosyl diglycerides (−0.9 mmol/kg flour), monogalactosyl diglycerides (−0.4 mmol/kg), and *N*-acyl-phosphatidyl ethanolamine (−0.3 mmol/kg) were hydrolyzed, and a concomitant formation of digalactosyl monoglycerides (+0.6 mmol/kg), monogalactosyl monoglycerides (+0.6 mmol/kg), and *N*-acyl-lysophosphatidyl ethanolamine (+0.5 mmol/kg) was found. The lipase-induced changes of the lipid fraction caused increases in bread volume of 56–58%, depending on the type and concentration of the added lipase. The current results confirm the important relationship between the lipid fraction composition and the baking performance of flour.

Controlled release properties of Zein–fatty acid blend films for multiple bioactive compounds

Arcan, I. and A. Yemenicioğlu, *J. Agric. Food Chem.* *62*: 8238–8246, 2014, http://dx.doi: 10.1021/jf500666w.

To develop edible films having controlled release properties for multiple bioactive compounds, hydrophobicity and morphology of zein films were modified by blending zein with oleic ($C_{18:1}$)Δ^9, linoleic ($C_{18:2}$)$\Delta^{9,12}$, or lauric (C_{12}) acids in the presence of lecithin. The blend zein films showed 2–8.5- and 1.6–2.9-fold lower initial release rates for the model active compounds, lysozyme (LYS) and (+)-catechin (CAT), than the zein control films, respectively. The change of fatty acid chain length affected both CAT and LYS release rates while the change of fatty acid double bond number affected only the CAT release rate. The film morphologies suggested that the blend films owe their controlled release properties mainly to the microspheres formed within their matrix and encapsulation of active compounds. The blend films showed antilisterial activity and antioxidant activity up to 81 μmol Trolox/cm^2. The controlled release of multiple bioactive compounds from a single film showed the possibility of combining application of active and bioactive packaging technologies and improving not only safety and quality but also health benefits of packed food.

Comparison of the volatiles formed by oxidation of phosphatidylcholine to triglyceride in model systems

Zhou, L., *et al., J. Agric. Food Chem. 62*: 8295–8301, 2014, http://dx.doi: 10.1021/jf501934w.

The oxidative stability of oleoyl and linoleoyl residues esterified in the form of triglyceride (TAG) and phosphatidylcholine (PC) during thermal treatment was investigated. Headspace solid-phase microextraction (HS-SPME) followed by gas chromatography–mass spectrometry (GC–MS) analysis was used to determine the volatile compounds from oxidized PL and TAG molecular species. The results showed that aldehydes were the major volatile oxidized compounds (VOCs) of 1-stearoyl-2-oleoyl-*sn*-glycero-3-phosphocholine (SOPC), 1-stearoyl-2-linoleoyl-*sn*-glycero-3-phosphocholine (SLPC), and 1,3-distearoyl-2-linoleoyl-glycerol (SLS), while ketones, especially saturated methyl ketones, were the major VOCs of 1,3-distearoyl-2-oleoyl-glycerol (SOS). The monitoring of the oxidative degradation using liquid chromatography–electrospray ionization–mass spectrometry (LC–ESI–MS) showed that either monounsaturated or diunsaturated fatty acyl groups were less oxidized when in the form of PCs than when in the form of TAGs. This finding demonstrated that the choline group in the form of PCs could increase the stability of fatty acyl groups to oxidation in comparison to TAGs.

How lipidomics provides new insight into drug discovery

Lamaziere, A., *et al., Expert Opinion On Drug Discovery 9*: 819–836, 2014, http://dx.doi: 10.1517/17460441.2014.914026.

Automated lipidomic methods based on mass spectrometry (MS) are now proposed to screen a large variety of candidate drugs available that inhibit de novo lipid synthesis and replace tedious methods based on radiotracer incorporation. A major new interest in inhibitors of *de novo* lipogenesis is their proapoptotic effect observed in cancerous cells. Areas covered: In this review, the authors focus on the screening methods of antilipogenic inhibitors targeting the synthesis of malonylCoA (carbonic anhydrase, acetylCoA carboxylase), palmitylCoA (fatty acid synthase condensing and thioesterase subunits) and monounsaturated fatty acids (D9-desaturase). The consequences of inhibition depend on how the pathway deviates above the blockade: accelerated mitochondrial fatty acid oxidation following the decreased malonylCoA level, accumulation of ketone bodies and increased cholesterol synthesis following the increased acetylCoA level. Side effects such as anorexia and skin defects may critically decrease therapeutic indices in the long term. The authors emphasize the need for assessment of toxicity in short-term treatments inducing proapoptotic effects observed in aggressive hormone-dependent malignancies. Expert opinion: The activity of lipogenesis inhibitors can be recognised in lipid profiles established by a combination of MS-based measurements and multivariate analysis processing hundreds of lipid molecular species. Because the method can be automated, it is suitable for screening large chemical libraries, with particular focus on anticancer activities.

Enzymatic hydrolysis of steryl glycosides for their analysis in foods

Munger, L.H. and L. Nystrom, *Food Chem. 163*: 202–211, 2014, http://dx.doi: 10.1016/j.foodchem.2014.04.082.

Steryl glycosides (SG) contribute significantly to the total intake of phytosterols. The standard analytical procedure involving acid hydrolysis fails to reflect the correct sterol profile of SG due to isomerization of some of the labile sterols. Therefore, various glycosylases were evaluated for their ability to hydrolyse SG under milder conditions. Using a pure SG mixture in aqueous solution, the highest glycolytic activity, as demonstrated by the decrease in SG and increase in free sterols was achieved using inulinase preparations (decrease of >95%). High glycolytic activity was also demonstrated using hemicellulase (63%). The applicability of enzymatic hydrolysis using inulinase preparations was further verified on SG extracted from foods. For example in potato peel Δ(5)-avenasteryl glucoside, a labile SG, was well preserved and contributed 26.9% of the total SG. Therefore, enzymatic hydrolysis is suitable for replacing acid hydrolysis of SG in food lipid extracts to accurately determine the sterol profile of SG.

Production of structured triacylglycerols from microalgae

Rezanka, T., *et al., Phytochemistry 104*: 95–104, 2014, http://dx.doi: 10.1016/j.phytochem.2014.04.013.

Structured triacylglycerols (TAGS) were isolated from nine cultivated strains of microalgae belonging to different taxonomic groups, i.e. *Audouinella eugena*, *Balbiania investiens*, *Myrmecia bisecta*, *Nannochloropsis limnetica*, *Palmodictyon varium*, *Phaeodactylum tricornutum*, Pseudochantransia sp., *Thorea ramosissima*, and *Trachydiscus minutus*. They were separated and isolated by

CONTINUED ON NEXT PAGE

means of NARP-LC/MS-APCI and chiral LC and the positional isomers and enantiomers of TAGs with two polyunsaturated, i.e. arachidonic (A) and eicosapentaenoic (E) acids and one saturated, i.e. palmitic acid (P) were identified. Algae that produce eicosapentaenoic acid were found to biosynthesize more asymmetrical TAGs, i.e. PPE or PEE, whereas algae which produced arachidonic acid give rise to symmetrical TAGs, i.e. PAP or APA, irrespective of their taxonomical classification. Nitrogen and phosphorus starvation consistently reversed the ratio of asymmetrical and symmetrical TAGs.

Phosphoinositides: minor lipids make a major impact on photoreceptor cell functions

Rajala, R.V.S., *et al.*, *Scientific Reports 4*: 5463, 2014, http://dx.doi: 10.1038/srep05463.

Activation of the phosphoinositide (PI) cycle generates the second messengers that control various aspects of cellular signaling. We have previously shown that two PI cycle enzymes, type II phosphatidylinositol 5-phosphate 4-kinase (PIPK II alpha) and phosphoinositide 3-kinase (PI3K), are activated through light stimulation. In our earlier studies, we measured enzyme activities, instead of directly measuring the products, due to lack of sensitive analytical techniques. Cells have very low levels of PIs, compared to other lipids, so special techniques and sensitive analytical instruments are necessary for their identification and quantification. There are also other considerations, such as different responses in different cell types, which may complicate quantification of PIs. For example, although light activated PIPK IIa, there was no increase in PI-4,5-P2 measured by liquid chromatography-mass spectrometry (LC/MS) This discrepancy is due to the heterogeneous nature of the retina, which is composed of various cell types. In this study, we examined PI generation in situ using immunohistochemistry with specific PI antibodies. PIs were generated in specific retinal cell layers, suggesting that analyzing PIs from the total retina by LC/MS underscores the significance. This suggests that PI-specific antibodies are useful tools to study the cell-specific regulation of PIs in the retina.

Conjugated linolenic acids and their bioactivities: a review

Yuan, G.F., *et al.*, *Food & Function* 5: 1360–1368, 2014, http://dx.doi: 10.1039/c4fo00037d.

Conjugated linolenic acid (CLNA) is a mixture of positional and geometric isomers of octadecatrienoic acid (α-linolenic acid, *cis*- 9,cis-12,*cis*-15–18:3 *n*-3) found in plant seeds. Three 8,10,12–18:3 isomers and four 9,11,13–18:3 isomers have been reported to occur naturally. CLNA isomers such as punicic acid, α-eleostearic acid and jacaric acid have been attributed to exhibit several health benefits that are largely based on animal and in vitro studies. This review has summarized and updated the evidence regarding the metabolism and bioactivities of CLNA isomers, and comprehensively discussed the recent studies on the effects of anti-carcinogenic, lipid metabolism regulation, anti-inflammatory, anti-obese and antioxidant activities of CLNA isomers. The available results may provide a potential application for CLNA isomers from natural sources, especially edible plant seeds, as effective functional food ingredients and dietary supplements for the above mentioned disease management. Further research, especially human randomized clinical trials, is warranted to investigate the detailed physiological effects, bioactivity and molecular mechanism of CLNA.

Analytical approaches for the assessment of free fatty acids in oils and fats

Mahesar, S.A., *et al.*, *Anal. Methods 6*: 4956–4963, 2014, http://dx.doi: 10.1039/c4ay00344f.

Free fatty acids (FFA) are produced by the hydrolysis of oils and fats. The level of FFA depends on time, temperature and moisture content because the oils and fats are exposed to various environments such as storage, processing, heating or frying. Since FFA are less stable than neutral oil, they are more prone to oxidation and to turning rancid. Thus, FFA is a key feature linked with the quality and commercial value of oils and fats. The American Oil Chemists' Society (AOCS), the Association of Official Analytical Chemists (AOAC) and the European Commission (EC) Regulations have established almost identical standard methods for the assessment of FFA. These methods are based on titration, where oils or fats need to be dissolved in hot neutralized ethanol or ethanol/diethyl ether using phenolphthalein as an end point indicator. Titrimetric procedures are, however, laborious and need large amounts of chemicals and solvents. The cost of chemicals and environmental issues further limit these procedures. In addition, accurate detection of end points, especially for highly colored crude oil using a colorimetric indicator, is a difficult task. Despite these disadvantages, the titration method is unfortunately still being used in most of the edible-oil industries for the determination of FFA. Because of a lack of any comprehensive review on this very important topic, we have made an attempt to present a review in order to discuss the various methods available with special emphasis on the instrumental methods because of their high sensitivity, accuracy and rapidity.

Hormones, polyamines, and cell wall metabolism during oil palm fruit mesocarp development and ripening

Teh , H. F., *et al.*, *J. Agric. Food Chem. 62*: 8143–8152, 2014, http://dx.doi: 10.1021/jf500975h.

Oil palm is one of the most productive oil-producing crops and can store up to 90% oil in its fruit mesocarp. Oil palm fruit is a sessile drupe consisting of a fleshy mesocarp from which palm oil is extracted. Biochemical changes in the mesocarp cell walls, polyamines, and hormones at different ripening stages of oil palm fruits were studied, and the relationship between the structural and the biochemical metabolism of oil palm fruits during ripening is discussed. Time-course analysis of the changes in expression of polyamines, hormones, and cell-wall-related genes and metabolites provided insights into the complex processes and interactions involved in fruit development. Overall, a strong reduction in auxin-responsive gene expression was observed from 18 to 22 weeks after pollination. High polyamine concentrations coincided with fruit enlargement during lipid accumulation and latter stages of maturation. The trend of abscisic acid (ABA) concentration was concordant with GA_4 but opposite to the GA_3 profile such that as ABA levels increase the resulting elevated ABA/GA_3 ratio clearly coincides with maturation. Polygalacturonase, expansin, and actin gene expressions were also observed to increase during fruit maturation. The identification of the master regulators of these coordinated processes may allow screening for oil palm variants with altered ripening profiles.

Production characterization and efficiency of biodiesel: a review

Mythili, R., *et al.*, *Int. J. Energy Res.* *38*: 1233–1259, 2014, http://dx.doi: 10.1002/er.3165.

Vegetable oil is one of the main first generation liquid biofuels. The fuel characteristics of vegetable oil such as viscosity and atomization cannot be accommodated by existing diesel engines. An alternate process has been developed to improve the fuel characteristics of vegetable oils through the process of alcoholysis to produce a fuel called biodiesel. It can be used in engines as substitute for fossil fuel. This paper reviews the characteristics of different oils available for biodiesel production and the production technologies, engine performance using vegetable oil and biodiesel, and emission studies.

Plant sterols from foods in inflammation and risk of cardiovascular disease: A real threat?

Alernany, L., *et al.*, *Food Chem. Toxicol.* *69*: 140–149, 2014, http://dx.doi: 10.1016/j.fct.2014.03.038.

High dietary intakes of cholesterol together with sedentary habits have been identified as major contributors to atherosclerosis. The latter has long been considered a cholesterol storage disease., however, today atherosclerosis is considered a more complex disease in which both innate and adaptive immune-inflammatory mechanisms as well as bacteria play a major role, in addition to interactions between the arterial wall and blood components. This scenario has promoted nutritional recommendations to enrich different type of foods with plant sterols (PS) because of their cholesterol-lowering effects. In addition to cholesterol, PS can also be oxidized during food processing or storage, and the oxidized derivatives, known as phytosterol oxidation products (POPs), can make an important contribution to the negative effects of both cholesterol and cholesterol oxidation oxides (COPs) in relation to inflammatory disease onset and the development of atherosclerosis. Most current research efforts have focused on COPs, and evaluations of the particular role and physiopathological implications of specific POPs have been only inferential. Appreciation of the inflammatory role described for both COPs and POPs derived from foods also provides additional reasons for safety studies after long-term consumption of PS. The balance and relevance for health of all these effects deserves further studies in humans. This review summarizes current knowledge about the presence of sterol oxidation products (SOPS) in foods and their potential role in inflammatory process and cardiovascular disease.

Lipogenesis in cancer progression (Review)

Mounier, C., *et al.*, *Int. J. Oncology* *45*: 485–492, 2014, http://dx.doi: 10.3892/ijo.2014.2441.

In normal tissues, energy-providing lipids come principally from circulating lipids. However, in growing tumors, energy supply is mainly provided by lipids coming from de novo synthesis. It is not surprising to see elevated expression of several lipogenic genes in tumors from different origins. The role of lipogenic genes in the establishment of the primary tumor has been clearly established. A large number of studies demonstrate a role of fatty acid synthase in the activation of cell cycle and inhibition of apoptosis in tumor cells. Other lipogenic genes such as the acetyl CoA carboxylase (ACC) and the stearoyl CoA desaturase 1 (SCD1) are highly expressed in primary tumors and also appear to play a role in their development. However, the role of lipogenesis in the metastatic process is less clear. In the present review, we aim to present the most recent evidences for the key role of lipogenic enzymes in the metastatic process and in epithelial to mesenchymal transition.

Lipids in cell biology: how can we understand them better?

Muro, E., *et al.*, *Mol. Biol. Cell* *25*: 1819–1823, 2014, http://dx.doi: 10.1091/mbc.E13-09-0516.

Lipids are a major class of biological molecules and play many key roles in different processes. The diversity of lipids is on the same order of magnitude as that of proteins: cells express tens of thousands of different lipids and hundreds of proteins to regulate their metabolism and transport. Despite their clear importance and essential functions, lipids have not been as well studied as proteins. We discuss here some of the reasons why it has been challenging to study lipids and outline technological developments that are allowing us to begin lifting lipids out of their “Cinderella” status. We focus on recent advances in lipid identification, visualization, and investigation of their biophysics and perturbations and suggest that the field has sufficiently advanced to encourage broader investigation into these intriguing molecules. ■