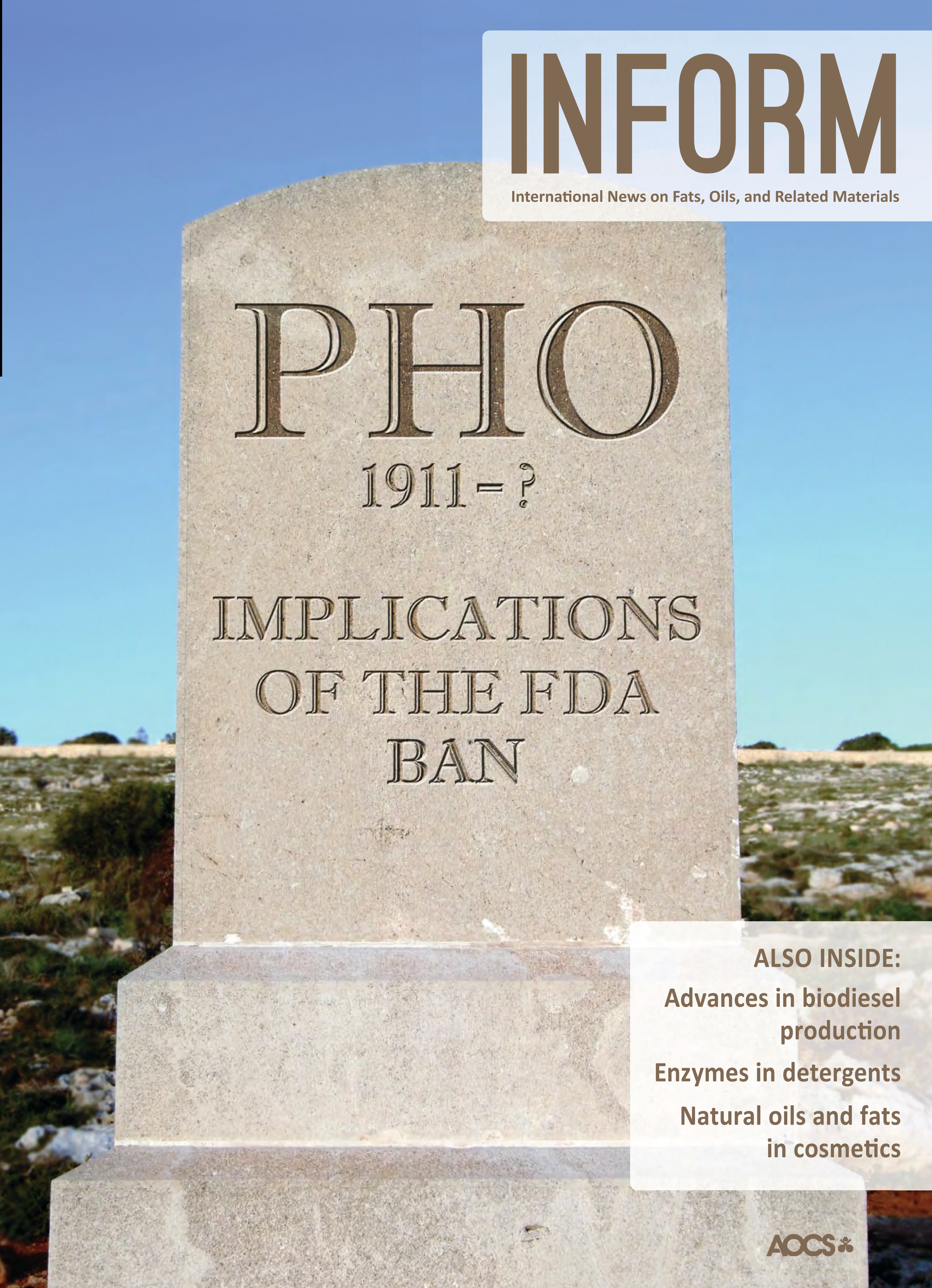
INFORM July/August 2014 Volume 25 (7) 401–480

INFORM

International News on Fats, Oils, and Related Materials



ALSO INSIDE:

Advances in biodiesel production

Enzymes in detergents

Natural oils and fats in cosmetics

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INFORM
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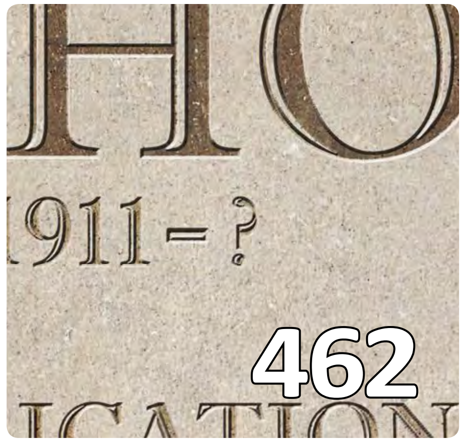

Inform app and digital edition only:

- 2014 AOCS Annual Meeting & Expo photo album
- Implementing the FDA Food Safety Modernization Act (FSMA)
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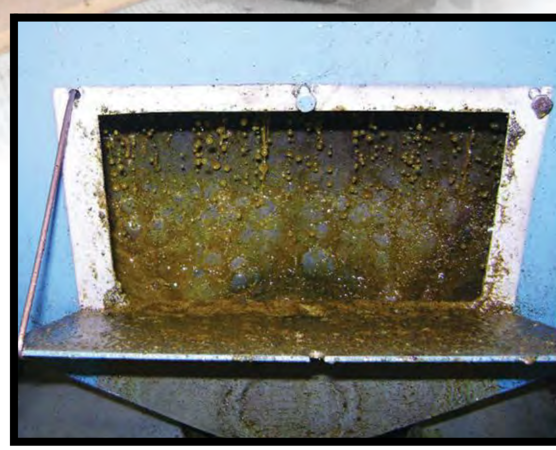

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◀ Alan McHughen gave an invited presentation, "GMO Policy, the Impending International Trade Train Wreck," at the Biotechnology Division dinner. The educator, scientist, consumer advocate, and author of *Pandora's Picnic Basket: The Potential and Hazards of Genetically Modified Foods* has first-hand experience with the technical, biosafety, and policy issues from both sides of the regulatory process. As molecular geneticist, he developed internationally approved commercial crop varieties using both conventional breeding and genetic engineering (GE) techniques. He also had input to the development of US and Canadian regulations governing the safety of GE crops and foods, served on US National Academy of Sciences panels investigating the environmental effects of transgenic plants and the safety of GE foods, and served as a reviewer for a third panel that looked at sustainability of US agriculture and the economic impacts of biotechnology on US agriculture. McHughen uses understandable, consumer-friendly language to explode the myths and explore the genuine risks of GE technology. He recently served as a US Senior Policy Analyst at the White House.

◀ One of the livelier events, Newcomer Speed Networking, was shoulder-to-shoulder, and people kept asking if there was room for one more. Word had spread that the event was the best way for people new to the organization to meet a lot of people in a short amount of time.

People who completed a personal profile in inform|connect were pictured on the cover of *Inform* magazine as Scientist of the Year.

2014 AOCS Annual Meeting & Expo

Kathy Heine

"If I had one dollar to spend, would I be better off using it to influence regulators or the customers who buy my product?"

That was just one of many insightful questions raised during the 2014 AOCS Annual Meeting & Expo, held May 4–7 in San Antonio, Texas. More than 1,500 professionals representing 46 countries attended the Joint World Congress with the Japan Oil Chemists' Society (JOCS), where they learned about the latest scientific and technical research, shared practical technical and business solutions, recognized individuals for their scientific achievements and service to the Society, and grappled with numerous market, regulatory, and environmental challenges.

Trans fats, which jumped to the forefront of challenges in November 2013, when the US Food and Drug Administration announced its preliminary determination that partially hydrogenated oils (PHOs), are not "generally recognized as safe" for use in food, were the focus of an emerging topics symposium, a technical session featuring innovative technologies for trans-fat reduction in shortening and oils, and a special afternoon session that brought food scientists, industry representatives, regulators, and public education groups together to consider the practical implications of eliminating PHOs from manufactured foods (see articles on pages 462 and 464).

Alan McHughen, author of the award-winning book *Pandora's Picnic Basket: The Potential and Hazards of Genetically Modified Foods* (2000), was a special invited speaker. The public sector educator, scientist, and consumer advocate spoke at the Professional

CONTINUED ON NEXT PAGE

Attendees were encouraged to join and help beta test inform|connect, AOCS' new community and information resource for people interested in fats- and oils-based products and technologies. Completing a personal profile put individuals in touch with a vast network of experienced individuals. Members of this network can talk globally one-on-one. They can share ideas, resources, and events with individual members or the entire global community. They can receive information in real time, through an RSS feed, or as a daily digest. They can post a question or comment; blog or start a discussion thread; participate in discussion forums; or upload, share, organize, tag, rate, and download documents from a growing resource library for biobased products and technologies.

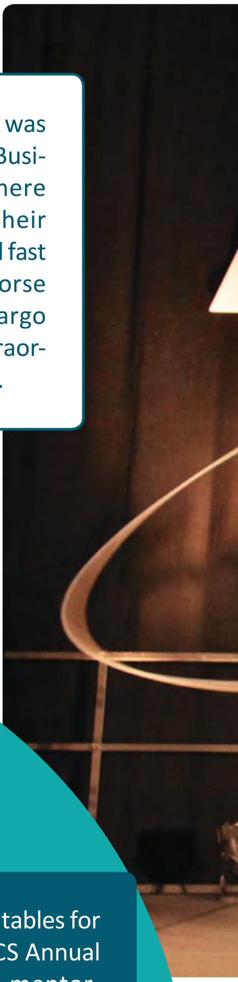
Educator's Common Interest Group session about dispelling popular misconceptions related to genetically modified organisms (GMO). His presentation at the Biotechnology Division Dinner, "GMO Policy, the Impending International Trade Train Wreck," provided a unique perspective into consumers' understanding of genetically modified foods and how the biotechnology industry can address their concerns.

Other key issues that prompted vigorous discussion included formulating home and personal care products in a changing regulatory environment, how to supply enough oils—particularly healthful omega-3s—to meet the needs of the world's growing population, the food vs. fuel debate, sustainability, and traceability. A technical session on suspensions, emulsions, and foams sponsored jointly by the Surfactants & Detergents and Edible Applications Technology Divisions allowed professionals from these two areas to explore common ground and exchange ideas, while a total of 450 oral and 175 poster presentations addressed the technical intricacies of analyzing 2- and 3-MCPD esters and glycidol in edible oils and whole foods, methods for identifying adulteration in vegetable oils, determining the composition and quality of algal and marine oils, energy-related applications of surfactants, the use of enzymes and other advances in oilseed processing, new uses for glycerine, evidence-based claims for foods and drugs, lipid crystallization, and many other topics.

The Expo, which featured 71 exhibitors, gave attendees an opportunity to see the latest oils- and fats-related equipment and technologies. Three general networking receptions, the AOCS Annual Business Meeting/Luncheon, and the Expo Sweet Retreat offered opportunities to interact with colleagues over lunch, a glass of wine, or dessert; and several scheduled networking events were held specifically for newcomers, students, young professionals, and professional educators.

Best of all, meeting attendees joined and beta-tested a new information and networking platform, called inform|connect, that will enable them to continue the conversation and build on the connections they made at the meeting by collaborating, networking, and exchanging information on an ongoing basis with other professionals who are similarly interested in fats- and oils-based products and technologies.

More complete photographic coverage of the meeting can be found in the digital and mobile editions of *Inform*.



▶ AOCS President Steven Hill was lassoed at the AOCS Annual Business Meeting/Luncheon, where guests were treated after their meals to Texas-style roping and fast and fancy gun handling by horse trainer, ranch hand, Wells Fargo stage driver, and cowboy extraordinaire, Ben Stafford Rodgers.

▼ Established professionals hosted tables for young professionals during the AOCS Annual Business Meeting/Luncheon. This mentoring activity gave AOCS's younger members a chance to meet and seek career advice from members who have led the industry and served the community for many years.

▲ Who doesn't love pie? The Expo Sweet Retreat, free for everyone having a full registration, was a chance to explore exhibits and to network while indulging one's sweet tooth.

▼ Registrants from around the world donated a wide variety of international toys (pictured) and cash donations totaling $161.25 to AOCS' San Antonio Toy Drive. The toys and money were given to the Children's Hospital of San Antonio.

◀ The AOCS Expo featured instrumentation, equipment, technologies, and services from 71 international companies.

▲ During the AOCS Business Meeting/Luncheon, AOCS presented the president of the Japanese Oil Chemists' Society (JOCS), Mitsuo Miyazawa (center), with a print by Illinois photographer, Larry Kanfer, titled "Midsummer Respite." Miyazawa presented AOCS with two crystal goblets. The gifts demonstrated the mutual appreciation each association had for the other in making the Joint World Congress with the JOCS a success.

▲ Six AOCS Honored students were recognized during the special Awards Plenary and Recognition session. Pictured from left to right: Taiwo Akanbi, from Deakin University, Australia; Ketinun Kittipongpittaya and Ying Yang from the University of Massachusetts Amherst, USA; Mia Falkeborg from Aarhus University, Denmark; Darren Gouk Shiou Wah from the University of Malaya, Malaysia; and Xiaowei Zhang from Shanghai Jiao Tong University, People's Republic of China.

◀ The gavel was passed to incoming AOCS President Steven Hill. In his first address as president, Hill talked about AOCS' need to repopulate the governing board and other leadership positions with fresh talent, and he urged members to complete a questionnaire via the AOCS website that will be used to select potential candidates for leadership positions.

▲ The 19th Annual AOCS Foundation Silent Auction raised nearly $7,000 for student programs. Best-selling items included an Echo Smartpen and Livescribe Notebooks donated by Mondelez, a Vivitar HD action sports camera donated by Crown Iron Works, a Nike golf bag with golf balls and accessories donated by ADM, Bose acoustic noise-canceling headphones donated by Wacker Chemical Corp., and a 16 GB iPod Nano donated by Graham Corp.

◄ Michael Flock (center) received the Thomas H. Smouse Memorial Fellowship, which encourages and supports outstanding graduate research. Flock is a doctoral student in the Department of Nutritional Sciences at The Pennsylvania State University, USA, where he investigates the role of fatty acids and their metabolites in modulating the immune response. Flock's advisor is AOCS member Penny Kris-Etherton. He is pictured here with incoming AOCS President Steven Hill and Past President Timothy G. Kemper.

Enzyme-catalyzed biodiesel made from low-quality oils

- **In the first quarter of 2014, both Blue Sun Biodiesel in St. Joseph, Missouri, USA, and Vieselfuel LLC in Stuart, Florida, USA, announced the full-scale production of biodiesel based on lipase as catalyst.**

- **Production at both sites has been in operation for over a year now. Novozymes has been the enzyme supplier and partner, and the accomplishment of full-scale production is the result of lengthy, dedicated research and development work.**

- **The new lipase technology enables the processing of oil feedstocks with any concentration of free fatty acids and with lower energy costs than with a standard chemical catalyst. In this article, a senior scientist manager at Novozymes describes the process and how it was developed.**

P.M. Nielsen

Utilizing lipases in the production of biodiesel dates back more than 10 years, and a considerable number of articles suggest the use of immobilized enzymes (Fjerbaek, L., *et al.*, 2009). The first trials using liquid formulated lipases instead of immobilized ones took place at Novozymes' laboratories in 2006 and resulted in the first patent filings.

In 2008, the Danish National Advanced Technology Foundation supported a large research effort involving universities and a biodiesel producer. At the same time, Novozymes began a collaboration with Piedmont Biofuels in Pittsboro, North Carolina, USA. The objectives of both projects were to find a lipase with a selling price low enough to compete in the chemical biodiesel market and to demonstrate the enzymatic biodiesel process in pilot or production scale. Originally, the collaborators believed that the result would be a low-cost immobilized lipase, but with time the most efficient process proved to be one with a new liquid formulated lipase (Cesarini, S., *et al.*, 2013). The results led to the latest patent filing in 2012, which describes the basis for the BioFAME® process utilizing liquid-formulated lipases as a catalyst and includes the reuse of the enzyme (Patent WO2012/098114, 2012).

The final enzymatic biodiesel process consists of an enzyme reaction step followed by polishing as shown in Figure 1.

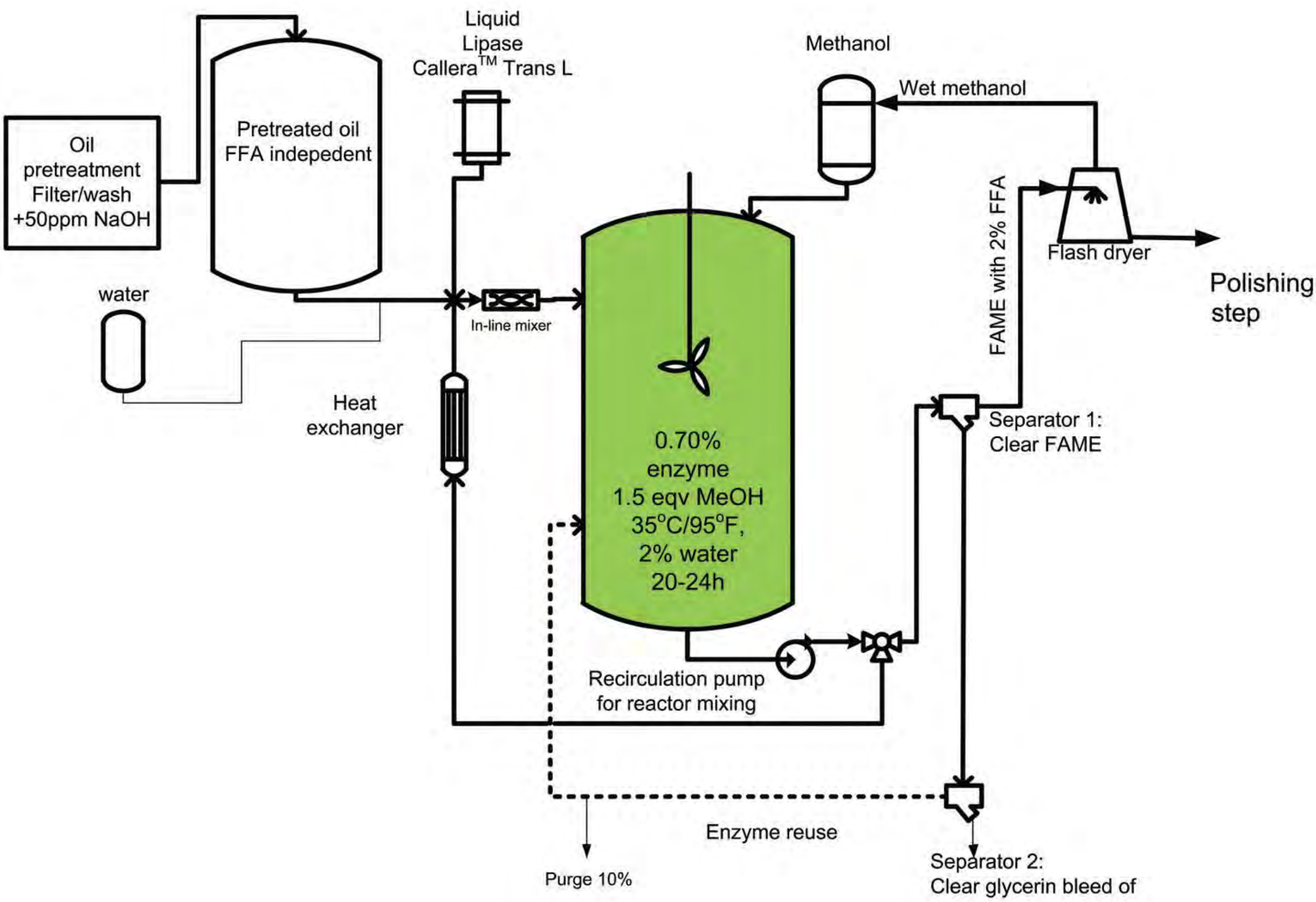


FIG. 1. The enzymatic biodiesel process for processing low-quality oils with high FFA. Abbreviations: FFA, free fatty acids; FAME, fatty acid methyl esters.

The operating principle of the enzyme reactor is the creation of an emulsion with a small amount of water (1–2%), as the enzyme works specifically at the interface between oil and water. Constant and efficient mixing during the reaction is required. One crucial specification for the oil feedstock was discovered; it must not contain acidity from mineral acids added upstream. Neutralization of such acids can be ensured by, for instance, 50 ppm NaOH added as a 10% solution. The reaction temperature must be controlled to 35°C/95°F, and the methanol added gradually to prevent enzyme inactivation. Typically, the required methanol is added during the first 6–10 hours of reaction. An efficient enzyme dosage of 0.7% is suggested, and with the reuse option the enzyme consumption will be close to 0.2% w/w on oil. It is only in the first batch that the addition of water is required. During additional batches the water from the reused heavy phase and the wet methanol is normally sufficient.

CONTINUED ON NEXT PAGE

INFORMATION

- Cesarini, S., P. Diaz, and P.M. Nielsen, Exploring a new, soluble lipase for FAMEs production in water-containing systems using crude soybean oil as a feedstock, *Process Biochem. 48*:484–487, 2013.
- Fjerbaek, L., K.V. Christensen, and B. Norddahl, A review of the current state of biodiesel production using enzymatic transesterification, *Biotechnol. Bioeng. 102*:1298–1315, 2009.
- Nielsen, P.M., Production of fatty acid alkyl esters, World Intellectual Property Organization Patent WO2012/098114, 2012.

TABLE 1. Data from the testing of different oils at typical BioFAME conditions—two used cooking oils, two corn oils from bioethanol by-products, and one PFAD

	Feedstock FFA, %	After BioFAME reaction				
		FFA, %	Monoglycerides, %	Diglycerides, %	Triglycerides, %	Bound glycerides, %
UCO 1	6.3	1.6	0.36	0.34	0.30	0.17
UCO 2	8.5	1.4	0.40	0.60	0.13	0.21
Corn oil 1	8.9	1.4	0.46	0.20	0.02	0.15
Corn oil 2	9.1	1.3	0.45	0.28	0.02	0.16
PFAD[a]	85.0	2.7	0.90	0.30	0.10	0.29

[a]UCO, used cooking oil; PFAD, palm fatty acid distillate.

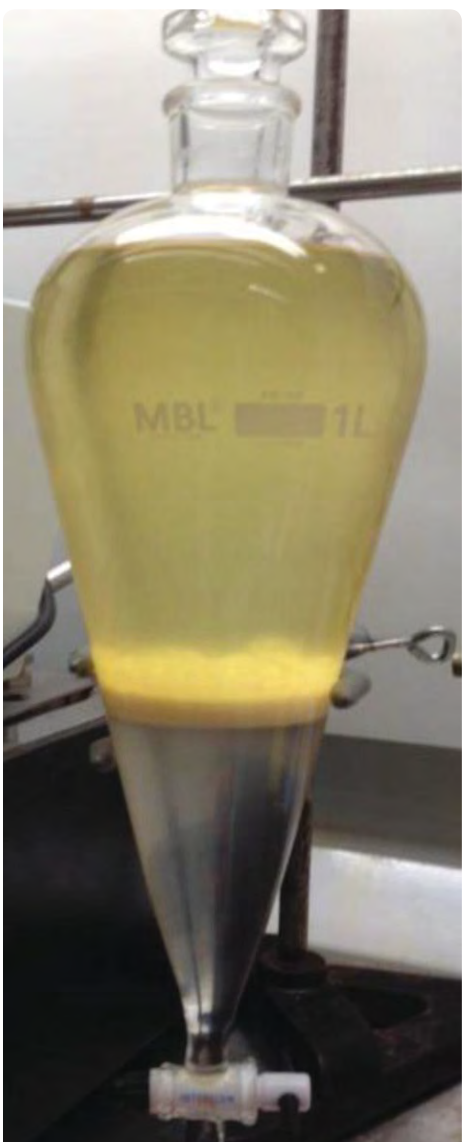


FIG. 2. The biodiesel reaction mixture, exemplified with soybean oil. The top phase is fatty acid methyl esters, the middle phase is an emulsion including >90% of the enzyme activity, and the bottom layer consists of the clear glycerin phase.

Figure 1 (page 413) shows the reactor in connection with centrifuges to separate the fatty acid methyl esters (FAME) and glycerin after the reaction. Alternatively, gravity settling in the reactor can be used, but it requires a relatively long time to produce clear glycerin. In either case, a small loss of enzyme activity occurs in every batch. The methanol/temperature conditions cause a slight inactivation of the enzyme, and there is a physical loss of enzyme in the separation step. Experience can ensure that the overall enzyme activity loss is limited to <15% per batch.

Use of the liquid lipases was a breakthrough, as they are much cheaper to produce and provide technological as well as cost benefits. By using the lipase Novozymes Callera Trans®, it is possible to produce biodiesel from a large variety of oil qualities. The ability to produce biodiesel from feedstock regardless of its FFA content ultimately makes the process a more cost-efficient way to produce biodiesel.

One of the key technologies involved is the recovery of the enzyme. The reaction time of 20–24 hours is dependent on a certain concentration of enzyme, for example, 0.7% of the oil. To lower associated costs, the enzyme is collected and reused. After the reaction, the reaction mixture is separated by gravity/centrifuge into three layers as illustrated in Figure 2. The glycerin phase after separation is very different from the glycerin obtained from an alkaline-catalyzed process, as it is almost free from salt.

The FAME phase from the enzyme reaction typically consists of a composition with bound glycerin <0.22% and FFA 2%. The FFA content varies, as it is dependent on the FFA content in the feed. At very high FFA content, such as that found in palm fatty acid distillate, it can typically reach 2.5–3.0% FFA. A low FFA content after the reaction can be achieved by controlling the water and methanol contents, taking the water formed by the FFA esterification also into consideration. Data from different oil reactions are included in Table 1.

The polishing step is required mainly owing to the FFA content which has to be reduced to <0.25% according to ASTM specification. This can take place as one of several alternative process steps:

1. Caustic wash. The caustic wash is based on the refining concept that eliminates FFA by a NaOH wash of virgin oil. The residual FFA content in the FAME phase is relatively low and the formation of soap is limited. However, the solubility of soap in the FAME is different from its solubility in oil, and a higher recirculation volume of soap/FAME than the normal 2.5 times soap volume is required. One benefit of the caustic wash is the significant reduction in monoglycerides.

2. Resin esterification. Resin technology is used today to eliminate FFA from oil as a pretreatment to biodiesel production with Na-methoxide catalyst. The concept is also applicable as a polishing step and uses a resin catalyzing the esterification at high temperatures (90°C/195°F) and methanol concentration (15–20%).

3. Sulfuric acid esterification. The sulfuric acid esterification is well established as a pretreatment for high-FFA feedstocks, for example, animal fat. There are limitations to the level of FFA that can be esterified, and the equipment has to be glass lined to prevent excessive corrosion. As the BioFAME reaction delivers FFA at a typical 2%, the sulfuric acid process might be able to reach in-specification FFA levels in one step.

4. Enzymatic esterification. Technically, this is probably the most advantageous of the processes mentioned. Aside from the FFA esterification, it also ensures the transesterification of the remaining glycerides. The cost of the enzyme needs to be considered in this case.

Distillation of the final product is an option to secure against any carryover from low -quality oils, for example, to ensure that waxes or metal ions are not found in the final biodiesel. An improved color and cold soak quality can also be secured by distillation.

Novozymes is currently finalizing the development work of the enzymatic biodiesel application and is ready to officially launch the concept later this year. Together with our partners who are using the lipase Callera Trans in full-scale production, we have shown that biodiesel can be produced from oils having different low qualities independent of FFA content and having a low cost for methanol recovery. The process has been installed at two full-scale plants, one as a retrofitted process to a traditional plant and the other as a greenfield plant. This is the first step into the biodiesel industry, but future perspectives for enzymatic processes are already foreseen, such as combined degumming and transesterification and sterylglycoside acylation.

P.M. Nielsen is senior science manager with Novozymes R&D group Bioenergy Opportunities.Contact: pmn@novozymes.com

Innovative catalysts open new opportunities in biodiesel market

William Summers

The current, widely used process for producing biodiesel dates to chemistries extant since the late 19th and early 20th centuries: batch operations, using homogeneous catalysts, batch separations, and the like. As the US biodiesel industry began to expand rapidly in 2005, US producers faced the persistent problems of competing with the food industry for the same feedstock—refined, bleached, and deodorized (RBD) soybean oil—and ever-increasing prices and thinner margins. Along with this came the still-simmering "food vs. fuel" debate over how US agricultural potential should be allocated.

While the opportunity for a new biodiesel technology capable of processing no-food feedstock was vast, to be commercially viable such a technology had to be better suited to large-volume commodity production, to be largely insensitive to feedstock variability, and to provide a better return on invested capital than existing technologies. For Benefuel (Irving, Texas, USA), the challenge was to surpass the initial entry of Axens (Salindres, France) Esterfip-H® catalyst, which entered the US market in 2007.

In working with our partners at the National Chemical Laboratory (NCL; Pune, India), a new solid powder catalyst capable of both esterification and transesterification emerged. This new catalyst afforded high yields of fatty acid methyl esters (FAME) and glycerin under mild conditions (Sreeprasanth *et al.*, 2006) using a wide variety of available fats and oils. Free fatty acids (FFA), which are common in less refined and less expensive feedstocks such as poultry fat, yellow grease, and palm oil derivatives, have long posed serious problems in conventional biodiesel processing. Benefuel licensed the exclusive worldwide rights to this NCL technology in 2006 and continued discovery and development work with NCL.

Within the first year after signing the license agreement, Benefuel had developed with NCL a second solid catalyst—more suited to fixed-bed applications and thus large-scale commercial fuel production—to accompany the first powder

catalyst, which is highly effective in batch operation. Both catalysts are effective in converting fatty acids (FA), fats or oils, and mixtures of these into methyl esters. Benefuel began work on process scale-up in fixed-bed reactors in 2008.

To us, the path ahead was clear: The biodiesel industry needed a fully continuous, fully integrated production refinery for biodiesel—one that could receive a variety of feedstocks and process them continuously to biodiesel and glycerin. The fixed-bed reactor design and our new catalyst were at the heart of this approach. Although the wide versatility of our catalysts for esterification and transesterification were well recognized, development of other applications had to wait for process validation in biodiesel.

Benefuel's Ensel® fixed-bed process is quite simple (Fig.1). It employs our second solid catalyst, which was developed in conjunction with Süd-Chemie India Pvt. Ltd. (Kerala)and patented in the United States and Japan (US 8,124,801 and JP 5,470,382) with applications in other countries.

This durable, promoted, metal oxide catalyst is largely insensitive to water and effectively converts every feedstock that has been tested in numerous pilot plant-scale operations. Examples include degummed soybean oil, cottonseed oil, corn oil from dried distillers' grains with solubles, yellow grease, beef tallow, crude palm oil, palm fatty acid distillate, and even a mixture of degummed soybean oil and oleic acid (7:3, vol/vol).

The basic design of Benefuel's ENSEL process for transesterification involves three major components: fixed-bed reactors, an oil–glycerin separation stage, and a pair of distillation columns. Each element of the process operates continuously and can be monitored at critical points with inline sensors for tight control.

A new proprietary solid catalyst process developed by Benefuel:

- **converts inedible fats and oils, which are renewable feedstocks, into specification biodiesel;**
- **converts both glycerides and free fatty acids into alkyl esters for industrial use; and**
- **operates at lower cost than any other current process for esterification or transesterification.**

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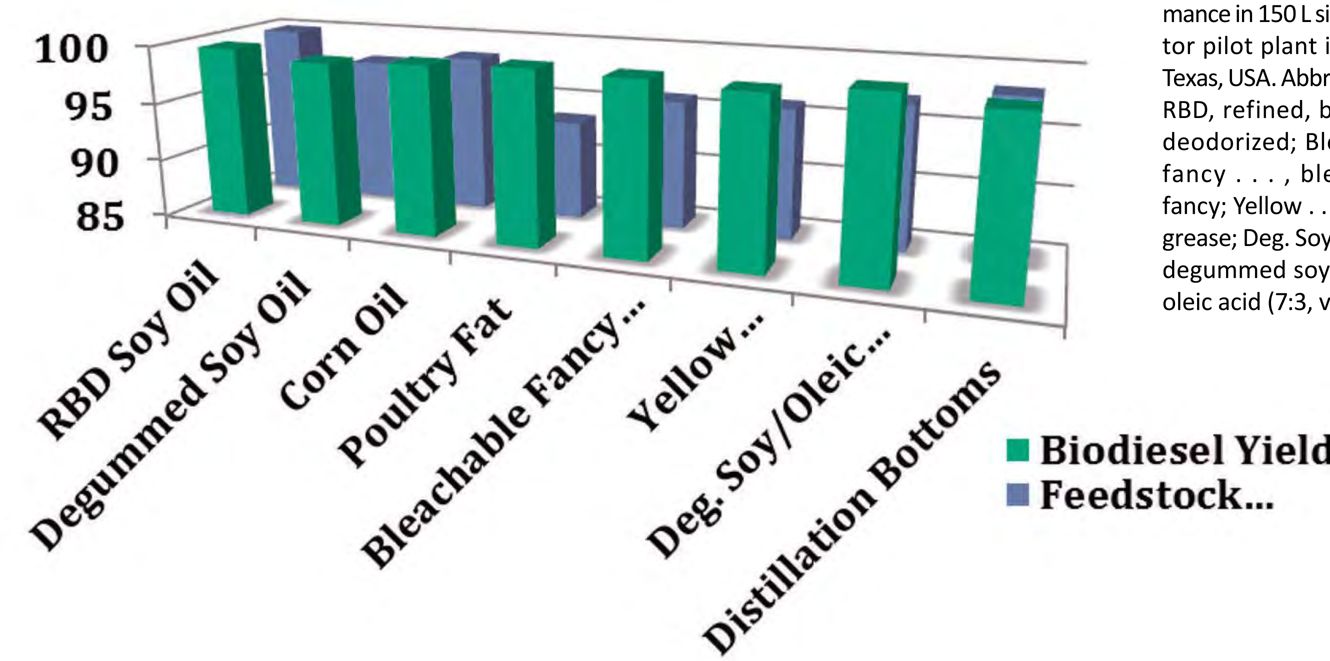

FIG. 1. Catalyst performance in 150 L single reactor pilot plant in Euless, Texas, USA. Abbreviations: RBD, refined, bleached, deodorized; Bleachable fancy . . . , bleachable fancy; Yellow . . . , yellow grease; Deg. Soy/Oleic . . , degummed soybean oil/oleic acid (7:3, vol/vol).

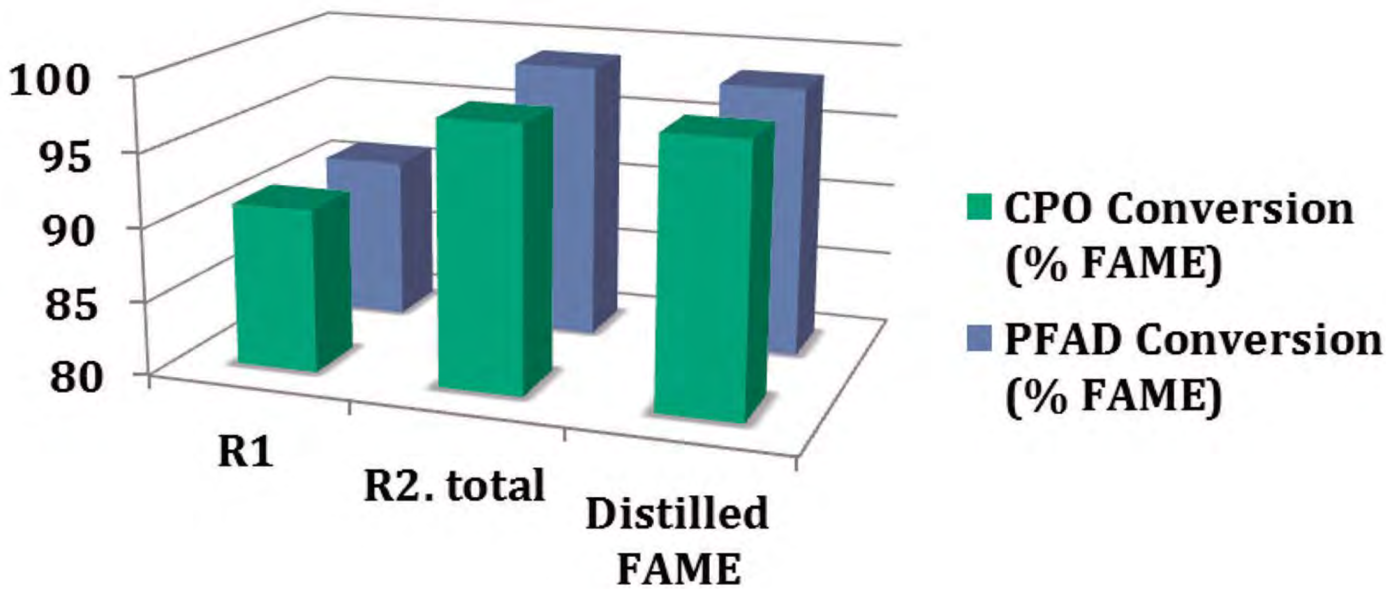

FIG. 2. Catalyst performance in a 300 L double reactor [two reactors in series] pilot plant in Matsuyama, Japan. Abbreviations: R1, reactor 1; R2., total (i.e., total product of R1 added to product from R2); Distilled FAME, distilled fatty acid methyl esters; CPO, crude palm oil; PFAD, palm fatty acid distillate.

The process starts with renewable, inedible feedstock, requiring some minimal pretreatment to remove insolubles and water, which would otherwise displace feedstock. The catalyst is contacted with methanol and feedstock under specific conditions of temperature (190–210°C), pressure (40–50 bar) , and flow rate (weight hourly space velocity = 0.4–0.6/hr), followed by recovery and refinement of the excess methanol, product separation, and FAME distillation. Still bottoms can be recycled to increase carbon efficiency, and the glycerin co-product is low in both ash and non-glycerol organic matter.

The reactor is generally columnar in shape, suited for medium-pressure service at moderate temperatures in flooded mode. In this vessel, the reagents—triglycerides (TG) and an excess of methanol in the liquid phase—come in contact with the active catalyst's surface, which accelerates the transformation of the glycerides to methyl esters.

As the liquid stream exits the reactor, the pressure is reduced on the stream of crude biodiesel, and methanol and the volatile methanol (and water if the feedstock contains FFA) quickly flash to vapor and are carried directly to the methanol refining distillation unit.

The separation can be a simple decanter, in which the product crude biodiesel (the oil layer) and glycerin mixture separates because of the difference in density. Benefuel also holds exclusive rights in a novel electrostatically enhanced separation system, which can dramatically shorten the residence time compared to conventional decanters.

The recovered glycerin can be pumped to a small vacuum distillation column to remove any volatiles (3–4% of total glycerin volume) and then to co-product storage. The volatiles, consisting mostly of water and methanol, are pumped to the methanol recovery system.

Distillation of the recovered oil phase is the last stage of the process. This two-step distillation removes any residual volatiles (first stage: residual methanol, water, and volatile

The advantages of using solid acid catalysts

Solid acid catalysts offer several advantages for continuous or batch operation production of biodiesel and synthetic esters. These include:

- no feedstock constraints; can use fats, oils, methyl esters, or fatty acids
- wide range of feedstock quality choices
- limited pretreatment needed, to remove insolubles
- lower capital expenditures (CAPEX) and operating expenditures (OPEX) than conventional processes
- adaptable to "greenfield," "brownfield," or "retrofit" facilities
- lowest cost of production of fatty acid methyl esters
- nonaqueous downstream processing, minimal waste streams
- better conversion and higher selectivity for esters

FIG. 3. The 1 TPD demo semi-works unit is a very small biodiesel plant (the main skid is 20 feet x 12 feet x 4 feet) and capable of providing quality fuel continuously. The support units included a methanol distillation system, a sipped-film evaporator for FAME distillation and an electrostatic separator to separate FAME from glycerin.

unsaponifiables) and refines the methyl esters from any higher-boiling impurities (second stage: unconverted glycerides and high-boiling unsaponifiables). The recovered methyl esters are continuously analyzed against ASTM specifications for B100 validation.

Distillation of the crude biodiesel ensures continuous, high-quality output and minimal risk of cold flow issues caused by residual glycerides. As specifications continue to tighten, even conventionally designed biodiesel plants are adding a final stage distillation.

In 2009, as work on the biodiesel process scale-up shifted from NCL's labs to Benefuel's domestic and Japanese pilot plants (Fig. 2), work at NCL refocused to develop other reaction modes with these same catalysts. Among these are the conversion of TG or fatty acids into alkyl fatty acid esters with higher-boiling alcohols and of FAME and acyl glycerides into polyol esters, for which we now have three separate process modes: batch (stirred tank reactor) and continuous (fixed bed reactor or catalytic reactive distillation). These processes leading to biodegradable lubricant base oil and other oleochemicals await pilot-scale testing for commercial applications.

THE SOLID CATALYST ADVANTAGE

The advantages of solid catalytic processing are simply economic—continuous production at commercial scale without reference to periodic changes of feedstock or feedstock blends; a catalyst life of several years instead of "catalyst as reagent," as in conventional biodiesel production; and an ability to blend

CONTINUED ON NEXT PAGE

feedstocks to achieve optimal cold-flow properties in the final product at a low raw material cost.

When compared on the basis of production, Benefuel estimates that the ENSEL process has the lowest cost producer advantage in the market (Fig. 3, page 419). This competitive advantage offers ENSEL producers a strong economic edge over conventional biodiesel production processes in their numerous variations. Except for "green" diesel, which requires a source of hydrogen and affords no glycerin co-product, ENSEL can be adapted to existing and greenfield operations.

Benefuel is currently partnered with Flint Hills Resources LLC (Wichita, Kansas, USA) in the retrofitting of the former Axens' biodiesel plant in Beatrice, Nebraska, USA to operate with the ENSEL process and is engaged in one other US greenfield biodiesel project, while pursuing other opportunities in Southeast Asia and Canada.

William Summers is chief science officer of Benefuel Inc. Since 1974, Summers has managed multiple technology businesses with a focus on developing processes for new products and improving existing operational efficiencies. He can be contacted at wsummers@benefuel.net.

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NEWS & NOTEWORTHY

AOCS Expert Panel to continue work on MCPD-E and GE

The AOCS Expert Panel on Process Contaminants met during the May 2014 AOCS Annual Meeting & Expo (AM&E) to set priorities.

The panel was formed in December 2009 and to date has focused on two process contaminants formed during the refining of vegetable oils: MCPD esters (MCPD-E), including esters of 3-monochloropropane-1,2-diol (3-MCPD-E), and glycidyl esters (GE). The presence of 3-MCPD-E in vegetable oils was first reported in 2006; many of the data gaps identified then regarding the occurrence, toxicokinetics, and toxicity of these substances remain.

At its most recent meeting, in March 2014, the Codex Alimentarius Commission's Committee on Contaminants in Foods affirmed that 3-MCPD-E and GE remain at the top of the priority list for evaluation by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The compounds also remain a priority for the European Food Safety Authority (EFSA), which issued a preliminary exposure assessment in September 2013. The data upon which the EFSA report is based, however, were from 2009–2011, which was before the Expert Panel and AOCS developed three validated indirect methods for the characterization of 3-MCPD-E, 2-MCPD-E, and GE in oils and fats and one validated direct method for the characterization of GE. (See http://tinyurl.com/MCPD-Methods for more information on process contaminants and the various methods. For more on EFSA's report and the AOCS response to it, see *Inform* 25:21–23, 2014.)

EXPERT PANEL SETS PRIORITIES

Given the level of regulatory activity regarding MCPD-E and GE, the AOCS Expert

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BRIEFS

The International Oil Mill Superintendents Association (IOMSA) announced in May 2014 that all Texas A&M University Libraries' holdings of the *Oil Mill Gazetteer* (*OMG*) have been digitized and are now available online at http://tinyurl.com/TAML-OMG. *OMG* has been IOMSA's official monthly publication since 1901 and covers events and topics of interest to the vegetable oil extraction industry. AOCS Press has published the magazine since 2003.

■■■

US exports to Mexico of grain, oilseeds, and related products averaged 22.2 million metric tons (MMT) per year from 2008–2012, with an average annual value of $7.3 billion, according to a report by the Center for North American Studies at Texas A&M University (College Station, USA). Those statistics represent a 22% volume increase over the average of the early 2000s, according to the research findings. Yellow corn, most commonly used for animal feed and corn starch, was the largest volume export of the product categories, accounting for 35% in 2011. Soybeans, crushed for meal and oil, accounted for 13%. The study is available at http://cnas.tamu.edu.

■■■

Malaysia's Sime Darby Berhad announced in April 2014 that it will take a 30% stake, valued at $30 million, in Verdezyne, a renewable chemicals company based in San Diego, California, USA. Sime Darby said it plans to emerge as the single largest investor in Verdezyne, together with existing investors BP Alternative Energy, Royal DSM, OVP Venture Partners, and Monitor Ventures. The companies will focus on converting traditional and nontraditional palm-based commodities into products of higher value. Verdezyne's planned first commercial plant in Malaysia will have an annual capacity in excess of 13,000 metric tons, according to a news release. ■

Panel on Process Contaminants agreed that further studies are needed. These include:

- An examination of methods for determining levels of MCPD-E and GE in spreads and dressings based on work presented at the AM&E;
- An evaluation of methods suitable for determining levels of MCPD-E and GE in infant formulae;
- A review of the limits of detection of methods already published (quantification will be required for exposure data); and
- An evaluation of methods for determining levels of MCPD-E and GE in meat- and potato-based products that are fried or pre-fried.

For more information, or to submit a method, contact Richard Cantrill, AOCS' technical director and chief science officer, by email (rcantrill@aocs.org) or phone (+1 217-693-4830).

US FDA extends comment period on proposed rule on sanitary transportation

The US Food and Drug Administration (FDA) announced in May 2014 that it would extend the comment period by 60 days on its proposed rule titled "Sanitary Transportation of Human and Animal Food." The comment period was originally scheduled to end May 31, 2014. The extension also applies to the associated information collection provisions, FDA said in a news release.

The proposed rule appeared in the February 5, 2014, issue of the *Federal Register*. Once it is final, it will require certain shippers, receivers, and carriers who transport food by motor or rail vehicles to take steps to prevent the contamination of human and animal food during transportation. It would also establish criteria for sanitary transportation practices, such as properly refrigerating food, adequately cleaning vehicles between loads, and properly protecting food during transportation.

USP comments on economically motivated food adulteration

Emphasizing the specific risks posed by the intentional and fraudulent adulteration of food ingredients for economic gain, the United States Pharmacopeial Convention (USP; Beltsville, Maryland) has submitted a public comment letter to the US Food and Drug Administration (FDA) urging the FDA to reconsider its strategy to address economically motivated adulteration (EMA) of food ingredients.

"Economically motivated adulteration of food ingredients is a significant concern, with its own challenges, posing a threat to public safety, eroding consumer confidence in the integrity of food, and disrupting markets by placing control of the supply chain in the hands of criminals," said Ronald Piervincenzi, chief executive officer at USP. "EMA should be addressed as its own unique category of food adulteration."

USP recommends that FDA consider a framework tailored to the specific nature of EMA. While USP agrees that it is not ideal to handle EMA under a typical food-defense/vulnerability approach, the organization says EMA would be equally misplaced under the rules concerning preventive controls. The suggested approach would include a vulnerability assessment mostly focused on determining the likelihood of EMA occurring but also including a component of public health risk assessment; a second component would be a vulnerability control plan to mitigate these risks.

Any food ingredient can be adulterated, and the list of potential adulterants is equally unlimited. The best way to protect consumers and safeguard industry is to focus on determining where EMA is most likely to occur. Publicly available standards can also help safeguard against adulteration of food ingredients by helping [ensure] food integrity and excluding ingredients that have been substituted, diluted, or replaced, through fraud or other means," said Piervincenzi.

USP highlighted the wide array of concerns related to economically motivated food adulteration, including:

- Dilution—such as olive oil diluted with potentially toxic tea tree oil or products watered down using non-potable water.
- Substitution—including sunflower oil partially substituted with mineral oil or hydrolyzed leather protein in milk.
- Concealment—such as harmful food coloring applied to fresh fruit to cover defects.
- Mislabeling—including toxic Japanese star anise labeled as Chinese star anise or mislabeled/recycled cooking oil.

Updated NGFA trade rules booklet available

A new booklet containing the latest version of the National Grain and Feed Association's (NGFA) trade rules and arbitration rules now is available for download at http://ngfa.org/traderules.

The new booklet incorporates changes adopted or ratified in April 2014 during NGFA's annual convention and that now are in effect.

NGFA has five sets of trade rules:

- Grain Trade Rules: Adopted in 1902, these rules govern all transactions of a financial, mercantile, or commercial nature involving grain. Grain, as defined by the US Grain Standards Act, includes corn, wheat, rye, oats, barley, flaxseed, grain sorghum, soybeans, mixed grain and any other food grains, feed grains, and oilseeds for which standards are established under that law (7 US Code Section 76).
- Feed Trade Rules: Adopted in 1921, these rules govern transactions of all feedstuffs (including mill products or co-products, such as distillers' grains). Users of these rules should note that references are made to ingredient definitions of the Association

SUSTAINABILITY WATCH

DuPont reports on global food, nutrition landscape

In May 2014, the DuPont Advisory Committee on Agricultural Innovation and Productivity issued an updated progress report on the global food and nutrition landscape, highlighting substantial gains in global food production rates, improvements in nutritional quality, and advances in eradicating extreme hunger and poverty, while also acknowledging that serious challenges remain.

DuPont convened the Advisory Committee in 2010 to explore global issues affecting food and nutrition security. Chaired by former US Senate Majority Leader Tom Daschle, the Advisory Committee brings together a group of experts in global agriculture development, science, policy, and economics.

Since its initial report in 2011, the committee has monitored global progress on food and nutrition security issues and explored three aspects in greater depth—the role of technology and innovation in agriculture; opportunities for advancing nutrition security; and the need for environmentally, socially, and economically sustainable agricultural systems.

Among its key findings, the committee concluded that in the short period since 2011, the world has made significant progress toward eradicating extreme hunger and poverty:

- Developing countries have managed to reach the point of nearly halving the proportion of those suffering from hunger.
- At current rates, the prevalence of undernourishment in developing regions is expected to fall to 13% by 2015, or half the rate from 1990 to 1992.
- From an efficiency perspective, global agricultural productivity is currently on track to meet the greater global food demand.
- Ongoing trade negotiations hold the promise of enabling increased movement of food around the world.
- Enhanced public-private sector collaborations are creating new, sustainable models for improving the livelihood of smallholder farmers.

Despite this progress, the committee stressed that critical challenges remain, with one in eight people remaining undernourished. Continued challenges include:

- Providing all available tools to farmers.
- Building sustainable agricultural systems.
- Empowering women farmers with resources, such as land and technical training.

Toward this end, the report stressed two themes as critical to food and nutrition security—the central role of farmers and the need to give them access to key technologies as well as the requirement for a comprehensive and collaborative approach across multiple partners and sectors.

The DuPont Advisory Committee on Agricultural Innovation and Productivity includes, besides Tom Daschle (chair), Jason Clay, senior vice president of market transformation at the World Wildlife Fund; Charlotte Hebebrand, director general of the International Fertilizer Industry Assoc.; Jo Luck, former president and CEO of Heifer International and World Food Prize Laureate; Ruth Oniang'o, founder and director of Rural Outreach Africa; J.B. Penn, chief economist for Deere & Co.; and Pedro Sanchez, director of the Agriculture and Food Security Center at The Earth Institute, Columbia University, and World Food Prize Laureate.

of American Feed Control Officials (http://www.aafco.org/).

- Barge Trade Rules: Adopted in 1964, these rules supplement the Grain Trade Rules and Feed Trade Rules whenever such shipments are designated by contract to be transported by barge.
- Barge Freight Trading Rules: Adopted in 1981, these rules govern all disputes of a financial, mercantile, or commercial character involving transactions in the purchase and/or sale of barge transportation.
- Secondary Rail Freight Trading Rules: Adopted in 2007, these rules govern all disputes of a financial, mercantile, or commercial character involving transactions between non-railroad parties in the purchase and/or sale of secondary rail freight transportation. ■

BRIEFS

According to Focus Taiwan News Channel (May 5, 2014), the CPC Corp. (a state-owned petroleum, natural gas, and gasoline company in *Taiwan*) will phase out its renewable energy policy before the end of the third quarter of 2014 because of problems its biodiesel fuels have caused motorists. CPC has been supplying B2 biodiesel (2% biodiesel plus 98% petrodiesel) to retail customers. The company reportedly said that Taiwan's humid weather and the low sulfur level in diesel fuels have let to clogging of fuel tanks by microbes. Taiwan has been using B2 since 2010.

■■■

The US Energy Information Administration reported in early May 2014 that US imports of biodiesel and renewable diesel totaled 525 million gallons (1.22 billion liters) in 2013, compared with 61 million gallons in 2012. Two principal factors drove the increase in US biodiesel imports: growth in domestic biodiesel demand to satisfy renewable fuels targets, and increased access to biodiesel from other countries. Consequently, the United States switched from being a net exporter of biomass-based diesel in 2012 to a net importer in 2013. For comparison, US biodiesel production in 2013 was 1.34 billion gallons, an increase of 35% over 2012.

■■■

Early in the second quarter of 2014, LanzaTech announced its intention to move its corporate headquarters from Auckland, New Zealand, to Skokie, Illinois, USA. LanzaTech personnel already employed in its Roselle, Illinois, facility will move to the Skokie site. The new headquarters, which will serve as the company's research and development center, will be at Skokie's Illinois Science and Technology Park, a $500 million, 23-acre bioscience campus. LanzaTech will share a 160,000 square foot (15,000 square meter) facility, occupying 41,000 square feet of lab and office space. The technology that LanzaTech has developed captures and reuses waste carbon emissions for the production of fuels and chemicals. ■

ENERGY

Equipment in the nose of the Guardian will precisely measure wind velocity when the jet flies through the wing tip wake vortices of a DC-8 during Alternative Fuel Effects on Contrails and Cruise Emissions -II flight tests. Image Credit: NASA Langley/David C. Bowman

Alternative fuel effects on contrails

In early May 2014 the US National Aeronautics and Space Administration (NASA) commenced a second set of studies on the effects of burning alternative fuels in jet engines on emissions and contrail formation. Understanding more about contrail formation is important because contrails are considered an essential variable in discussions about climate change.

Plans include flying NASA's workhorse DC-8 plane as high as 40,000 feet (12,000 meters) while its four CFM56 engines burn either JP-8 jet fuel or a 50:50 blend of JP-8 and renewable alternative fuel of hydroprocessed esters and fatty acids derived from camelina oil.

Three research aircraft are scheduled to take turns flying behind the DC-8 at distances ranging from 300 feet (90 m) to more than 10 miles (16 kilometers) to take measurements on emissions and to study contrail formation as different fuels are used. The German Aerospace Center is supplying a Falcon 20-E5 jet as one of the three chase plans, and the National Research Council of Canada is providing a CT-133 jet. The third is a NASA HU-25C Guardian jet.

In 2013 NASA conducted preliminary studies in a similar experimental design that found soot emissions were reduced 40–60% when blended fuel was burned compared with JP-8 by itself. However, Bruce Anderson, NASA's principal investigator for this program, said, "We weren't able to make clear ties between the type of fuel burned and formation of contrails."

Ice particles form when water vapor from jet exhaust condenses and freezes on some source of nuclei, forming contrails. The source of the nuclei, though, is not yet clearly identified. Possible triggers for the formation of contrails that are being

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considered include soot from the engine exhaust, the presence of sulfur in the jet fuels, or even just normal background aerosols.

To test the sulfur hypothesis, the DC-8 will fly with both a low-sulfur and a high-sulfur grade of JP-8 jet fuel.

There are also plans to fly the research aircraft into the turbulent, twisting air that streams for miles behind the DC-8's wingtips. The goal is to collect data and sample the number of particles and amount of CO_2 trapped with the vortices and compare that to the amount of fuel burned.

Flights are being staged at NASA's Armstrong Aircraft Operations Facility in Palmdale, California, mostly near Edwards Air Force Base. And, if weather conditions permit, NASA will coordinate with air traffic controllers and airline pilots to take measurements while trailing airliners flying in the Southern California region from a distance of 5 miles (8 kilometers) or more.

For further information see http://tinyurl.com/NASA-biofuel-contrail.

Motor oil from high-oleic soybean oil

Biosynthetic Technologies, based in Irvine, California, USA, has received certification from the American Petroleum Institute (API) on two motor oil formulations (5W-20 and 5W-30) that contain estolides made from high-oleic soybean oil. API test results verified that these biosynthetic-based oils met or exceeded the performance characteristics of most high-quality petroleum-based oils currently on the market.

These biosynthetic oils are able to keep engine surfaces cleaner and reduce wear on bearing surfaces as compared to petroleum-based oils. Working with Infineum, the additive subsidiary of ExxonMobil and Shell, Biosynthetic Technologies recently completed a successful field trial fleet test using these high-oleic-based motor oils in taxis operating in the city of Las Vegas. After running over 150,000 miles (240,000 kilometers) in stop-and-go driving in the desert heat, taxi engines from cabs that used the biosynthetic oils showed less visible deposits and baked-on varnish than engines run on conventional petroleum motor oils.

The company plans to build a large, full-scale facility, possibly in the Houston, Texas, area, within the next two years, according to the United Soybean Board (http://tinyurl.com/USB-lubricants).

Nanoparticles perform two processing steps at once

Scientists with the US Department of Energy's Ames Laboratory (Iowa, USA) have developed a nanoparticle that performs two processing functions at once for the production of renewable diesel.

In their first efforts, the Ames Lab research group, including Igor Slowing and coworkers, used bi-functionalized mesostructured nanoparticles containing amine groups that captured free fatty acids from vegetable oils and nickel nanoparticles that catalyze the conversion of the acids into renewable diesel. (Nickel has been researched widely in the scientific community because it is approximately 200 times less expensive than noble metals traditionally used in fatty acid hydrogenation, e.g., platinum or palladium.)

The creation of a bi-functional nanoparticle improved the quality of the resultant renewable diesel. Using nickel alone for the fuel conversion resulted in broken hydrocarbon chains, that is, "cracking." That product had a lower potential for use as a fuel. But with inclusion of particles containing amine groups, "We no longer saw the cracking of molecules. So the result is a better catalyst that produces a hydrocarbon that looks much more like diesel," according to Slowing.

The group then changed the catalyst to iron, which is 100 times cheaper than nickel. Results showed the end product was improved even further, the conversion was faster, and the amount of CO_2 lost in the process was reduced.

For further information see http://tinyurl.com/ames-lab-nanoparticles.

REG to acquire Tyson's half of Dynamic Fuels

On May 21, 2014, Renewable Energy Group, Inc. (REG; Ames, Iowa, USA) announced it had reached an agreement with Tyson Foods, Inc. to acquire Tyson's 50% ownership position in Dynamic Fuels, LLC. Completion of the transaction is contingent on the closing of REG's December 2013 announced agreement to acquire substantially all of the assets of Syntroleum Corp. (*Inform* 25:152–153, 2014), the other partner in Dynamic Fuels. Once completed, the deal will result in REG owning all of Dynamic Fuel's 75 million gallons (284 million liters) per year nameplate capacity renewable diesel biorefinery in Geismar, Louisiana, USA.

Tyson and Syntroleum formed Dynamic Fuels in 2007 as a 50:50 joint venture, and the Geismar facility, completed in 2010, was the first large-scale renewable diesel biorefinery built in the United States.

Under terms of the agreement REG will acquire Tyson Foods' 50% interest in Dynamic Fuels by paying Tyson approximately $18 million in cash at closing and up to $35 million in future payments tied to production volume at the Geismar biorefinery over a period of up to 11.5 years. REG will also fund repayment of approximately $12 million of Dynamic Fuels' indebtedness to Tyson at closing.

The Geismar plant has been idle since November 2012 because of deteriorating market conditions. In the spring of 2013, the partners spent $7.3 million to replace a catalyst in the facility that was supposed to increase production efficiency. It was installed, but production never resumed (http://tinyurl.com/DynamicFuels-REG). Since then, Tyson and Syntroleum have each incurred costs of $1 million per month to keep the facility in standby mode.

REG already owns eight operating biodiesel refineries in Iowa, Illinois, Minnesota, and Texas that have a combined annual nameplate production capacity of 257 million gallons (973 million liters).

New biofuel for cold places?

Studies dating back to 1959 have shown that overwintering larvae of the goldenrod gall fly (*Eurosta solidaginis*) store carbohydrates and lipids in special fat body cells that survive intracellular freezing. More recent research on this gall fly has led University of Western Ontario (London, Canada) scientist Brent Sinclair and coworkers to suggest that they have found a way that could make biofuels stay liquid at cold temperatures (Marshall, K.E., *et al.*, Seasonal accumulation of acetylated triacylglycerols by a freeze-tolerant insect, *J. Exp. Biol. 217*:1580–1587, 2014; http://dx.doi.org/10.1242/jeb.099838).

Katie Marshall, a graduate student of Sinclair, and colleagues collected galls from goldenrod plants in fields near London, Ontario, during the 2011–2012 winter; ground them up; extracted the material with organic solvents; and sepa-

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rated the lipids by thin layer chromatography–flame ionization detection.

Results showed that the neutral lipid pool in overwintering prepupae of the gall fly contained nearly 36% acetylated triacylglycerols (Ac-TAG), and only 17% of long-chain TAG (LC-TAG), the typical form in which animals store fat. Further, the high concentrations of Ac-TAG, present only during winter, appear to be synthesized by the insect, not the plant host. Further evidence suggested that the fly may convert LC-TAG into Ac-TAG during winter and then back to LC-TAG in the spring (http://tinyurl.com/rare-fat-gall-fly).

The mixture of Ac-TAG found in *E. solidaginis* had a "significantly lower melting point than equivalent LC-TAG," and thus remained liquid at temperatures the insects undergo in the wild. Larvae reportedly can emerge unscathed after experiencing temperatures as low as –80°C.

Marshall told *The Scientist* magazine, "We have two hypotheses at the moment about how Ac-TAG prevent tissue damage: The acetyl group might help the molecule to function like an antifreeze, or it may just be that Ac-TAG remain liquid enough to reduce the mechanical damage that happens during cytoplasmic freezing."

Sinclair commented, "The discovery that gall flies can process long-chain triacylglycerols into this low temperature version paves the way for researchers to develop new ways to turn regular fats into biofuels that work in Canada's cold winters or chilly high altitudes" (http://tinyurl.com/insects-biofuels).

Converting used cooking oil to plastics

Saudi Basic Industries Corp. (SABIC), a diversified manufacturing company active in chemicals and intermediates, industrial polymers, fertilizers and metals, is planning to use cooking oil and fat waste to produce plastics. According to Bloomberg.com (http://tinyurl.com/SABIC-Bloomberg), this decision has been influenced by European manufacturers seeking packaging made from renewable sources.

Plastics operations acquired by SABIC in the past 12 years from Royal DSM NV, Huntsman Corp., and General Electric Co. are being adapted by SABIC to meet demand for materials that carry no risk of containing a plastic not certified as being safe for use with consumables. This demand means recycled packaging is not considered usable for making new packaging plastic because there is a risk it would contain uncertified plastic.

The waste fats will be used to make polyolefins alongside a naphtha-fed unit sat SABIC's plant in Geerlen, Netherlands. ■

BRIEFS

The search for easily sourced and functionally equivalent replacements for cocoa butter continues, as the website www.rssl.com recently noted. Shea and palm oil fractions are already in use as cocoa butter equivalents (CBE); a number of research teams are working on new CBE, including a group of Iranian scientists who looked at using camel hump fat (http://dx.doi.org/10.1016/j.supflu.2009.03.005, 2009). Work out of India (http://dx.doi.org/10.1016/j.jfoodeng.2012.10.051, 2013) focuses on the kernel of the kokum tree (*Garcinia indica*) as a source of CBE. Another possibility, according to Spanish researchers, is hard stearins (http://dx.doi.org/10.1016/j.foodchem.2012.11.141, 2013) from sunflower oil, mixed with mid-fraction palm oil. Meanwhile, a recent Malaysian study points to a mixture of palm stearin with mango seed fat as being able to tolerate high temperatures (http://dx.doi.org/10.1016/j.foodchem.2013.11.098, 2014).

■■■

On April 28, 2014, the US Food and Drug Administration (FDA) published a final rule prohibiting certain nutrient content claims for foods that contain the omega-3 fatty acids docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), and α-linolenic acid (ALA). (See http://tinyurl.com/FDA-label-claim.) The rule will take effect January 1, 2016. It prohibits statements on the labels of food products, including dietary supplements, claiming that the products are "high in" DHA or EPA, as well as prohibiting the use of synonyms such as "rich in" and "excellent source of." The final rule similarly prohibits some such claims for ALA. The final rule takes no action with respect to other such claims for ALA. Under the Food, Drug and Cosmetic Act, nutrient content claims such as "high in" are allowed only for nutrients for which a reference level to which the claim refers has been set. FDA has not established nutrient levels that can serve as the basis for nutrient content claims for DHA, EPA, or ALA. ■

FOOD, HEALTH & NUTRITION

New work on almonds

A number of almond-related research studies were presented recently at the American Society of Nutrition (ASN)'s Scientific Sessions and Annual Meeting, held in conjunction with Experimental Biology 2014 in San Diego, California, USA. The studies, which were funded by the California Almond Board, examined the effects of almond consumption on overall diet quality and health status, abdominal adiposity, measures of appetite and satiety, and cardiovascular risk factors. Abstracts were published in the April 2014 issue of *The FASEB Journal* (the journal of the Federation of American Societies for Experimental Biology).

The studies included the following:

- Carol O'Neil of Louisiana State University (Baton Rouge, USA) presented an analysis of 24,808 adults aged 19 and older, using National Health and Nutrition Examination Survey data from 2000–2010 showing that almond consumers (n = 395; defined as those who reported eating any amount of almonds or almond butter in the previous 24 hours) had increased nutrient intake, improved overall dietary quality, and better physiological status compared with those who did not eat almonds. This is a cross-sectional study; therefore, the data cannot be used to draw causal relationships but suggests an association between almond consumption and positive health status. (See http://tinyurl.com/FASEB-O-Neil.)

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- Many commonly consumed snack foods are nutrient poor and elicit weak dietary compensation (the adjustment in energy intake made by individuals in subsequent meals in response to earlier food intake). Richard Mattes from Purdue University (West Lafayette, Indiana, USA) examined the effects of snacking on nutrient-rich almonds in 137 adult participants at risk for type 2 diabetes. Consuming 1.5 ounces (43 grams) of dry-roasted, lightly salted almonds daily helped curb participants' appetites and moderate blood glucose concentrations, while significantly improving vitamin E and monounsaturated fat intake. After a month of snacking on 250 calories (approximately 46 grams) from almonds daily, participants did not gain weight. (See http://tinyurl.com/FASEB-Mattes.)
- Another crossover, randomized clinical trial examined the metabolic response to 2 ounces (57 grams) of almonds compared with dairy fat in isocaloric and equal macronutrient meals consumed by overweight/obese pregnant women. Preliminary results suggest that almonds may help improve satiety, reduce appetite, and help promote healthy weight gain during pregnancy, although further research is needed. (See http://tinyurl.com/FASEB-Pregnancy.)

Rising CO_2 poses threat to human nutrition

At the elevated levels of atmospheric CO_2 anticipated by around 2050, crops that provide a large share of the global population with most of their dietary zinc and iron will have significantly reduced concentrations of those nutrients, according to a new study led by the Harvard School of Public Health (HSPH; Boston, Massachusetts, USA). Given that an estimated two billion people already suffer from zinc and iron deficiencies, resulting in a loss of 63 million life years annually from malnutrition, the reduction in these nutrients represents the most significant health threat ever shown to be associated with climate change, according to the researchers.

"This study is the first to resolve the question of whether rising CO_2 concentrations—which have been increasing steadily since the Industrial Revolution—threaten human nutrition," said Samuel Myers, research scientist in the Department of Environmental Health at HSPH and the study's lead author.

Some previous studies of crops grown in greenhouses and chambers at elevated CO_2 had found nutrient reductions, but those studies were criticized for using artificial growing conditions. Experiments using free-air carbon dioxide enrichment (FACE) technology became the gold standard because FACE allowed plants to be grown in open fields at elevated levels of CO_2, but those prior studies had small sample sizes and were inconclusive.

The researchers analyzed data involving 41 cultivars of grains and legumes from the C_3 and C_4 functional groups (plants that use C_3 and C_4 photosynthetic pathways) from seven different FACE locations in Japan, Australia, and the United States. The level of CO_2 across all seven sites was in the range of 546–586 parts per million. The scientists tested the nutrient concentrations of the edible portions of wheat and rice (C_3 grains), maize and sorghum (C_4 grains), and soybeans and field peas (C_3 legumes).

The results showed a significant decrease in the concentrations of zinc, iron, and protein in C_3 grains. For example, zinc, iron, and protein concentrations in wheat grains grown at the FACE sites were reduced by 9.3%, 5.1%, and 6.3%, respectively, compared with wheat grown at ambient CO_2. Zinc and iron were also significantly reduced in legumes; protein was not.

The finding that C_3 grains and legumes lost iron and zinc at elevated CO_2 levels is significant. Myers and his colleagues estimate that 2–3 billion people around the world receive 70% or more of their dietary zinc and/or iron from C_3 crops, particularly in the developing world, where zinc and iron deficiency is already a major health concern.

C_4 crops appeared to be less affected by higher CO_2, which is consistent with underlying plant physiology, as C_4 plants concentrate CO_2 inside the cell for photosynthesis so they might be expected to be less sensitive to extracellular changes in CO_2 concentration.

The researchers were surprised to find that zinc and iron varied substantially across cultivars of rice. That finding suggests that there could be an opportunity to breed reduced sensitivity to the effect of elevated CO_2 into crop cultivars in the future.

In addition to efforts to reduce CO_2 emissions, breeding cultivars with reduced sensitivity to CO_2, fortification of crops with iron and zinc, and nutritional supplementation for populations most impacted could all play a role in reducing the human health impacts of these changes, said Myers. "Humanity is conducting a global experiment by rapidly altering the environmental conditions on the only habitable planet we know. As this experiment unfolds, there will undoubtedly be many surprises. Finding out that rising CO_2 threatens human nutrition is one such surprise," he said.

The study appeared in *Nature* (http://dx.doi.org/10.1038/nature13179, 2014).

Links between dietary fats and colon cancer tumor growth found

New genetic evidence could strengthen the link between dietary fats and colon cancer progression.

Scientists led by Arizona State University (ASU; Phoenix, USA) researcher and physician Raymond DuBois found that the deletion of peroxisome proliferator-activated receptor delta (PPAR-δ) in a mouse model of colon cancer blocked key steps required for the initiation and progression of tumor growth.

"This study has shown without a doubt there is a new function for a key molecule, PPAR-δ, in the initiation and progression of colon cancer," said DuBois, executive director of ASU's Biodesign Institute. "These results also provide a new rationale for developing therapeutics that could block PPAR-δ to treat inflammatory bowel disease and colorectal cancer."

The DuBois research team has been in investigating the link between inflammation and colon cancer for the past two decades. Evidence for this link comes from data showing that the use of nonsteroidal anti-inflammatory drugs (NSAID) reduced the risk of developing colorectal cancer by 40–50%. NSAID target cyclooxygenase-2 (COX-2), which is central to the production of the pro-inflammatory molecule prostaglandin E2 (PGE2), found at high levels in colorectal tumors. DuBois' research team has long sought to uncover the key molecular steps regulating the COX-2/PGE2 pathway.

PPAR are essential in regulating the breakdown and storage of fats within a cell, and the DuBois team wanted to investigate the role PPAR-δ had on chronic inflammation and colorectal cancer progression.

In a mouse model of colon cancer, the team knocked out the gene regulating production of PPAR and found that the mice showed no clinical or cellular signs of chronic inflammation. Furthermore, when looking at the immune response, they found none of the usual immune cells associated with inflammation.

They also measured the levels of COX-2 and found that PPAR was required for induction of COX-2 expression and that high levels of PGE2 production that are associated with inflammation and colon cancer.

"We found that both PPAR and COX-2-derived PGE2 signaling coordinately promote tumorigenesis. This is likely to be clinically relevant because the elevation of both PPAR-δ and COX-2 in tumor tissues correlates with poor prognosis in colorectal cancer patients," said DuBois. "This provides us with

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an important new clue in designing and developing a therapeutic arsenal to stop the initiation and progression of colon cancer."

The study was published in the *Proceedings of the National Academy of Sciences* (http://www.pnas.org/cgi/doi/10.1073/pnas.1324233111, 2014). The research was supported in part by the National Institutes of Health and the National Colorectal Cancer Research Alliance.

Olestra to the rescue

Remember olestra (trade name: Olean)? Developed by the Procter & Gamble Co. (P&G; Cincinnati, Ohio, USA), olestra is a synthetic polyester of sucrose with up to eight attached fatty acids. Because of the size of its molecules, olestra passes straight through the digestive tract, thus functioning as a fat with zero calories. Used in snack foods, the compound developed a reputation for causing abdominal cramping and loose stools. Although it was approved by the US Food and Drug Administration as a food additive in 1996 (with an FDA-mandated warning label about the intestinal effects), olestra-containing products such as potato chips (crisps) never found wide acceptance by consumers.

According to work conducted in the United States and Australia beginning in the late 1990s, olestra has been shown to speed up the removal of toxins from the body. Much of that work was led by Ronald Jandacek of the University of Cincinnati, including a study in mice that was published in 2005. A new clinical trial in humans reported in the *Journal of Nutritional Biochemistry* (http://dx.doi.org/10.1016/j.jnutbio.2014.01.002, 2014) and led by Jandacek produced similar findings.

"The findings showed that the rate of PCB (polychlorinated biphenyls) disappearance from the participants that ate olestra was markedly faster during the one-year trial than that before the trial," said Jandacek.

Twenty-eight residents of Anniston, Alabama, USA, who had documented high levels of PCB after an industrial accident, participated in the 12-month study. ■

BRIEFS

Archer Daniels Midland Co. (Decatur, Illinois, USA) and Synthetic Genomics, Inc. (La Jolla, California, USA) announced in May their entry into a long-term agreement to develop and commercialize omega-3 docosahexaenoic acid (DHA) produced by algae. Synthetic Genomics has developed technologies to grow algae in fermentation tanks. The agreement is based on the premise that extracting DHA directly from heterotrophically grown algae yields a highly purified form of DHA, which can then be used as a dietary supplement for humans and in animal feed.

■■■

The European Food Safety Authority (EFSA) announced on May 16, 2014, that its review of Monsanto's genetically modified soybean MON 87769 did not reveal any safety issues regarding potential toxicity and allergenicity. Nor were there concerns about human health and nutrition. Since the use of oil derived from MON 87769 will result in a higher intake of stearidonic acid, EFSA recommended a post-market monitoring plan to confirm the exposure assessment using realistic consumption data for the European population.

■■■

In the second quarter of 2014 Novozymes announced the establishment of a new research and development center near Research Triangle Park, North Carolina, USA. The company will invest $36 million over the next three years and create 100 new research and development jobs.

■■■

Li Shihua, general manager of Bayan Jianong Agriculture Co. Ltd., the biggest seed and agricultural-production material supplier in Bayan, told ChinaDaily.com that around 70% of corn seed sold in the county is counterfeit and that this is quite common for the whole northeast region of China (http://tinyurl.com/ChinaDaily-counterfeit). ■

BIOTECHNOLOGY

Vermont to require GMO labeling

Peter Shumlin, governor of the US state of Vermont, signed a law on May 8 requiring that foods made with genetically modified organisms (GMO) be labeled as such. The law is set to take effect July 1, 2016. It would be the first time that any part of the United States would join with more than 60 other countries that require labeling of genetically engineered foods. Two dozen other states are currently considering mandatory labeling of such foods.

Legal experts predict there will be a challenge to this law, based on First Amendment rights. The US Food and Drug Administration has argued that genetically engineered foods do not differ from other foods "in any meaningful or material way" or present any different or greater safety concerns than foods developed by conventional plant breeding methods. Thus, attorneys point out that Vermont would have to prove that failure to label GMO-containing foods would harm consumers (http://tinyurl.com/VT-GMO-1stAmendment). Furthermore, proving that there are known or probable risks to human health—in contrast to possible risks—could be difficult.

A statement released by the Grocery Manufacturers Association (Washington, DC, USA) on May 8 said, in part, "Today, Vermont Governor Peter Shumlin signed into law HB 112, a bill that is critically flawed and not in the best interests of consumers. It sets the nation on a costly and misguided path toward a 50-state patchwork of GMO labeling policies that will do nothing to advance the safety of consumers."

Cathleen Enright, executive vice president for food and agriculture for the Biotechnology Industry Organization (Washington,

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DC), issued the following statement in response on May 8: "Unfortunately, when labels are mandated to promote one product over another, as this one in Vermont, the additional cost burden is placed on the state's farmers, food manufacturers, grocers, and consumers. . . . Such a program could needlessly increase food costs on the average household by as much as $400 per year" (http://tinyurl.com/VT-BIO-GMO-label).

A law similar to that in Vermont has also been proposed in New York State. William Lesser, a professor in the Dyson School of Applied Economics and Management (Cornell University, Ithaca, New York, USA) released a 29-page report on May 16, 2014, on the "Costs of labeling genetically modified food products in N.Y. state" (http://tinyurl.com/Lesser-labeling-NY). His calculations suggested that the annual midpoint cost of such labeling for a family of four would be $800. Lesser did point out that this number was an estimate only, and no one knows how consumers and the food industry will react if labeling is mandated (http://tinyurl.com/Lesser-comment).

Non-GMO lecithin

ADM announced plans in early May to increase its production capacity for non-genetically modified organism (non-GMO) lecithin by expanding capacity at its soybean processing facility in Latur, India, and by adding new rapeseed processing capabilities to its existing facility in Hamburg, Germany. ADM currently offers non-GMO lecithin, but this expansion will complement ADM's current North American production and allow ADM to produce non-GMO lecithin locally for customers in Europe and Asia.

In a company statement, Dan Larson, vice president, lecithin for ADM Foods & Wellness, said, "Our customers are seeing increasing consumer demand for non-GMO ingredients. This investment shows ADM's commitment to meeting our customer's evolving ingredient demands in a very dynamic marketplace."

Cargill also anticipates increased sales for non-GMO lecithin; they expect, however, to meet the demand with sunflower-based lecithin. The company points out that non-GMO soybean crops are increasingly at risk of contamination from GMO variants, owing to the increasing frequency with which GMO soybeans are being planted. Thus, it is becoming more difficult to segregate the non-GMO products.

Cargill says demand is growing for its Topcithin™ sunflower lecithin, a non-GMO emulsifier, as more manufacturers seek alternatives to soy lecithin. After four years of trying, Cargill announced at the end of April that it had obtained approval for the sale and use of sunflower lecithin in Japan, the only country in which it had not previously been approved for food applications. This also means that food companies around the world can export products containing Topcithin for sale in the growing Japanese market.

Plants' desaturating enzymes pair up

Scientists at the US Department of Energy's Brookhaven National Laboratory (BNL; Upton, New York) have found that certain enzymes responsible for desaturating fatty acids can link up to efficiently pass intermediate products from one enzyme to another. "Engineering these enzyme interactions to channel metabolites along desired metabolic pathways could be a new approach for tailoring plants to produce useful products," said BNL biochemist John Shanklin, lead author on a paper reporting the results in the *Journal of Biological Chemistry*.

Getting plants to accumulate high levels of more healthful polyunsaturated fatty acids, or unusual fatty acids that could be used as raw materials in place of petroleum-derived chemicals in industrial processes, are a few possible outcomes.

The idea would be to take advantage of a process called metabolic channeling, wherein enzymes that act sequentially in a particular metabolic pathway interact with each other so that they are able to pass molecules to each other without them entering the general metabolite pool of the cell. This close arrangement of enzymes also prevents intermediates from entering the metabolic channel.

Previous studies by Shanklin's group had shown that a distinct kind of desaturase enzyme that floats freely in plant plastids pair up with themselves to form dimers. The group had also studied baker's yeast and determined that its membrane-bound desaturase formed dimers too. But no studies had looked for these kinds of macromolecular arrangements in membrane-bound fatty acid desaturases (FAD) in higher plants. The current study used a molecular-genetic approach to explore the organization of membrane desaturases found in the plastids and endoplasmic reticulum of *Arabidopsis*, a common experimental plant.

Ying Lou, a postdoctoral research fellow working in Shanklin's lab, used several independent methods of bi-molecular complementation—methods that produce a signal if two test proteins come together—to establish which desaturases interact with themselves or others.

The scientists found that all the plant membrane desaturases they examined are capable of forming self-associating dimers in plant cells—pairings of two identical desaturase enzyme molecules. They also found that certain desaturases with different functions could also pair up, but others could not.

"The naturally pairing enzymes turn out to have interesting patterns," Shanklin said in a statement released by BNL (http://tinyurl.com/BNL-enzyme-dimers). "They are found in the same subcellular locations within the cell, and are involved in subsequent steps of the same metabolic pathway, suggesting a physiological driver for the observed pairings.

"Other pairings between very similar desaturases from different locations that we expected to pair up didn't," he added.

To test the idea that the paired enzymes were working together, the scientists conducted another series of experiments called metabolic flux analysis, drawing on BNL biochemist Jörg Schwender's expertise. This method follows mass-labeled compounds through the various reaction pathways.

"Think of a city map with lots of ways to get from A to B. This method traces how many molecules travel along each route," Schwender said. The analysis showed that one of the natural enzyme pairings performed two steps of a particular metabolic process without releasing an intermediate product.

"This was clear evidence that these two linked enzymes were working in concert to channel metabolites through this metabolic pathway in an efficient manner in living plant cells," Shanklin said. "Our findings suggest genetic techniques may be used to engineer these kinds of interactions into other desaturase enzymes—including enzymes that don't associate natu-

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rally—to push metabolites along desired pathways to produce useful products."

The original research appeared online on May 8: Lou, Y., J. Schwender, and J. Shanklin, FAD2 and FAD3 desaturases form hetero-dimers that facilitate metabolic channeling in vivo, *Journal of Biological Chemistry,* http://dx.doi.org/ 10.1074/jbc.M114.572883, 2014.

GM mosquitoes fight disease

Brazilian authorities decided in April 2014 that a genetically modified (GM) strain of mosquitoes whose offspring die before reaching adulthood do not pose a significant risk to humans or the environment. The decision will open up the possibility that the UK biotech firm Oxitec, which developed the insects, will sell them in Brazil as a control strategy for the mosquito-borne dengue fever.

The male GM mosquitoes have two additional genes: One makes a protein that causes a breakdown in the insect's development, and a second acts as a marker useful for monitoring the mosquitoes in the field. Wild female mosquitoes that mate with GM males transfer the genes to their offspring, which die before reaching maturity.

Researchers from the University of São Paulo, along with Oxitec, have tested this approach in three field trials in Brazil's Bahia state since 2011. In these, successive releases of the transgenic strain reduced the wild population of the *Aedes aegypti* mosquito by 79–93%.

EFSA to assess food enzyme safety

The European Food Safety Authority (EFSA) announced the completion of its first safety assessment of a food enzyme, xylanase, on May 14. This action is part of a plan by European Union (EU) decision makers to set up an authorized list of these substances.

EFSA is beginning a systematic evaluation of enzymes to comply with legislation that came into force in 2009 to harmonize the use of food enzymes across the EU. Before then food enzymes, other than those used as food additives, were not regulated at EU level.

The law applies to enzymes that perform any technological function in the manufacture, processing, preparation, treatment, packaging, transport, and storage of food. It includes food enzymes used as processing aids. It does not include food enzymes intended for human consumption, such as those added for nutritional purposes.

Producers will need to submit applications for the authorization of new and existing enzymes used in foods by March 11, 2015, the deadline set by the European Commission. EFSA will carry out safety evaluations of the food enzyme dossiers before they can be considered for inclusion on the list of approved food enzymes by EU decision makers. EFSA's Panel on Food Contact Materials, Enzymes, Flavourings and Processing Aids estimates there will around 300 food enzyme applications. ■

AOCS MEETING WATCH

October 6–9, 2014. World Conference on Fabric and Home Care—Montreux 2014, Montreux Music & Convention Centre, Montreux, Switzerland. http://Montreux.aocs.org

November 17–18, 2014. Edible Oil Refining: From the Fundamentals to New Technologies, Crowne Plaza Shanghai Pudong, Shanghai, China.

November 19–20, 2014. AOCS–CCOA Joint Symposium on Functional Lipids, Crowne Plaza Shanghai Pudong, Shanghai, China.

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

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

On May 1, 2014, Unilever and Solazyme, Inc.—a renewable oil and bioproducts company—announced the introduction of sustainable algal oils as an ingredient in one of Unilever's bar soap brands, Lux. Products from the recently completed manufacturing trial have been on store shelves in Brazil since early March 2014, the companies said. Unilever and Solazyme have been collaborating for five years on multiple projects, culminating in a supply agreement covering the first of Solazyme and Unilever's jointly developed tailored oils with an initial supply of at least 10,000 metric tons. The vast majority of the oil for the soap products will be produced in the joint Bunge-Solazyme renewable oils facility in Moema, Brazil. Unilever expects to purchase the full volume within 12 to 18 months, the company said in a news release.

■■■

Cargill (Minnetonka, Minneapolis, USA) has acquired Turkish oleochemical company Alemdar Kimya in order to manufacture its vegetable oil-based industrial products in Turkey, Cargill Turkey's Chairman Murat Tarakçıoğlu said at a press conference in late April 2014. Cargill's total holdings in Turkey are now about $50 million, he added.

■■■

The American Chemistry Council (ACC) has released a list of principles that it says will help the US Environmental Protection Agency and other federal agencies conduct "more scientifically sound and timely" chemical hazard and risk assessments. Too many do not "consistently meet the benchmarks of objectivity, transparency, and scientific accuracy," noted ACC. "Flawed assessments may create public confusion, stir unwarranted alarm, and lead to unnecessary regulatory actions." See http://tinyurl.com/ACC-Principles (pdf) for more information. ACC is a trade group based in Washington, DC, USA.

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HOME & PERSONAL CARE

Best paper, new applications for glycerine win awards

Research aimed at finding ways to overcome roadblocks to industrial production of value-added chemicals from glycerine received the 2014 Glycerine Innovation Award at the 105th AOCS Annual Meeting & Expo (AM&E) in San Antonio, Texas, USA.

The 2014 honoree is Xiaofei "Philip" Ye, associate professor at the University of Tennessee's Department of Biosystems Engineering and Soil Science in Knoxville, USA. The ACI/NBB Glycerine Innovation Award recognizes outstanding achievement for research into new applications for glycerine, with particular emphasis on commercial viability.

Ye undertook his research in response to the rapid growth of the biodiesel industry worldwide, which has resulted in the production of large amounts of glycerine, creating a need to quickly and effectively convert crude glycerine into value-added chemical products.

Three major commodity chemicals that can be derived from glycerine—acrylic acid, lactic acid, and propylene glycol—have been the subjects of extensive research in recent years. These chemicals serve as building blocks for plastics and polymers that are environmentally friendly, with wide applications in superabsorbent polymers, textile treating agents, adhesives, thermosetting resin, and synthetic fibers.

Despite the research, however, there are still "bottleneck problems" hindering the industrial production of these chemicals from glycerine.

"These bottleneck problems are the use of crude glycerine instead of purified glycerine as feedstock, the catalyst deactivation in the conversion of glycerine, and energy and hydrogen efficiency in the conversion of glycerine," said Ye.

"My research focuses on innovative technology development to overcome these bottleneck problems. In addition, I also conducted engineering modeling and economic analysis that justify and promote the use of

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innovative technologies for the commercial production of value-added chemicals from glycerine."

Ye's recent research in this area has been published in such journals as the *Journal of the American Oil Chemists' Society*, *ChemSusChem*, *Biofuels*, *Fuel Processing Technology*, and *Catalysis Letters*.

The American Cleaning Institute® (ACI) and the National Biodiesel Board (NBB) sponsor the annual award, which includes a plaque and a $5,000 honorarium. It was presented at the AOCS Industrial Oil Products Division luncheon on Tuesday, May 6, 2014.

Also at the AM&E, ACI recognized three researchers—Julia Boos, Wiebke Drenckhan, and Cosima Stubenrauch—as having written the best paper published in the *Journal of Surfactants and Detergents* (*JSD*) during 2013. The paper, "Protocol for studying aqueous foams stabilized by surfactant mixtures," appeared in the October 2013 issue of *JSD*. The abstract is available at http://tinyurl.com/JSD-Best-Paper.

Foams are dispersions of air in an aqueous surfactant solution that surrounds closely packed air bubbles. The properties of foams strongly depend on the type and amount of surfactant, which stabilizes the bubbles against coalescence. However, if one wants to compare the foaming properties of different surfactants (or surfactant mixtures) quantitatively, one needs to make sure that starting conditions are appropriate—namely, foams of the same liquid fraction, overall bubble size, and overall bubble size distribution.

"The protocol for studying foams presented in this work will help scientists from academia and the nonacademic sector to identify the important parameters for characterizing foams. It is only with this knowledge that quantitative comparisons are possible, which, in turn, allow for a proper classification of surfactants with regard to their foaming properties," Stubenrauch said.

Boos currently works as a research scientist at oelheld GmbH, Stuttgart, Germany, although this award-winning research was performed while she was in Stubenrauch's group at the University of Stuttgart in Germany. Drenckhan is CNRS researcher at the Laboratoire de Physique des Solides at the University of Paris in France. Stubenrauch is chair of "Physical Chemistry of Condensed Matter" at the University of Stuttgart.

P2 Science receives funding, partners with Desmet

Connecticut Innovations (CI), an organization that funds Connecticut (USA) businesses, has made a $500,000 investment in P2 Science Inc. of New Haven. This investment was part of a $1 million Series A funding round also involving Elm Street Ventures.

P2 Science is a specialty chemical company dedicated to producing high-value, high-margin consumer and industrial product ingredients from biomass. In addition to new proprietary ingredients, the company's products will include vegetable-based equivalents of chemical ingredients previously only available from petrochemical sources and will be suitable for direct substitution for such ingredients in customer products, said P2 in a news release.

The company's core refining steps uses proprietary process known as hybrid ozonolysis (HO) to convert biomass into aldehydes for use in fragrances and flavors, di-acids for use in cosmetics and polymers, and derivatives of aldehydes, such as alcohols, esters, and surfactants, for use in cosmetics, personal care products, and lubricants.

The company has begun manufacturing product ingredients using a pilot reactor installed at its lab in New Hanover.

In related news, P2 recently announced that it has partnered with global engineering company Desmet Ballestra SpA for the commercialization of Desmet's reactor technology in P2's proprietary HO process. P2 has already installed and run a pilot-scale falling film reactor from Ballestra at P2's lab.

Antibacterial soaps more effective?

The use of antibacterial soaps can reduce the spread of harmful bacteria, which often lead to foodborne illness, more effectively than using non-antibacterial soaps, according to research funded by the American Cleaning Institute (ACI) and Personal Care Products Council (PCPC). Both groups are trade associations based in Washington, DC, USA.

The research, published in the peer-reviewed *Journal of Food Protection* (http://dx.doi.org/10.4315/0362-028X.JFP-13-366, 2014), used laboratory data, together with simulation techniques, to compare the ability of non-antibacterial and antibacterial products to reduce the risk of the infectious disease shigellosis, which is often spread during food preparation.

Lead researcher Donald Schaffner of Rutgers University's Department of Food Science says the data show that the use of three antibacterial wash products results in a statistically significant reduction in the presence of *Shigella* (the bacterium that causes shigellosis) compared to the use of the non-antibacterial soaps.

In the study, 163 subjects were recruited to compare two non-antibacterial products and three antibacterial products, with a study design intended to simulate food handling. The participants' hands were exposed to *Shigella* and then treated with one of the five products before the subjects handled melon balls. The resulting levels of *Shigella* on the food were then measured.

The levels of *Shigella* were then used to predict the outcome from an event in which 100 people would be exposed to *Shigella* from melon balls that had been handled by food workers with *Shigella* on their hands.

The data showed all three antibacterial treatments significantly lowered the concentration of *Shigella* compared with the non-antibacterial treatments. Based on this model, the paper predicted that handwashing with the antibacterial treatments could significantly reduce the number of illnesses.

"This research provides strong evidence that antibacterial soaps are significantly more effective than non-antibacterial soaps in reducing *Shigella* on the hands and its subsequent transfer to ready-to-eat foods," the authors write.

Triclosan apparently spurs growth of breast cancer cells

The safety of triclosan as an antimicrobial ingredient in soaps, toothpastes, and other products has been under investigation and debate for a number of years. Now scientists are reporting new evidence that appears to support these worries. Their study, published in the journal *Chemical Research in Toxicology* (http://dx.doi.org/10.1021/tx5000156, 2014) found that triclosan, as well as octylphenol—which is used in paints, pesticides, and plastic agents—promoted the growth of human breast cancer cells in lab dishes and breast cancer tumors in mice.

Kyung-Chul Choi and colleagues at Chungbuk National University in the Republic of Korea note that hormonal imbalances seem to play a role in the development of breast cancer. Given that link, researchers are investigating whether endocrine-disrupting chemicals (EDC), which are compounds that act like hormones, might spur cancer cell growth. EDC are ubiquitous in products and in the environment. Prior research has found that two EDC—triclosan and octylphenol—have accumulated in the environment. Additionally, triclosan is reportedly detectable in the urine of an estimated 75% of the US population. Choi's team wanted to see what effect the two compounds have on breast cancer cells.

In tests on human breast cancer cells and in special immunodeficient mice with tissue grafts, the scientists found that both agents interfered with genes involved with breast cancer cell growth, resulting in more cancer cells. Mice exposed to the two compounds had larger and denser breast cancer tumors than the control group. "Although the doses of EDC were somewhat high, we did this to simulate their effects of daily exposure, as well as body accumulation due to long-term exposure, simultaneously in animal experiments," said Choi. "Thus, exposure to EDC may significantly increase the risk of breast cancer development and adversely affect human health," the researchers state in the paper.

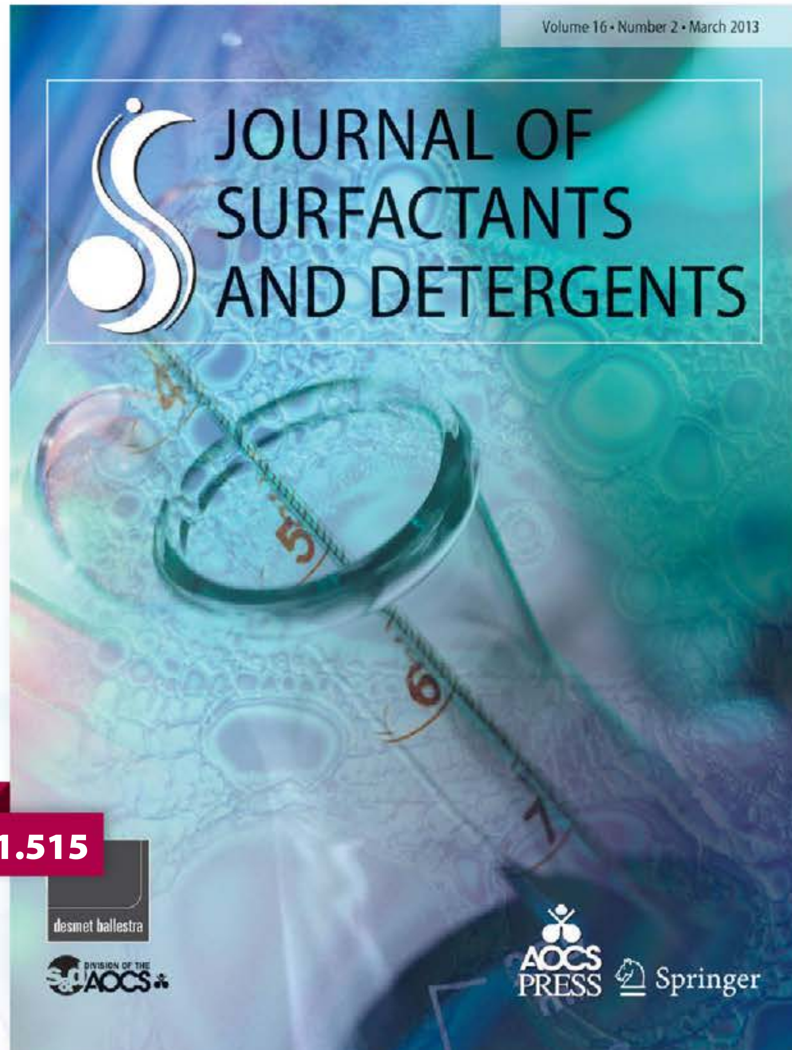
"Triclosan has been thoroughly studied for the potential to cause cancer and the results have been reviewed by government and independent scientists. The conclusions are that it does not," noted Richard Sedlak, American Cleaning Institute (ACI) executive vice president, technical and international affairs, in a statement. ACI is a trade association based in Washington, DC, USA.

"The researchers presenting this new work carried out their investigation under controlled conditions that don't appear to be relevant to how triclosan exposure occurs and, in the end, leads them to only speculate that there is possibly an effect. They are silent on how their findings stack up against the wealth of data supporting the conclusion that triclosan is not a carcinogen."

The authors cite funding from the National Research Foundation of Korea and the Rural Development Administration of Korea. ■

al Care Resources

From AOCS Journals



Journal of Surfactants and Detergents (JSD)

The peer-reviewed, science journal dedicated to the surfactants and detergents industry.

Jean-Louis Salager, Editor-in-Chief

JSD is a peer-reviewed, bimonthly journal that publishes research papers and reviews in the area of surfactants and detergents. This includes the basic and applied science of petrochemical and oleochemical-based surfactants, the development and performance of surfactants in all applications, as well as the development and manufacturing of detergent ingredients and their formulation into finished products.

2012 Impact Factor
1.515

Jean-Louis Salager has been the editor-in-chief of AOCS' *Journal of Surfactants and Detergents* (JSD) since 2008. He is the founder of the School of Chemical Engineering at the University of Los Andes in Mérida–Venezuela and is a professor emeritus of its faculty. He was awarded Venezuela's National Scientific Prize, the highest scientific and technological recognition of the country, and the Simón Bolivar Prize, its highest academic award. Under his editorship, *JSD* has gone from publishing quarterly to publishing six times a year and has doubled the number of published articles and performance indices such as the download number and the impact factor.

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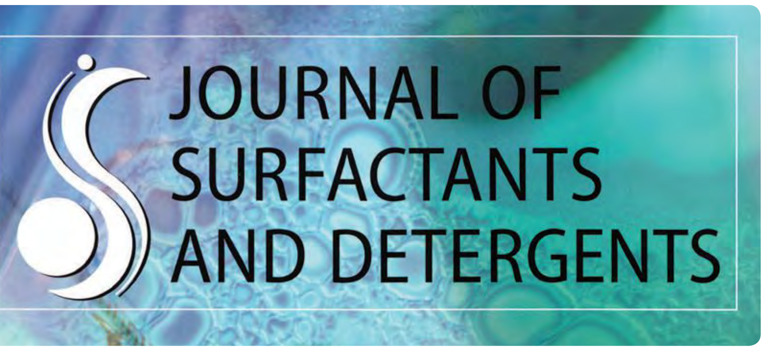
Journal of Surfactants and Detergents seeks Editor-in-Chief



The American Oil Chemists' Society (AOCS) seeks candidates for the Editor-in-Chief position of the *Journal of Surfactants and Detergents* (www.aocs.org/journals/jsd.cfm), a peer-reviewed, bimonthly (six issues per year) journal publishing research papers and reviews in the area of surfactants and detergents.

Content includes the basic and applied science of petrochemical and oleochemical-based surfactants, the development and performance of surfactants in all applications, as well as the development and manufacturing of detergent ingredients and their formulation into finished products. In the past five years, JSD has grown considerably. It has gone from publishing four times to six times a year and has doubled the number of published articles and performance indices such as the impact factor (1.515) and the download number.

The Editor-in-Chief position requires a motivated individual with experience in the field of surfactants and detergents research who is interested in making a significant contribution to a global society that provides information about fats, oils, and related materials including surfactants and detergents. Strong leadership qualities are a must. According to AOCS policy, the term for this appointment is five years, with an option for one additional term. We are seeking someone to begin this position in January 2015. This is a volunteer position with the only compensation being travel reimbursement to assist in attending a limited number of conferences each year.

The Editor-in-Chief sets direction for the publication while overseeing the paper solicitation process and making final selections for publication. Duties include leading a team of Associate Editors; working with AOCS and the international publisher Springer to define editorial policies; communicating with peer reviewers, prominent international authors, and the AOCS leadership team; attending Society and industry events; and chairing a Journal meeting at the Society's Annual Meeting & Expo.

For consideration, please submit the following documents by **September 1, 2014**: letter of intent (please include your interest in and vision for the position), vitae, and any other material that supports your candidacy. Send the documents to Janet Brown (janet.brown@aocs.org). Finalists will be interviewed in September, and a final decision will be made by November. For further information, please contact Janet Brown, AOCS Director, Content Development (phone: +1 217-693-4897; Fax: +1 217-693-4898; e-mail: janet.brown@aocs.org). ■

BRIEFS (cont. from page 441)

Ashland Specialty Ingredients, a commercial unit of Ashland Inc. (Wilmington, Delaware, USA) has introduced a web-based tool designed to help manufacturers of personal care products identify preservatives best suited for skin care and hair care formulations. Ashland said in a statement that it created the tool to better serve formulators responsible for preserving products in accordance with changing consumer requirements as well as varying regulations around the world. Formulators may access the new selector tool at http://ashland.com/pr/preservativesapp. ■

CLASSIFIED

PATENTS

Photopolymerisable composition

Knocke, F., XETOS AG, US8603730, December 10, 2013

There is described a photopolymerisable composition comprising: (i) 75–99% by weight of an ethylenically unsaturated monomer or a monomer mixture of different ethylenically unsaturated monomers, (ii) 0.5–25% by weight of a triglyceride or a mixture of different triglycerides, and (iii) 0.1–10% by weight of a photoinitiator system that activates the polymerisation of the ethylenically unsaturated monomer(s) upon exposure to actinic radiation, wherein the composition is a homogeneous, clear and, at 20°C, liquid mixture. Furthermore, there are described elements manufactured from such photopolymerisable compositions and methods for the formation of light-resistant holograms therefrom. The photopolymerisable compositions are useful, in particular, as recording material for optical elements having refractive index modulation, in particular, holograms.

Method for purifying fatty acid alkyl ester greatly loaded with saponification products

Bonsch, R., *et al.,* Lurgi GmbH, US8604228, December 10, 2013

A method for the continuous extraction of impurities, in particular saponification products, from a fatty acid alkyl ester phase produced by transesterification of vegetable or animal oils or fats with a great tendency to form saponification products, by means of an aqueous, acid glycerol phase containing a complexing agent.

Method for preserving a microorganism

Higashiyama, K., Nippon Suisan Kaisha, Ltd., US8609397, December 17, 2013

A method for preservation of a microorganism capable of microbial production of a polyunsaturated fatty acid or a compound comprising a polyunsaturated fatty acid as a constituent fatty acid, which method comprises: (i) forming spores in a spore-forming medium at pH 4–7 containing a nutrient source comprising an inorganic salt and a saccharide; (ii) suspending the spores obtained in (i) in sterilized water, or sterilized water containing a surfactant and/or an inorganic salt to prepare a spore suspension, and adding a cryoprotectant at 5–15% to prepare a cryopreserving spore suspension; and (iii) preserving the cryopreserving spore suspension obtained in (ii) at between –100°C and –20°C.

Selective biodegradation of free fatty acids in fat-containing waste

Reuter, C.J., *et al.,* Osprey Biotechnics, Inc., US8609398, December 17, 2013

A process of selectively degrading fatty acids in fat-containing waste materials without significant degradation of triglycerides, thereby converting otherwise economically burdensome waste materials into valuable products, involves contacting a fat-containing waste comprising triglycerides and fatty acids with a bacterial culture comprising *Pseudomonas* bacteria capable of degrading fatty acids into water and carbon dioxide, and wherein the bacterial culture is substantially free of microorganisms capable of producing extracellular lipase in an amount that would cause significant degradation of the triglycerides.

Gear oil composition

Okada, T., and S. Hara, Idemitsu Kosan Co., Ltd., US8609596, December 17, 2013

To provide a gear oil composition containing a base oil, and compounded therein: (i) an ashless dithiocarbamate compound and (ii) an ester of pentaerythritol and a C_{12}–C_{20} branched fatty acid, the ester having a hydroxyl value of 20–100 mg KOH/g. The gear oil composition has a high transmission efficiency and shows both of resistance to sludge formation and extreme pressure property.

Stabilized, antimicrobially effective composition with a content of bispyridinium alkane

Beilfuss, W., *et al.,* Air Liquide Sante (International), US8609697, December 17, 2013

An aqueous-based composition which includes (i) at least one bispyridinium alkane (for example, octenidine) and (ii) at least one stabilizer selected from antioxidants, complexing agents, reducing agents, UV filters and photoprotective agents, in particular α-tocopherol, and BHT [butylated hydroxytoluene]. The composition can also include (iii) one or more auxiliaries selected from, for example, nonionic surfactants, ethers, solvents and polymers, in particular fatty alcohol alkoxylates and alkoxylated fatty acid monoglycerides. The presence of the stabilizer reduces or prevents the appearance of decomposition products of bispyridinium alkanes and, in the case of the presence of auxiliaries, of decomposition products of the auxiliaries, such as ethers and peroxides.

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

Biohydrogenation of fatty acids is dependent on plant species and feeding regimen of dairy cows

Petersen, M.B., and S.K. Jensen, *J. Agric. Food Chem. 62*:3570–3576, 2014, http://dx.doi.org/10.1021/jf405552m.

Rumen biohydrogenation (BH) of C18:3n-3 (ALA) and C18:2n-6 (LA) has been shown to be reduced in cows fed species-rich herbage, but plant species offering the best protection against BH are yet to be elucidated. The aim of the present study was to investigate differences in rumen *in vitro* BH of ALA and LA between single plant species and feeding regimens. Rumen fluid was collected from cows fed either total mixed ration (TMR), species-rich silage (HERB), or grass silage (GRASS). Five single species (alfalfa, birdsfoot trefoil, chicory, English plantain, and salad burnet) and a grass-clover mixture (white clover and ryegrass) were incubated in three replicas up to 30 h and subsequently analyzed for fatty acid content. Michaelis–Menten kinetics was applied for quantifying the BH rate. BH proceeded at the lowest rate in alfalfa and salad burnet ($P < 0.005$), and independent of species BH rate was lower in HERB and GRASS compared to TMR ($P < 0.001$).

Evaluation of a rice bran oil-derived spread as a functional ingredient

Bakota, E.L., *et al., Eur. J. Lipid Sci. Technol. 116*:521–531, 2014, http://dx.doi.org/10.1002/ejlt.201300259.

As consumers continue to become more interested in the health properties of the food ingredients they purchase, the market potential for new functional ingredients, such as structured lipids and spreadable products, continues to grow. Recently we reported a solvent fractionation procedure for the production of a spreadable product derived from rice bran oil. This material is enriched in phytosterols and rice bran wax relative to crude rice bran oil and has rheological properties that differ vastly from the constituent oil. Here we evaluate the suitability of such a spread for use as a functional ingredient. Two potential avenues are explored: the use of the material as an antioxidant source in frying oils, and the use of this material as a fat replacer in baked goods. As an additive, the material was shown to impart oxidative stability to the oil. This spread was also successfully incorporated into two baked goods with

JAOCS

JOURNAL OF THE AMERICAN OIL CHEMISTS' SOCIETY

Journal of the American Oil Chemists' Society (June)

- Comparison of the lipid content, fatty acid profile and sterol composition in local Italian and commercial royal jelly samples, Ferioli, F., E. Armaforte, and M.F. Caboni
- Structure and physical properties of plant wax crystal networks and their relationship to oil binding capacity, Blake, A.I., E.D. Co, and A.G. Marangoni
- Optimization of triacylglycerol-estolide analysis by matrix-assisted laser desorption/ionization-mass spectrometry, Zhang, H., M.A. Smith, and R.W. Purves
- Composition of coconut testa, coconut kernel and its oil, Appaiah, P., L. Sunil, P.K. Prasanth Kumar, and A.G. Gopala Krishna
- A primary method for the determination of hydroxyl value of polyols by Fourier transform mid-infrared spectroscopy, Tavassoli-Kafrani, M.H., J.M. Curtis, and F.R. van de Voort
- Application of EPR spectroscopy and DSC for oxidative stability studies of *Nigella sativa* and *Lepidium sativum* seed oil, Naik, A., V. Meda, and S.S. Lele
- Purification and biochemical characterization of lipase from Tunisian *Euphorbia peplus* latex, Lazreg Aref, H., H. Mosbah, A. Fekih, and A. Kenani
- Modification of stearidonic acid soybean oil by immobilized *Rhizomucor miehei* lipase to incorporate caprylic acid, Ifeduba, E.A. and C.C. Akoh
- Antioxidant activity of sesame (*Sesamum indicum* L.) cake extract for the stabilization of olein-based butter, Nadeem, M., C. Situ, A. Mahmud, A. Khalique, M. Imran, F. Rahman, and S. Khan
- Effect of flaxseed meals and extracts on lipid stability in a stored meat product, Waszkowiak, K., and M. Rudzińska
- Content of antioxidants, antioxidant capacity and oxidative stability of grape seed oil obtained by ultra sound-assisted extraction, Malićanin, M., V. Rac, V. Antić, M. Antić, L.M. Palade, P. Kefalas, and V. Rakić
- Comparison of fatty acid profile of specialty maize to normal maize, Sanjeev, P., D.P. Chaudhary, P. Sreevastava, S. Saha, A. Rajenderan, J.C. Sekhar, and G.K. Chikkappa
- Properties and stability of hazelnut oil organogels with beeswax and monoglyceride, Yılmaz, E., and M. Öğütcü
- Isoflavone content of soybean cultivars from maturity group 0 to VI grown in northern and noudrthern China, Zhang, J., Y. Ge, F. Han, B. Li, S. Yan, J. Sun, and L. Wang
- GC-FID/MS analysis of fatty acids in Indian cultivars of *Moringa oleifera*: potential sources of PUFA, Saini, R.K., N.P. Shetty, and P. Giridhar
- Heat treatment and chemical composition of fatty acids and rosin acids mixtures: effects on their thermal properties and morphology, Mäki-Arvela, P., M. Mikkola, J. Hemming, K. Eränen, S. Willför, and D.Y. Murzin

- Physicochemical and antioxidant characteristics of kapok (*Ceiba pentandra* Gaertn.) seed oil, Anwar, F., U. Rashid, S.A. Shahid, and M. Nadeem
- Renewable source based non-biodegradable polyurethane coatings from polyesteramide prepared in one-pot using oleic acid, Rajput, S.D., V.V. Gite, P.P. Mahulikar, V.R. Thamke, K.M. Kodam, and A.S. Kuwar
- Investigation of some physicochemical properties of mixtures of morama seed oil with (C_6–C_9) *n*-alkanes at 298.15 and atmospheric pressure, Yeboah, S.O., I. Oathotse, and W.A.A. Ddamba
- Properties of soy protein produced by countercurrent, two-stage, enzyme-assisted aqueous extraction, de Almeida, N.M., J.M.L.N. de Moura Bell, and L.A. Johnson

Lipids

Lipids (June)

- Lipidomic analyses of female mice lacking hepatic lipase and endothelial lipase indicate selective modulation of plasma lipid species, Yang, Y., T. Kuwano, W.R. Lagor, C.J. Albert, S. Brenton, D.J. Rader, D.A. Ford, and R.J. Brown
- Rumen metabolism of 22:6n-3 *in vitro* is dependent on its concentration and inoculum size, but less dependent on substrate carbohydrate composition, Vlaeminck, B., T. Braeckman, and V. Fievez
- The *trans*-10,*cis*-15 18:2: a missing intermediate of *trans*-10 shifted rumen biohydrogenation pathway? Alves, S.P., and R.J.B. Bessa
- The relative proportions of different lipid classes and their fatty acid compositions change with culture age in the cariogenic dental pathogen *Streptococcus mutans* UA159, Custer, J.E., B.D. Goddard, S.F. Matter, and E.S. Kaneshiro
- Analysis of *Pseudomonas aeruginosa* PAO1 lipid A changes during the interaction with model organism, *Caenorhabditis elegans*, Vigneshkumar, B., S. Radhakrishnan, and K. Balamurugan
- Inter-tissue differences in fatty acid incorporation as a result of dietary oil manipulation in Port Jackson sharks (*Heterodontus portusjacksoni*), Beckmann, C.L., J.G. Mitchell, D.A.J. Stone, and C. Huveneers
- Retroconversion of docosapentaenoic acid (n-6): an alternative pathway for biosynthesis of arachidonic acid in *Daphnia magna*, Strandberg, U., S.J. Taipale, M.J. Kainz, and M.T. Brett
- Development of the analysis of fecal stanols in the oyster *Crassostrea gigas* and identification of fecal contamination in shellfish harvesting areas, Harrault, L., E. Jardé, L. Jeanneau, and P. Petitjean
- Development of an automated multi-injection shotgun lipidomics approach using a triple quadrupole mass spectrometer, Bowden, J.A., J.T. Bangma, and J.R. Kucklick

consistently high acceptability ratings for both baked goods tested.

An improved method for determining the phosphorus content in vegetable oils

Chen, B., *et al., Eur. J. Lipid Sci. Technol. 116*:548–552, 2014, http://dx.doi.org/10.1002/ejlt.201300378.

During pretreatment process for oil sample, charring and ashing processes of oil in AOCS Official Method Ca 12-55 were improved. Oil was pretreated with concentrated sulfuric acid and potassium hydroxide instead of zinc oxide. As a result, soluble phosphate was obtained in a short time; the subsequent steps were also simplified. First, phosphorus contents were measured, then the equivalent phosphatide contents in oil samples were calculated. The RSD (relative standard deviation) was only 1.03%. According to the spiking experiments at low, middle and high concentration levels, recoveries were between 97.03% and 100.99%; RSD were all less than 1.57% ($n=5$). The method was applied for determining the equivalent phosphatide content of different types of oils. Compared with AOCS Official Method Ca 12-55, the improved method can provide a more effective means for detecting and analyzing the phosphorus or the equivalent phosphatide content in vegetable oils.

Improved zeolite regeneration processes for preparing saturated branched-chain fatty acids

Ngo, H.L., *Eur. J. Lipid Sci. Technol. 116*:645–652, 2014, http://dx.doi.org/10.1002/ejlt.201300315.

Ferrierite zeolite solid is an excellent catalyst for the skeletal isomerization of unsaturated linear-chain fatty acids (i.e., oleic acid) to unsaturated branched-chain fatty acids (i.e., iso-oleic acid) follow by hydrogenation to give saturated branched-chain fatty acids (i.e., isostearic acid). In order for the isomerization process to be cost effective, the spent zeolite catalyst must be capable of regeneration for subsequent uses. We report a much improved zeolite regeneration protocol. The Ferrierite zeolite is efficiently regenerated by heating at 115°C for 20 h after each use and treatment with an acid solution after every fifth or sixth use. This approach allows the catalyst to be successfully used at least 20 times without significant decrease in conversion and selectivity. The unused and regenerated catalysts have been thoroughly characterized by various analytical techniques. The improved

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MINTEC STATISTICAL ANALYSIS

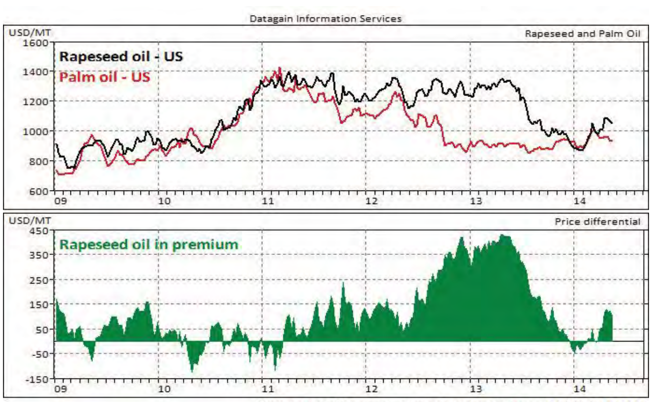
Awies Qureshi

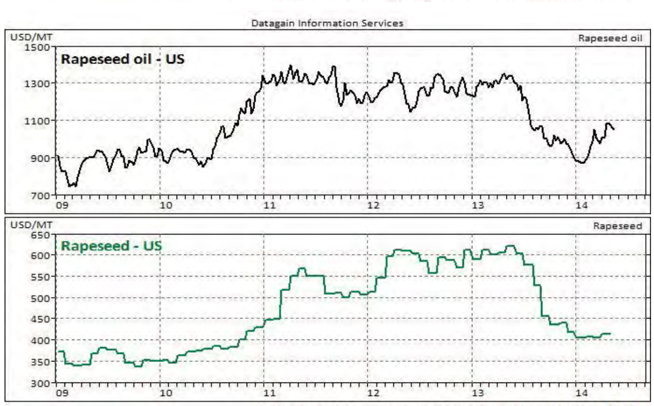
The price of palm oil remained relatively stable throughout 2013 despite a rise in global production, only rising towards the latter half of 2013 and into 2014 due to stronger than expected demand from the biofuel sector. Legislation changes made in Indonesia, the world's largest palm oil producer, will more than double the biofuel content in diesel, increasing demand from the biofuel industry. Global production of palm oil in 2013/14 is expected to rise by 5% year-on-year to 58.8 million metric tons (MMT). Early forecasts suggest a further 6% increase in production for 2014/15. Global consumption is also expected to rise by 5% in 2013/14 to 57.3 MMT and increase by a further 6% for 2014/15.

Palm oil and rapeseed oil prices have been increasing in early 2014 in line with the other major vegetable oils. Apart from higher demand from the biofuel sector, palm oil has also faced temporary supply concerns as the unusually dry weather experienced for the first few months of 2014 in Malaysia led to a reduction of supply from the world's second largest producer.

Rapeseed oil prices fell considerably over 2013, reaching a three-year low as beneficial weather in major producing countries has helped to raise global rapeseed production to a record high, while export demand declined as the biofuel sector substituted to cheaper oils. Rapeseed production in Canada, the world's largest producer, rose to a record 18 MMT in 2013/14, up 30% year-on-year. Canadian ending stocks also rose significantly to 3.1 MMT in 2013/14 from 0.6 MMT.

Global rapeseed oil production rose by 4% in 2013/14 to 25.9 MMT, while rapeseed production will reach 71.1 MMT, up 12% year-on-year, largely due to the increased production from Canada. Global ending stocks of rapeseed are also expected to rise, reaching 6.7 MMT in 2013/14, up 76% year-on-year. However, consumption has continued to increase, driven by increased demand from China, Canada, India and the US. Early estimates suggest that production in 2014/15 will fall 3% to 68.4 MMT.





catalyst regeneration protocol should enable cost-effective large-scale production of isostearic acid via zeolite-catalyzed skeletal isomerization.

Analysis of phytostanyl fatty acid esters in enriched foods via UHPLC-APCI-MS

Scholz, B., *et al., J. Agric. Food Chem. 62*:4268–4275, 2014, http://dx.doi.org/10.1021/jf500957a.

A method for the analysis of phytostanyl fatty acid esters, the functional ingredients of cholesterol-lowering enriched foods, was developed. The procedure is based on (i) separation of the intact esters via reversed-phase ultrahigh-performance liquid chromatography (ULPLC); (ii) detection by atmospheric pressure chemical ionization–mass spectrometry (APCI-MS); and (iii) quantification using selected ion monitoring (SIM) mode. In employing a C8 column, phytostanyl fatty acid esters sharing the same stanol nucleus could be separated according to the esterified fatty acids while esters with different stanol moieties could be distinguished via SIM based on the formation of an intense fragment ion $[M - \text{fatty acid} + H]^+$. The suitability of the approach was demonstrated using different types of enriched foods reflecting the diversity in potential matrices (skimmed milk drinking yogurt, margarine, and soft-cheese-style spread). The developed methodology extends the analytical basis for authenticity and quality assessments of functional foods enriched with phytostanyl fatty acid esters.

The food metabolome: a window over dietary exposure

Scalbert, A., *et al., Am. J. Clin. Nutr. 99*:1286–1308, 2014, http://dx.doi.org/10.3945/ajcn.113.076133

The food metabolome is defined as the part of the human metabolome directly derived from the digestion and biotransformation of foods and their constituents. With >25,000 compounds known in various foods, the food metabolome is extremely complex, with a composition varying widely according to the diet. By its very nature it represents a considerable and still largely unexploited source of novel dietary biomarkers that could be used to measure dietary exposures with a high level of detail and precision. Most dietary biomarkers currently have been identified on the basis of our knowledge of food compositions by using hypothesis-driven approaches. However, the rapid development of metabolomics resulting from the development of highly sensitive modern analytic instruments, the availability of metabolite databases, and progress in (bio)informatics has made agnostic approaches more attractive as shown by the recent identification of novel biomarkers of intakes for fruit, vegetables, beverages, meats, or complex diets. Moreover, examples also show how the scrutiny of the food metabolome can lead to the discovery of bioactive molecules and dietary factors associated with diseases. However, researchers still face hurdles, which slow progress and need to be resolved to bring this emerging field of research to maturity. These limits were discussed during the First International Workshop on the Food Metabolome held in Glasgow. Key recommendations made during the workshop included more coordination of efforts; development of new databases, software tools, and chemical libraries for the food metabolome; and shared repositories of metabolomic data. Once achieved, major progress can be expected toward a better understanding of the complex interactions between diet and human health.

Infrared stabilization of rice bran and its effects on γ-oryzanol content, tocopherols and fatty acid composition

Yılmaz, N., *et al., J. Sci. Food Agric. 94*:1568–1576, 2014, http://dx.doi.org/10.1002/jsfa.6459.

Rice bran is a nutritionally valuable by-product of paddy milling. In this study an experimental infrared (IR) stabilization system was developed to prevent rice bran rancidity. The free fatty acid content of raw and IR-stabilized rice bran samples was monitored every 15 days during 6 months of storage. In addition, energy consumption was determined. The free fatty acid content of rice bran stabilized at 600 W IR power for 5 min remained below 5% for 165 days. No significant change in γ-oryzanol content or fatty acid composition but a significant decrease in tocopherol content was observed in stabilized rice bran compared with raw bran. IR stabilization was found to be comparable to extrusion with regard to energy consumption. IR stabilization was effective in preventing hydrolytic rancidity of rice bran. By optimizing the operational parameters of IR stabilization, this by-product has the potential for use in the food industry in various ways as a value-added commodity.

Docosahexaenoic acid inhibits vascular endothelial growth factor (VEGF)-induced cell migration via the GPR120/PP2A/ERK1/2/eNOS signaling pathway in human umbilical vein endothelial cells

Chao, C.-Y., *et al., J. Agric. Food Chem. 62*:4152–4158, 2014, http://dx.doi.org/10.1021/jf5007165.

Cell migration plays an important role in angiogenesis and wound repair. Vascular endothelial growth factor (VEGF) is an endothelial cell-specific mitogen that is essential for endothelial cell survival, proliferation, and migration. Docosahexaenoic acid (DHA), an n-3 polyunsaturated fatty acid, shows both anti-inflammatory and antioxidant activities *in vitro* and *in vivo*. This study investigated the molecular

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mechanism by which DHA downregulates VEGF-induced cell migration. Human umbilical vein endothelial cells (HUVEC) were used as the study model, and the MTT assay [MTT = 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide], Western blot, wound-healing assay, and phosphatase activity assay were used to explore the effects of DHA on cell migration. GPR120 is the putative receptor for DHA action. The results showed that DHA, PD98059 (an ERK1/2 inhibitor), and GW9508 (a GPR120 agonist) inhibited VEGF-induced cell migration. In contrast, pretreatment with okadaic acid [OA, a PP2A (protein phosphatase 2) inhibitor] and *S*-nitroso-*N*-acetyl-DL-penicillamine (an NO donor) reversed the inhibition of cell migration by DHA. VEGF-induced cell migration was accompanied by phosphorylation of ERK1/2 and eNOS. Treatment of HUVEC with DHA increased PP2A enzyme activity and decreased VEGF-induced phosphorylation of ERK1/2 and eNOS. However, pretreatment with OA significantly decreased DHA-induced PP2A enzyme activity and reversed the DHA inhibition of VEGF-induced ERK1/2 and eNOS phosphorylation. These results suggest that stimulation of PP2A activity and inhibition of the VEGF-induced ERK1/2/eNOS signaling pathway may be involved in the DHA suppression of VEGF-induced cell migration. Thus, the effect of DHA on angiogenesis and wound repair is at least partly by virtue of its attenuation of cell migration.

Palm oil and blood lipid–related markers of cardiovascular disease: a systematic review and meta-analysis of dietary intervention trials

Fattore, F., *et al., Am. J. Clin. Nutr.* 99:1331–1350, 2014, http://dx.doi.org/10.3945/ajcn.113.081190.

Palm oil (PO) may be an unhealthy fat because of its high saturated fatty acid content. The objective was to assess the effect of substituting PO for other primary dietary fats on blood lipid–related markers of coronary heart disease (CHD) and cardiovascular disease (CVD). We performed a systematic review and meta-analysis of dietary intervention trials. Studies were eligible if they included original data comparing PO-rich diets with other fat-rich diets and analyzed at least one of the following CHD/CVD biomarkers: total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, TC/HDL cholesterol, LDL cholesterol/HDL cholesterol, triacylglycerols, apolipoprotein A-I and B, very-low-density lipoprotein cholesterol, and lipoprotein(a). Fifty-one studies were included. Intervention times ranged from 2 to 16 weeks, and different fat substitutions ranged from 4% to 43%. Comparison of PO diets with diets rich in stearic acid, monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) showed significantly higher TC, LDL cholesterol, apolipoprotein B, HDL cholesterol, and apolipoprotein A-I, whereas most of the same biomarkers were significantly lower when compared with diets rich in myristic/lauric acid. Comparison of PO-rich diets with diets rich in trans fatty acids showed significantly higher concentrations of HDL cholesterol and apolipoprotein A-I and significantly lower apolipoprotein B, triacylglycerols, and TC/HDL cholesterol. Stratified and meta-regression analyses showed that the higher concentrations of TC and LDL cholesterol, when PO was substituted for MUFA and PUFA, were not significant in young people and in subjects with diets with a lower percentage of energy from fat. Both favorable and unfavorable changes in CHD/CVD risk markers occurred when PO was substituted for the primary dietary fats, whereas only favorable changes occurred when PO was substituted for trans fatty acids. Additional studies are needed to provide guidance for policymaking.

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CALL FOR NO

A. Richard Baldwin Distinguished Service

This is the Society's highest service award. It recognizes long-term, distinguished service to AOCS in positions of significant responsibility.

Nature of the Award: $2,000, a travel-and-expense allowance, and a plaque provided by Cargill.

Deadline: November 1

AOCS Award of Merit

This award recognizes productive service to AOCS: leadership in committee activities; service that has advanced the Society's prestige, standing, or interests; and service not otherwise specifically recognized.

Nature of the Award: A plaque.

Deadline: November 1

AOCS Fellow

The status of Fellow is awarded to members of AOCS whose achievements in science entitle them to exceptionally important recognition or to those who have rendered unusually important service to the Society or to the profession.

Nature of the Award: Fellow membership status and a plaque.

Deadline: December 1

CALL FOR NOMINATIONS

Each award has its own specific and unique nomination requirements. Please refer to the website for full details.

Nominations must be submitted through our new online process and must include all required letters, forms, and references for consideration.

Self-nominations are welcomed and encouraged.

Supelco/Nicholas Pelick-AOCS Research

This award recognizes outstanding original research of fats, oils, lipid chemistry, or biochemistry. The recipient must have published the research results in high-quality technical papers regarding fats, oils, lipid chemistry, or biochemistry.

Nature of the Award: $10,000, a travel-and-expense allowance, and a plaque. The award is sponsored by Supelco, a subsidiary of Sigma Aldrich Corp, and Nicholas Pelick, past president of AOCS.

Deadline: November 1

Stephen S. Chang

This award recognizes a scientist, technologist, or engineer whose distinguished accomplishments in basic research have been used by industries for the improvement or development of products related to lipids.

Nature of the Award: $1,500 and a jade horse, provided by the Stephen and Lucy Chang endowed fund.

Deadline: October 15

AOCS Young Scientist Research

This award recognizes a young scientist who has made a significant and substantial research contribution in one of the areas represented by the Divisions of AOCS.

Nature of the Award: $1,000, a plaque, and a travel-and-expense allowance provided by the International Food Science Center A/S.

Deadline: November 1

Corporate Achievement Award

This award recognizes industry achievement for an outstanding process, product, or contribution that has made the greatest impact on its industry segment.

Nature of the Award: A plaque.

Deadline: November 1

ACI/NBB Glycerine Innovation

The Industrial Oil Products Division initiated this award to recognize outstanding achievement for research in new applications for glycerine with particular emphasis on commercial viability.

Nature of the Award: $5,000 and a plaque provided by the American Cleaning Institute and the National Biodiesel Board.

Deadline: November 1

Samuel Rosen Memorial

Milton Rosen and the Surfactants and Detergents Division initiated this award to recognize a surfactant chemist for significant advancement or application of surfactant chemistry principles.

Nature of the Award: $2,000 and a plaque.

Deadline: November 1

Herbert J. Dutton

The Analytical Division initiated this award to recognize an individual who has made significant contributions to the analysis of fats and oils and related products or whose work has resulted in major advances in the understanding of processes utilized in the fats and oils industry.

Nature of the Award: $1,000, a travel-and-expense allowance, and a plaque.

Deadline: November 1

Timothy L. Mounts

The Edible Applications Technology Division initiated this award to recognize research relating to the science and technology of edible oils or derivatives in food products, which may be basic or applied in nature.

Nature of the Award: $750 and a plaque provided by Bunge North America.

Deadline: November 1

Edible Applications Technology Outstanding Achievement

This award recognizes a scientist, technologist, or leader who has made significant contributions to the Division's field of interest, or made contributions to the advancement of edible oils.

Nature of the Award: $500 and a plaque.

Deadline: November 1

OMINATIONS

Ralph Holman Lifetime Achievement

The Health and Nutrition Division established this award to annually recognize an individual who has made significant contributions to the Division's field of interest, or whose work has resulted in major advances in health and nutrition.

Nature of the Award: $500, a travel-and-expense allowance, and a signed orchid print.

Deadline: November 1

Processing Distinguished Service

The award recognizes and honors outstanding, meritorious service to the oilseed processing industry.

Nature of the Award: Travel-and-expense allowance and a certificate.

Deadline: December 1

Surfactants and Detergents Distinguished Service

The award recognizes outstanding, commendable service to the surfactants, detergents and soaps industry.

Nature of the Award: A plaque.

Deadline: December 1

Alton E. Bailey

This award is supported by the USA Section and recognizes research and/or service in the fields of fats and oils and related disciplines.

Nature of the Award: $750 and a plaque.

Deadline: November 1

AAOCS Award for Scientific Excellence in Lipid Research

This award recognizes a scientist from within the Australasian region that has made a significant research contribution towards fats and oils research, either cumulative or one major advancement.

Nature of the Award: Travel-and-expense allowance to attend the 2015 AAOCS Section meeting and a plaque.

Deadline: See website.

Thomas H. Smouse Fellowship

This award was established by the Archer Daniels Midland Foundation and the family and friends of Thomas H. Smouse. The purpose of this graduate fellowship is to encourage and support outstanding research by recognizing a graduate student pursuing an M.S. and/or Ph.D. degree in a field of study consistent with the areas of interest of AOCS.

Nature of the Award: The Fellowship level is up to $15,000 ($10,000 Fellowship, $5,000 for travel and research expenditures related to the student's graduate program).

Deadline: February 1

Ralph H. Potts Memorial Fellowship

This award recognizes a graduate student working in the field of chemistry of fats and oils and their derivatives. Qualifying research will involve fatty acids and their derivatives, such as long-chain alcohols, amines, and other nitrogen compounds.

Nature of the Award: $2,000, a plaque, and travel-and-expense allowance. The award is supported by AkzoNobel, Inc.

Deadline: October 15

Honored Student

This award recognizes graduate students in any area of fats and lipids. To receive the award, a candidate must remain a registered graduate student and must not have received a graduate degree or have begun career employment prior to the Society's Annual Meeting.

Nature of the Award: Travel-and-expense allowance and a certificate.

Deadline: October 15

Hans Kaunitz

This award is supported by the USA Section and encourages studies in the sciences relating to fats, oils, and detergent technology. This award is open to graduate students within the geographical boundaries of the USA Section.

Nature of the Award: $1,000, a travel-and-expense allowance, and a certificate.

Deadline: October 15

AOCS Division Awards for Students

These awards recognize students at any institution of higher learning, who are studying and doing research towards an advanced degree in fats, oils, proteins, lipids, surfactants, detergents, and related materials.

The following student awards are currently being offered by these AOCS Divisions:

- Analytical Division Student Award
- Biotechnology Student Excellence Award
- Edible Applications Technology Division Student Award
- Health and Nutrition Division Student Excellence Award
- Industrial Oil Products Division Student Award
- Lipid Oxidation and Quality Division Student Poster
- Processing Division Student Excellence Award
- Protein and Co-Products Division Student Poster
- Surfactants and Detergents Division Student Travel Award

Nature of the Award: Awards can consist of $100 to $1,000 and a certificate.

Deadline: Varies from October 15 to January 15

See website.

The award recipient must agree to attend the AOCS Annual Meeting & Expo and present an award address.

The 106th AOCS Annual Meeting & Expo will be held in Orlando, Florida, USA from May 3–6, 2015.

AOCS Awards contact ➤ awards@aocs.org • **www.aocs.org/awards**

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.*

A self-proclaimed "outsider" to oils and fats chemistry, Albert Dijkstra is an independent consultant. Desmet Ballestra (Zaventem, Belgium) is one of his main clients. He has developed several novel processes and technologies in edible oils processing, has received multiple AOCS and European awards, and is an accomplished editor and writer.

Why did you join AOCS?

When I became involved with edible oils and fats, I joined the AOCS, AFECG (Association française pour l'étude des corps gras; now SFEL, or Société française pour l'étude des lipides), and the DGF (Deutsche Gesellschaft für Fettwissenschaft). While in college, I also joined the Royal Dutch Chemical Society,and later the Royal Society of Chemistry, and the Society of Chemical Industry. I have maintained memberships in all of these societies over the years. They do a good job. I encourage young professionals to join, not only for their own benefit, but as a matter of principle.

Describe your career path.

After defending my Ph.D. thesis at Leiden University in the Netherlands in 1965, I started to work for Imperial Chemical Industrial (ICI) in its corporate research laboratory. I did not like it, however, so I asked to be transferred to production. I was moved to ICI Holland—where we made Terylene and Nylon polymer—to become chief chemist of the Fibers Section. I had no engineering training, I did not know what a specification was, and I had never dealt with quality control, complaints, or technical liaisons. I learned it all on the job. I also learned a lot about accounting and project management. I was quite successful and was promoted to the ICI Europa headquarters in Brussels. The company was poorly managed, though, and I was not entirely surprised to be dismissed.

Being out of a job in 1975—when several chemical companies had shed a lot of staff—was not easy, so I was glad to work on a freelance basis for Charles H. Kline & Co. (Fairfield, New Jersey, USA), a chemical market research company. The company had undertaken a worldwide study of the chlor-alkali market and needed a chemist/researcher. I got the job because, in addition to Dutch and English, I also speak German and French. I interviewed chemical companies in Spain, Italy, Germany, and the Netherlands and designed a new "accounting system" for the chemicals involved. Freelancing for Kline enabled me to apply for jobs and go to interviews, but there were not many available senior positions. Finally, at the end of 1977, I accepted a position as Research and Development (R&D) Director of Vandemoortele (Izegemt, Belgium), a family-owned, vertically-integrated company. I loved it from the start.

Of course, it was not easy. I had no idea about edible oils and fats, and I still consider myself an "outsider" in the field. There were quite a few people who resented my having been given this senior position, but my ICI background prepared me for the challenges I faced. I used my engineering training to upgrade processes, my management training to improve logistics, and my chemical/mathematical background to keep existing projects on track. In fact, in my first two weeks, I looked at a project in linear programming of fat blends and all the data that had been gathered and developed a system that saved the company more than my R&D outfit cost. Subsequently, I developed a dry fractionation process that made CBE (cocoa butter equivalent)-grade product that led to a joint venture with Fuji Oil Co. (Osaka, Japan), and I developed a process of directed esterification of sunflowerseed oil that produced margarine with more than 66% polyunsaturated fatty acids and less than 14% saturated fats. Standard Brands (now Nabisco Brands, Inc.; East Hanover, New Jersey, USA) bought a license for this technology. I introduced ICP (inductively coupled plasma) as a tool for determining trace elements, and I used it to develop TOP (a Dutch acronym for *totaal ontslijmingsprocess*), the degumming process that allows oils to be physically refined. This process is now owned by GEA Westfalia (Oelde, Germany) and is operated in a few dozen plants. Additionally, I was actively involved in opposing some Unilever patents to get out of an infringement suit.

Things were going very well. But in 1990, new management appeared and in 1997, the Vandemoortele oil mills and refineries were sold, mainly to Cargill. Since my department worked mainly for these divisions, I ended up on the street once more.

Shortly after, I came across an advertisement for a chemist who had experience in building an R&D laboratory and setting up an R&D department; knowledge of edible oils and fats would be appreciated. I had just been awarded the AOCS Chang Award so I felt eminently suitable and applied by email; I received a reply telling me that if I did not hear from them within three weeks, that would be it. They never contacted me.

I concluded that at 57, I was too old to find a job. So I decided to work as an independent consultant and have done so for the last 17 years. I first worked for Alfa Laval AB (Tumbla, Sweden), who provided me with a retainer to prevent me from working for Desmet Ballestra. But when my contact left, the retainer dried up and I started to work for Desmet. I have looked after their intellectual property, provided them with ideas, and occasionally coached their R&D projects.

As a self-employed scientist, I have also written articles, reviews, chapters and even a book (*Edible Oil Processing from a Patent Perspective*, published by Springer). I lecture at short courses, am an associate editor of the *JAOCS*, and regularly review manuscripts for other journals.

What do you love about your job?

What I like about it is being independent, deciding my own priorities, and giving attention where I see fit. For example, take the base-catalyzed interesterification reaction. Baltes published a mechanism for this in 1960 (*Die Nahrung 1*:1–16) and since then, everybody, myself included, just quoted Baltes. I then realized that there were some observations that this mechanism could not explain. So I wrote to several colleagues but most of them did not seem to worry about this. I came up with another mechanism that could explain those observations, and I think this is now generally accepted.

I like being a critical outsider who reads critically, can solve problems, can work out a solution, and can get ideas more or less accepted.

What is the biggest challenge you have encountered in your career, and how did you address it?

Perhaps the biggest challenge was finding a job when I still had three children at high school. They were worried too. I reassured them that they need not worry, that I would pay for their university studies, and that I hoped that they would not have to pay for my old age. Discovering that you are too old for a job when you have made several inventions during the last few years is quite something.

How has your industry changed since you entered the field?

Edible oils and fats processing has changed since I joined in 1978. Many smallish firms have disappeared, and the industry is now dominated by Archer Daniels Midland Co., Bunge Ltd., Cargill, and the Louis Dreyfuss Group. Companies such as Unilever and Procter & Gamble who did a fair amount of R&D are no longer active in the field, and the Big Four hardly carry out any R&D because the others don't. Why waste money on something that is unpredictable anyway?

Do you have any advice for those looking to enter your field?

To answer this question, I refer to the penultimate slide of my 2009 AOCS Alton E. Bailey Award address.

- Don't believe everything you read or people tell you. They often contradict each other anyway;
- Question established truths. They can be myths that originated as suggestions and started to lead a life of their own;
- Define the problem as concisely as possible. Then you are already halfway to the answer;
- Think before attempting experimental verification. Thinking is cheap, but laboratory work is expensive, especially when unnecessary;
- Above all, enjoy. Chemistry is fun, or at it least it should be.

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

More of the same probably: More cost saving, more MBAs who haven't got much idea what they are talking about, less

CONTINUED ON NEXT PAGE

R&D within the industry, more and more reliance on the few remaining suppliers, and less fun.

Describe a memorable job experience.

I was once asked to develop confectionery fats by a dry fractionation process. My employer, Vandemoortele, had taken over Palmafina, a subsidiary of Oleofina, which had recently installed a dry fractionation unit consisting of several crystallizers and a Florentine vacuum band filter. We had no idea how much olein was in the filter cake, but it looked quite dry. So we thought of a simple experiment. In the laboratory, we added anisole to the oil, which would not crystallize during fractionation and on gas-liquid chromatography would elute in between the fatty acid methyl esters (FAME). We carried out a fractionation and isolated the stearin by filtration using a Buchner filter.

We determined the fatty acid composition of the stearin by making FAME and, lo and behold, there was a lot of anisole in the sample; the olein content of the dry cake was around 70%. I then got hold of a small basket centrifuge (a household juice extractor) and we scooped some stearin into this extractor and switched it on. A large amount of olein emerged from the juice spout and the stearin that was left in the bowl had an iodine value of around 25%. It was drier than people now attain industrially with a membrane filter press.

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

When I agreed to work for Vandemoortele, I could not start straightaway. My future boss gave me Bailey's (the standard reference on food chemistry and processing technology related to edible oils and the nonedible byproducts derived from oils) and warned me that I should not get too annoyed. I did not like this handbook at all. The authors just reported what other people had published and did not worry about the contradictions. I then decided that if I were to write such a book, I would approach it differently: "A says this, B says something different, and their contradicting views can be reconciled by assuming the following." And then I would write something I thought of. I could also disagree with what these people had written and would say why I disagreed. So this is what I did when writing the processing chapters in *The Lipid Handbook.*

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

Don't be afraid to contact people. Use one of their publications to ask a pertinent question. Authors hardly ever get reactions on what they have written, so if they get a question or comment, they are likely to answer.

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

After a time in research and/or production, I would have trained as a patent agent. I could have ended up in a university lecturing about patent law and then working as patent agent after retirement.

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

I am afraid that the culture in edible oil processing has become more fashion-oriented and less science-based. A few examples:

Sustainability is just a marketing gimmick;

Trans isomers are bad because they increase blood serum cholesterol levels, and if this happens in a rabbit, it dies. But I am not a rabbit;

Cold-pressed oils can be quite dirty and have a short shelf life. Even so, they are sold at a premium;

High-oleic is very good, healthy, and stable. But by adding an anti-foam such as polydimethylsiloxane to a deep frying fat, this overrules any effect of fatty acid composition;

Purveyors of biodiesel technology are too concerned about profits and lack competence in chemistry.

In your area/field and considering today's market, is it more important to be well-rounded or a specialist?

This question more or less implies that the two possibilities are mutually exclusive, but to me, they are not. A person should have a broad base from agronomy to zoology and everything in between, so B for biotechnology, C for chemistry, D for detergents, E for economics, F for food science, and so on. With a broad knowledge base, one can specialize in what is needed at the time.

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

Possessing a degree does not make a person more intelligent or creative. It only shows the outside world that the person is capable of obtaining that degree. Going to a university should involve developing a critical attitude and independent thinking. Study an intriguing subject, and not because others say it offers good job opportunities or higher pay. It is much more fun to do a job in one's hobby field than to do something unenjoyable for more money. ■

Replacing **trans fats**

What will it mean for the food industry when partially hydrogenated oils are no longer generally regarded as safe?

- Late last year, the US Food and Drug Administration (FDA) announced plans to remove partially hydrogenated oils (PHO) from the list of food ingredients that are generally regarded as safe (GRAS).

- Over the past decade, the food industry has decreased the use of partially hydrogenated oils—which contain unhealthful trans-fats—by about 75%. But this new change will require that PHO disappear entirely from food products.

- Although it may sound simple, reformulating hundreds of food products that currently contain PHOs presents challenges to both ingredient suppliers and food manufacturers. This topic was the focus of a special session at the 2014 AOCS Annual Meeting & Expo (May 4–7), "Implications of FDA's Preliminary Determination Regarding Partially Hydrogenated Oils."

Christine Herman

Partially hydrogenated oils will be difficult to replace in certain food products where their unique chemical and physical properties play an important role, said Judith Moca, principal scientist at Kraft Foods.

THE APPEAL OF PHO

You could publish a book about all the useful characteristics of partially hydrogenated oils, she added. PHO are suitable in so many food applications because of their stability, high melting temperature, and optimum melting profile that ensures both a "proper mouth feel" and ideal behavior in melting applications.

Although PHO have been phased out of many foods, several product groups—including donuts, crackers, popcorn and frosting—still contain them. Replacing PHOs in these products will likely affect their taste, reduce their shelf life, and raise costs to food industries—and ultimately consumers.

THERE'S NO MAGIC BULLET FOR REPLACING PHO

One of the biggest challenges to replacing PHO is finding suitable alternatives. As it turns out there's no one-size-fits-all solution, according to Dennis Strayer, director of regulatory and product support at Bunge North America Inc. (St. Louis, Missouri, USA).

"We've developed alternatives," Strayer said, "but we're finding that these alternatives are not a single drop-in for all solutions."

In other words, what works for one application is not guaranteed to work for another, so food manufacturers will have to come up with individualized solutions for each product.

CHALLENGES TO INGREDIENT SUPPLIERS

If required to move quickly, Strayer said Bunge likely will look to readily available palm-based alternatives to replace PHO, but Bunge would have to address several issues that would come with the change.

Transportation. Palm oil would have to travel long distances to Bunge's centrally located US-based processing plants. Soybeans, which are the most common feedstock for PHO, travel about 200 to 300 miles to the plant, where they are crushed and the oil is stored onsite until it is used. Palm oil, on the other hand, would have to travel 8,500 miles across the Pacific ocean to a port on the west coast, then travel by rail to the Midwest.

The additional travel distance translates into higher costs and creates other logistical issues, such as managing inventories and the ups and downs of customers' demands, Strayer added.

Although rail cars will be freed up from not having to transport PHO, Strayer expects there won't be enough rail cars available to transport all the imported palm oil, and the wait time for ordering new rail cars could be up to several years owing to competition with the petroleum industry.

Storage. Soybean oil is a liquid down to about 30° F to 35° F (-1° C to 1° C), Strayer explained, which allows it to be stored in unheated tanks. But palm oil has a much higher melting point, so the company would need to purchase heated tanks in order to store the oil in liquid form.

Strayer estimates ingredient suppliers will need about three years to fully replace PHO. Then it will be up to the food industry to fully incorporate the new ingredients into products.

CHALLENGES TO FOOD MANUFACTURERS

For Kraft Foods, Moca said, phasing out all PHO will require reformulating about 150 raw materials that come from about 50 suppliers and go into roughly 400 formulations that make about 800 finished products. In a nutshell, a lot of work will need to be done.

Finding a suitable non-PHO alternative. The first barrier will be determining which oils should replace the PHO in each product. Moca said Kraft will consider many options and weigh the costs and benefits to determine which performs best without causing drastic changes to quality, cost, and taste. Potential PHO alternatives include tropical oil blends, interesterified oils, fully hydrogenated oils, dairy and animal fats, and naturally stable oils such as cottonseed or corn.

Kraft will also look at new oilseed varieties, Moca said, such as high-oleic soybean oil and other oils that have suitable characteristics. It will also consider oils from other sources, such as yeast or algae, and even look at different ways of hydrogenating, such as electrochemical hydrogenation, if it is possible to get the final ingredients approved by the FDA.

"The industry might not be there yet with all the solutions we need to have," Moca said. So it is not going to be as simple as replacing one supplier with another.

Documentation, testing, and sales. Each product reformulation requires a series of action steps to complete, Moca said, including redoing all the documentation and specifications for raw materials, formulae and finished goods, reviewing contracts with suppliers, and performing sensory testing and consumer testing.

Additionally, the sales team will need to be convinced that the non-PHO product is as safe as the previous product, and the marketing team will have to work to ensure customer approval of the changes.

"Sometimes, even if we make a very small change, guess what, they're able to pick it up," Moca said, even if the change is not detected by a sensory panel.

The bottom line. Switching from PHO to alternative oils almost certainly means higher prices for raw materials, Moca said. "At the end of the day, all of these costs are going to be seen in the retail price."

For Kraft, those additional costs will total up to a small fraction of its net revenue, Moca said. But she expects smaller companies will take the hardest hit if the anticipated PHO reclassification comes through.

NOT IMPOSSIBLE, JUST NOT PLEASANT

Strayer emphasized that the many issues surrounding the switch from PHO to non-PHO alternatives do not make it impossible to switch from PHOs to alternatives, just more challenging.

"The industry has been very resourceful over the years," he said. "We will find solutions on how to solve these things . . . this isn't the end of the world."

But it will take time and a lot of effort on the part of the food industry.

"Revoking the GRAS status [of PHO]," Moca said, "will . . . give manufacturers quite a bit of headache and you will have severe consequences," such as those mentioned above.

While they await the FDA's final decision regarding the GRAS status of partially hydrogenated oils, Moca said the food industry will continue to engage with the agency to discuss "less destructive and more effective ways of eliminating trans-fats from diets."

Christine Herman is a science writer for AOCS.

Innovative technologies for trans-fat reduction in shortening and oils

G.R. List and D.K. Nakhasi

Over the past decade the food industry made substantial progress in providing trans-fat replacements to meet nutrition labeling requirements mandated by the US Food and Drug Administration (FDA). Efforts to replace trans fats drove the reemergence of the trait-modified oil industry, which now furnishes about 20% of domestic oil needs for human consumption. This has occurred through the efforts of government, industry, and academic scientists over about a 25 year time frame.

- **Over the past decade the food industry made substantial progress in providing trans-fat replacements to meet nutrition labeling requirements. However, in late 2013, the US Food and Drug Administration (FDA) announced plans to remove partially hydrogenated oils from the generally regarded as safe (GRAS) list.**
- **The 2014 AOCS Annual Meeting and Expo in San Antonio, Texas, USA, held May 4–7, included a technical session on innovative technologies for trans-fat reduction in shortening and oils.**
- **Here is a review of that session.**

Time-honored oil processing methods have been modified to provide trans-fat replacements for the baking and food service sectors. Examples include enzymatic interesterification, modified hydrogenation, fractionation, and blending. By 2005 most foods had been reformulated, and by 2012 a substantial number were reduced to 0.2 grams trans-fatty acids/serving including food groups previously high in trans fats.

However, in late 2013 the US FDA announced plans to remove partially hydrogenated oils from the generally regarded as safe (GRAS) list. This leaves the future of catalytic hydrogenation as a fat modification tool in serious jeopardy despite a pronounced reduction in use. Thus, it seemed appropriate to review the progress made in trans-fat reduction in shortening and oils.

Perhaps the biggest challenge in reducing trans fats occurred in the baking industry. Roger Daniels (Stratas Foods, Memphis, Tennessee, USA) described his research as "Form Follows Function." Since baking shortenings perform many functions, trans-fat replacements must perform as well as the product they are replacing. Studies conducted on trans-free palm-oil-based and interesterified shortenings confirmed that excellent performance in cookies, cakes, and pie crusts were achieved.

Susan Knowlton (DuPont Co., Wilmington, Delaware, USA) described the performance of trait-modified soybean oils in food applications. Trait-modified soy oils have evolved from low-linolenic to mid- and high-oleic acid lines. Developed through traditional plant breeding, these oils are characterized by reduced polyunsaturates and increased monounsaturated fatty acids. As such, trait-modified oils are much more stable than the parent commodity oil. Trait-modified oils serve well in deep fat frying operations. Other applications for trait-modified soy oils include spray oils, pan and griddle frying, as well as in snack foods (both as an ingredient and for frying).

Dietary fats continue to be of great interest because of potentially adverse health and nutritional effects. Ed Hunter (Xavier University, Cincinnati, Ohio, USA) reviewed recent studies on the role of stearic acid in blood lipids. A careful review showed that stearic acid is neutral in elevating low-density lipoprotein (LDL) levels. This observation shows that the use of interesterified and fully hydrogenated fats poses little risk in elevating LDL levels.

Modified hydrogenation represents a possible low-trans option for food use. Neil Higgins (Bunge North America, St. Louis, Missouri, USA) showed that the use of chemically modified nickel catalysts coupled with increased pressure and lower temperature resulted in a drastic reduction in trans fat suitable for baking shortenings.

Although plant breeding has been useful in bringing trait-modified oils to commercialization, the use of biotechnology in combination with plant breeding has proven to be another option. Jerry Heise (Monsanto, St. Louis, Missouri) described applications of biotechnology for several soybean lines. A low-saturate high-oleic oil is a no-trans/low-saturate (6% saturated fat) product that performs well in deep fat frying and other food service applications. Omega-3 oils are of great interest because they are precursors to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) needed for prostaglandin synthesis. Commodity soybean oil contains about 7–8% omega-3 acids. Through biotechnology an enriched omega-3 soybean oil has been developed and is in the final stages of commercialization.

Palm/palm kernel oils offer numerous possibilities for trans-fat replacements. Gerry McNeill (IOI Loders Croklaan, Channahon, Illinois, USA) described the latest in alternatives to hydrogenation through use of tropical oils. Through fractionation, interesterification, hydrogenation, and blending, tropical fats have proven to be versatile and functional in baking applications.

Algal oils offer a trans-free solution, as discussed by Risha Bond (Solazyme Inc., South San Francisco, California, USA). A process was described for generating trans-free oil from algae that that were grown fermentatively as opposed to in open ponds. The product is available commercially and meets the requirements and composition for an edible oil

Sunflower oil is an old crop that has undergone considerable improvement. Monoj Gupta (MG Edible Oil Consulting International Inc., Lynwood, Washington, USA) traced the history and food uses of sunflower oil that culminated with NuSun® through the efforts of US Department of Agriculture scientists and Archer Daniels Midland Co. (Decatur, Illinois, USA). NuSun is a mid-oleic oil and is highly suitable in frying and snack foods. Other available sunflower oils include the high-linoleic and high-oleic acid varieties. Supply and the higher costs have been factors in expansion of the sunflower oil industry.

The food service industry is a major user of fats and oils. David Booher (Dow AgroSciences, Indianapolis, Indiana, USA) described the performance of trait-modified canola oil in food service applications. Canola oils commercially available include low-linolenic and high- and mid-oleic lines. The latter perform well in food service for frying, as spray oils, and for pan/griddle use. Although chemical interesterification is an old fat modification technology, the use of enzymes has only been commercialized in the past 10 years. Tom Tiffany (Archer Daniels Midland) reviewed the applications of the enzyme technology for production of baking fats along with performance data for cookies, cakes, and pies. These products were compared against hydrogenated shortenings and found to compare well.

Gary R. List co-chaired the session on which this article is based. He is currently working as a consultant after retiring from the US Department of Agriculture, Agricultural Research Service, National Center for Agricultural Utilization Research, in Peoria, Illinois, USA, and contributed two chapters in the recent AOCS Press title, Trans Fats Replacement Solutions. *He can be reached at grlist@telstar-online.net.*

The session's other co-chair, Dilip K. Nakhasi, is director of innovation at Bunge Oils, Inc. (Bradley, Illinois, USA). He can be reached at dilip.nakhasi@bunge.com.

Learn more on this topic

Gary List, co-chair of this Edible Applications Technology (EAT) session, also contributed two chapters in the recent AOCS Press title, *Trans Fats Replacement Solutions* (http://tinyurl.com/List-in-TFRS).

In one chapter List offers specific information on trans-fat replacement solutions for frying and baking applications, as well as for shortenings, margarines, and spreads. In his second chapter, List provides an overview of replacement solutions in North America. Both chapters have extensive lists of references.

Modification of gold nanoparticles for SERS analysis of edible oils

Michael Driver and Lili He

Raman spectroscopy is a vibrational spectroscopy method capable of providing a fingerprint spectrum of a compound based on its molecular structure. The method measures the amount of monochromatic light—usually from a laser in the visible, near infrared, or near ultraviolet range—that is scattered inelastically. Raman scattering occurs with a frequency of 1 in 10,000,000 photons.

Although Raman scattering is relatively weak, advances in laser and receptor technology have made Raman spectroscopy a very useful tool for sample characterization and identification. It is commonly used to identify and validate ingredients and to support other quality control measures in the pharmaceutical industry. It is also used in threat detection, as it is useful in determining different types of explosives.

- The hydrophobicity of gold nanoparticles capped by citrate was modified using a simple method involving octanethiol in hexane.
- Using modified gold nanoparticles, the authors observed substantial spectral changes of canola oil after it was oxidized.
- Surface-enhanced Raman spectroscopy (SERS) can determine the occurrence of oxidation in canola oil more quickly than with traditional tests.

Applying Raman spectroscopy to food samples is not new but, industry-wide, the method is not as popular as infrared spectroscopy. There are several reports on using Raman spectroscopy to analyze edible oils. One study characterized 21 different types of food lipids, demonstrating that it is possible to differentiate different types of similar oils using Raman spectroscopy. Another study was done to identify hazelnut oil contamination in olive oil, which is a practical analytical issue in the olive oil industry; standard methods for this analysis ordinarily involve longer and more complicated methods. In addition, two Raman characterization studies were done to monitor the oxidation process of oil.

Since Raman scattering is relatively weak, it was not previously considered to be sensitive enough to measure lipid oxidation, especially compared to traditional techniques. However, a new technique called surface-enhanced Raman spectroscopy (SERS) has recently been demonstrated to enhance Raman signals significantly, making Raman measurements much more sensitive. SERS utilizes noble metal nanostructures, such as gold or silver nanoparticles, to enhance the Raman scattering of a sample through a phenomenon called localized surface plasmon resonance. For the scattering to be enhanced this way, the sample must be within only a few nanometers of the nanoparticles.

Gold nanoparticles (GNP) are a colloidal solution stabilized by surface ligands such as citrate and less susceptible to oxidation than silver nanoparticles, which makes them a better substrate for this application. The two most frequently used sample preparations for SERS samples are the substrate method, in which the GNP are placed on a slide and dried, with the sample placed on top; or the solution method where the GNP are mixed with the sample, and the mixture is placed on the slide. Previously, we used the substrate method for testing lipid oxidation on silver dendrites, but the sensitivity was not very satisfactory. The solution method is preferable because it allows the GNP to bind with the sample molecules more uniformly. However, as most of the GNP are prepared in aqueous conditions, they are not compatible with the oil. Therefore, the GNP must be modified. Thiol-containing compounds have been used to modify the surface chemistry of the GNP due to their strong binding affinity to gold. The objective of our study was to

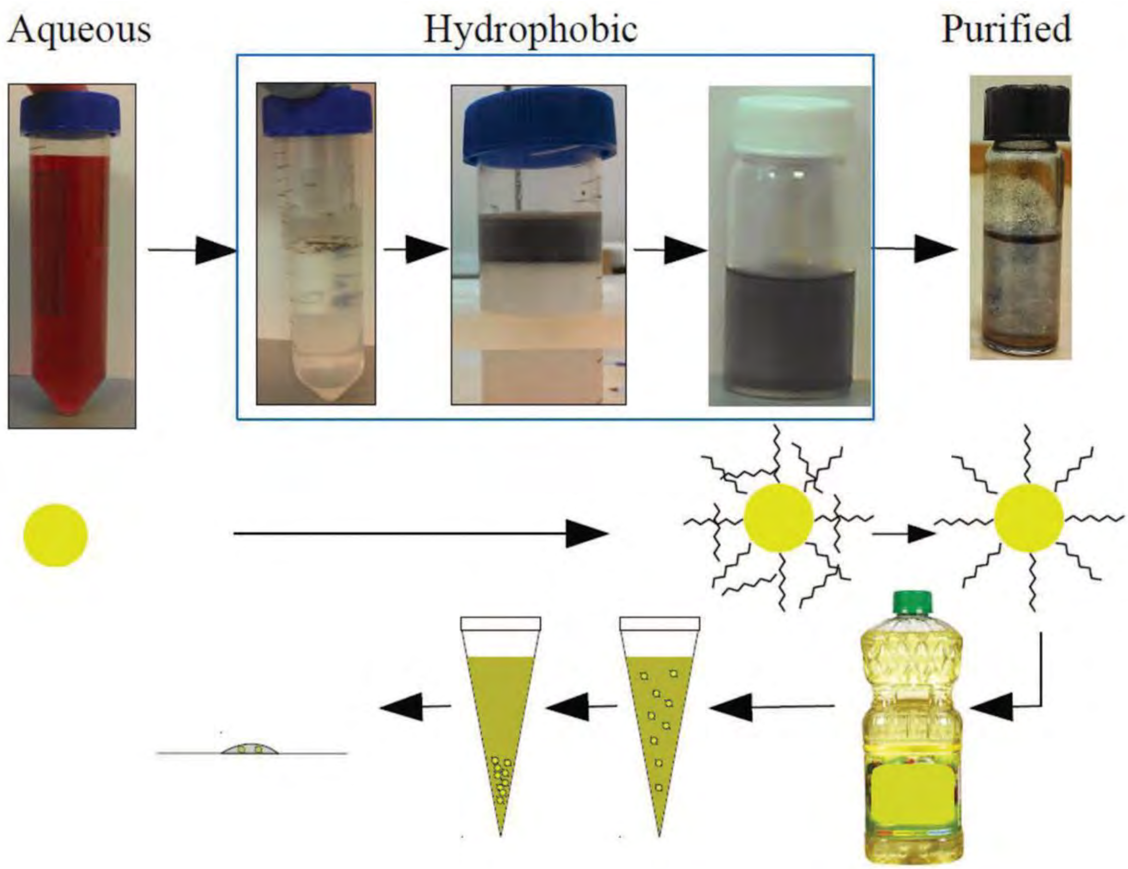

FIG. 1. Schematic illustration of preparation and use of hydrophobic gold nanoparticles (GNP) in vegetable oil.

modify the hydrophobicity of the GNP using octanethiol. The modified GNP were used to measure lipid oxidation products and to compare them with the traditional methods for measuring lipid oxidation.

In our novel method of modification, we mixed citrate-capped gold nanoparticles, octanethiol, and isopropyl alcohol for three days, allowing the thiols to fully bind to the gold surface. Isopropyl alcohol was used because it has a polarity in between that of water and hexane and similar to that of octanethiol, so it can be evenly distributed among the GNP. After mixing, hexane was added as the final solvent. To concentrate the GNP, we only used a quarter of the hexane as the original colloidal GNP mixture, effectively concentrating the gold 4×. When the hexane was added, the nanoparticles immediately accumulated at the interface of the aqueous-alcohol mixture and hexane. A brief three-minute homogenization helped push the nanoparticles up into the hexane for extraction.

To test the viability of the nanoparticles, we used them in a 10 day oil oxidation test. Canola oil was left in an incubator at 55°C in small individual vials. In order to compare with the normal Raman, we used 3% oil because it had a low Raman signal so the effects of SERS enhancements could be seen more

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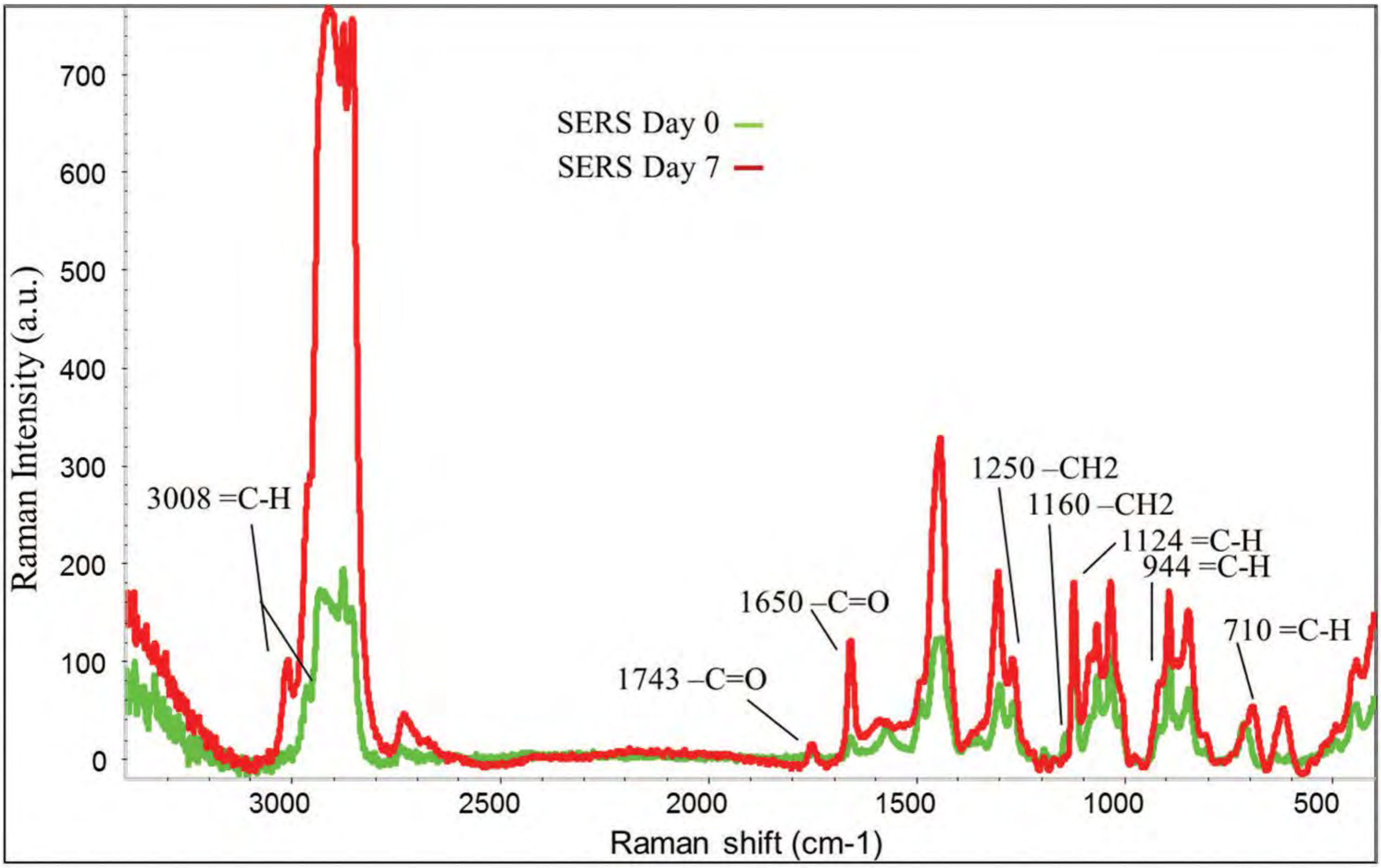
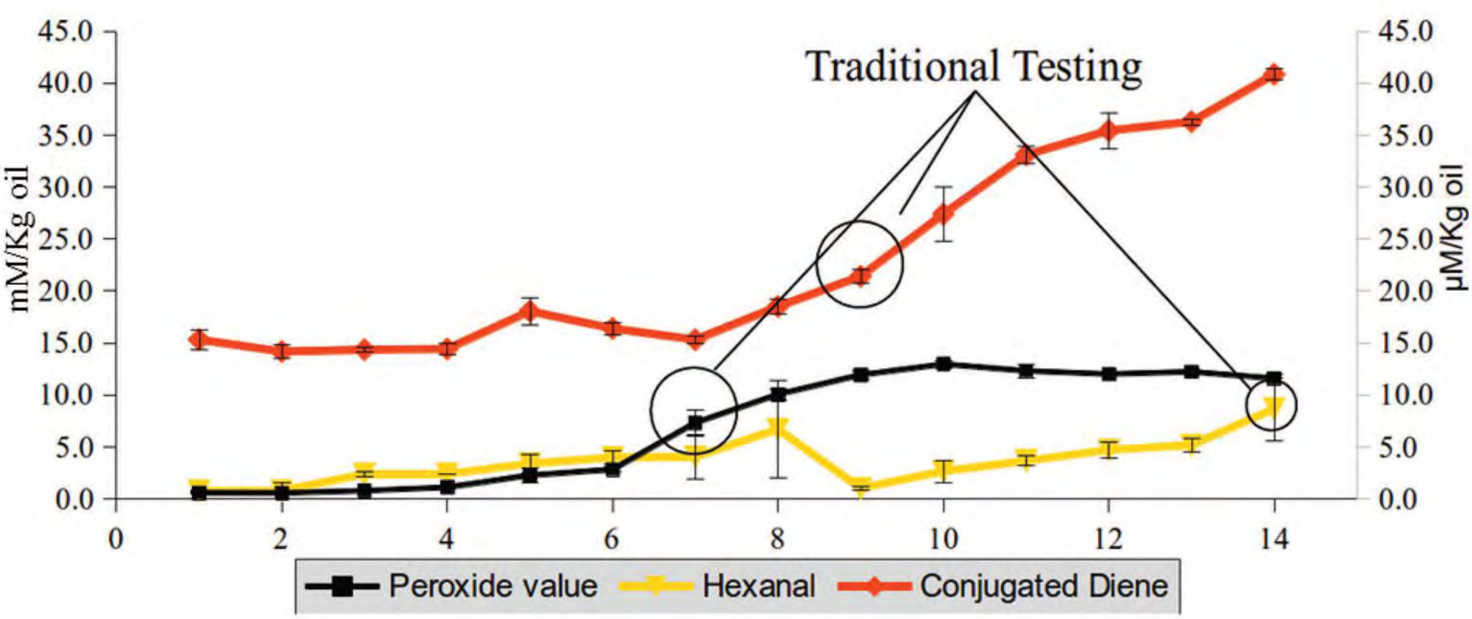


FIG. 2 (ABOVE). The 3% surface-enchanced Raman spectroscopy (SERS) spectrum of canola oil changed over the seven days. The assignments of the peaks are based on conventional Raman studies and may or may not be applicable to SERS. Further study is needed to identify the peak origins.

FIG. 3 (BELOW). Traditional tests analyzing for oxidized oil, namely, conjugated dienes (mM), peroxide values (mM), and hexanal (µM), determine oxidation at 9, 7 and 14 days, respectively. Error bars represent standard error, n = 3.



easily. When preparing the SERS sample, we first sonicated the modified GNP so they were fully dispersed. Then the GNP were used as the solvent to dilute the oil, compared with the pure hexane control. This was done daily for 10 days to measure the progression of lipid oxidation. We observed the SERS peaks decrease over time. However, the decrease in spectral intensity is not fully understood. One of the reasons may be due to the excess of octanethiol used to ensure the GNP were fully coated; therefore, the free octanethiol may provide background signals or limit the Raman enhancement due to the close contact with the GNP. To get rid of the excessive octanethiol, we added a washing step. First, the hydrophobic GNP were centrifuged, the liquid supernatant was extracted, and the nanoparticles/pellet was left to dry. Pure hexane was then added and the mixture was sonicated. The steps were repeated two more times to ensure a full cleaning (Fig. 1, page 467).

Using the new purified GNP, we carried out another trial. Figure 2 shows the spectra collected on day 0 and day 7. The enhancement was much better using these GNP, and the changes were more pronounced. Some of the peak changes may be characterized based on the previous conventional Raman studies, but more interestingly, SERS had the potential to shift some peaks and increased the sensitivity for peaks not before seen in the conventional Raman analysis of lipids. However, this also brought us the challenges to identify and explain the exact changes in the oil oxidation that were captured and enhanced by SERS. The substantial spectral changes may also indicate the changes could be captured much earlier than day 7. Further systematic study is needed for better quantifying and understanding the changes. Compared with the traditional methods for measuring conjugated dienes, peroxide values, and hexanal, this SERS method is more sensitive to detect the changes in an earlier time manner (Fig. 3).

In conclusion, SERS with hydrophobic GNP has shown itself viable for sensitively characterizing lipid samples. Measuring lipid oxidation with SERS is possible but is not quite as optimized as the traditional techniques. The critical factor of applying SERS to food oils is the nanoparticles themselves. Although they are simple to produce, they must be optimized in terms of size and surface ligands. Additionally, the difficulty in controlling the GNP aggregation poses the challenge of signal consistency. Nevertheless, this research provides a good proof of concept and an excellent starting point but still needs much more work to develop this technique for lipid chemistry application.

Michael Driver is a master's degree student studying food science at the University of Massachusetts–Amherst (USA). His research focuses on applying Raman spectroscopy and SERS to edible oils for analysis of oxidation and adulteration.

Lili He is an assistant professor in the Department of Food Science, University of Massachusetts–Amherst. She is interested in advanced analytical techniques and their applications in food chemistry, food safety, and food bioscience. She can be contacted at lilihe@foodsci.umass.edu; fax: +1 413-545-1262; telephone: +1 413-545-5847.

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A beginner's guide to enzymes in detergents

Peter Dybdahl Ollendorff Hede

Enzymes are increasingly important to detergent formulators for a wide range of tasks, including laundry, automatic dishwashing, and cleaning of industrial equipment used in the food industry.

Although the detailed ingredient lists for detergents vary considerably across geographies and categories, the main detergency mechanisms are similar. Stains are removed by mechanical action assisted by enzymes, surfactants, polymers, and builders.

Surfactants of various kinds help wash liquor to wet fabrics, and they assist in removing various stains by lowering the surface tension at the interface between the wash liquor and the fabric. Anionic surfactants and polymers further increase the repulsive force between the original soil, the enzymatically degraded soil, and the fabric, which prevents the soil from redepositing on the fabric.

Builders act to chelate, precipitate calcium and magnesium components, to provide alkalinity and buffering capacity, and to inhibit corrosion.

Enzymes in (heavy-duty) detergents degrade and thereby help solubilize substrate soils attached to fabrics or hard surfaces (e.g., dishes). Cellulases clean indirectly by gently hydrolyzing certain glycosidic bonds in cotton fibers. In this way, particulate soils attached to microfibrils are removed.

A further desirable effect of cellulases is to impart greater softness and improved color brightness of worn cotton surfaces. Many detergent brands are based on a blend of two or more enzymes - sometimes as much as eight different enzymes.

One of the driving forces behind the development of new enzymes and the modification of existing ones for detergents is to make enzymes more tolerant of other ingredients, such as builders, surfactants, and bleaching chemicals, as well as of alkaline solutions (See "Key challenge for enzymes used in detergents," on page 474). The trend toward lower wash temperatures, in particular in Europe, has also increased the need for additional and more efficient enzymes. Starch and fat stains are relatively easy to remove in hot water, but the additional cleaning power provided by enzymes is required in cooler water.

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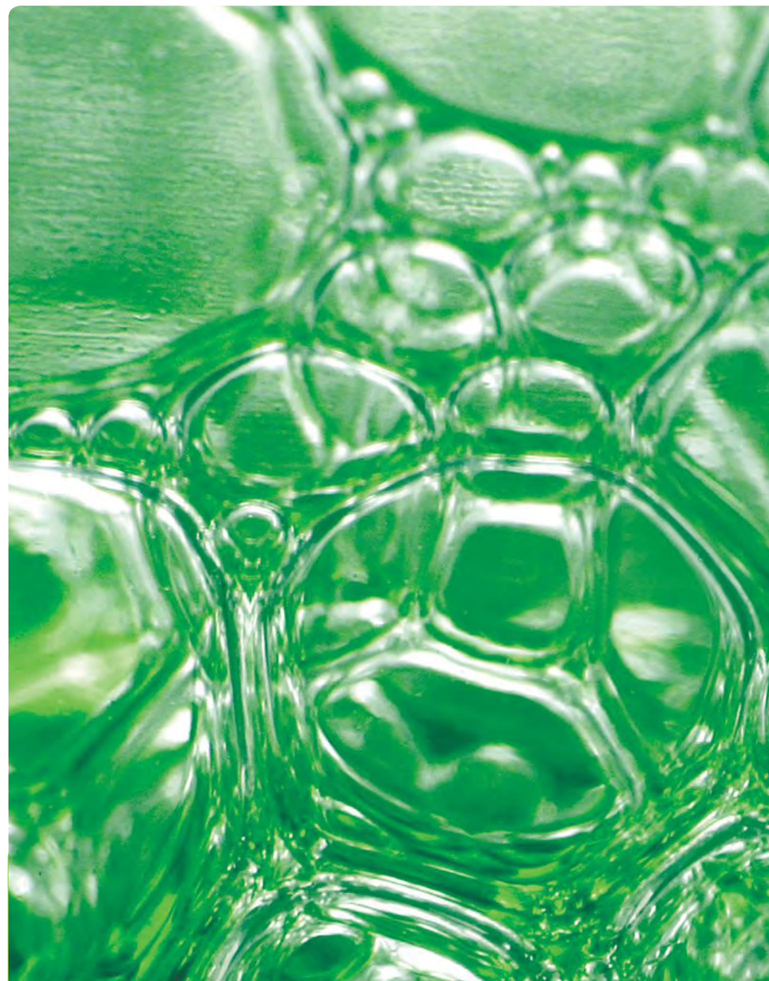

This article explains:

- **The major classes of enzymes and how they're used in detergents.**
- **The trends driving enzyme use in detergents and current trends for enzymes within detergents.**
- **The challenges of using enzymes in detergents and enzyme stabilization technology.**

MOST WIDELY USED ENZYMES

The most widely used detergent enzymes are hydrolases, which remove protein, lipid, and polysaccharide soils. Research is currently being carried out with a view to extending the types of enzymes used in detergents. Many complex, stubborn stains come from a range of modern food products such as chocolate ice cream, baby food, desserts, dressings, and sauces. To help remove these stains as well as classic stains such as blood, grass, egg, and animal and vegetable fat, a number of different hydrolases are added to detergents.

The major classes are proteases, lipases, amylases, mannanases, cellulases, and pectinases. Historically, proteases were the first of these to be used extensively to increase the effectiveness of laundry detergents.

Cellulases contribute to cleaning and overall fabric care by maintaining, or even rejuvenating, the appearance of washed cotton-based garments through selective reactions not previously available when washing clothes with surfactants unamended with enzymes.

Some lipases can act as alternatives to current surfactant technology by targeting greasy lipid-based stains.

Recent investigations show that multi-enzyme systems may replace up to 25% of a laundry detergent's surfactant system without compromising the cleaning effect. This leads to a more sustainable detergent that allows cleaning at a low wash temperature.

Mannanases and pectinases are used for hard-to-remove stains of salad dressing, ketchup, mayonnaise, ice cream, frozen desserts, milkshakes, body lotions, and toothpaste as well as banana, tangerines, tomatoes, and fruit-containing products such as marmalades, juices, drinkable yogurts, and low-fat dairy products.

The obvious advantages of enzymes make them acceptable for meeting consumer demands. Due to their catalytic nature, they are ingredients requiring only a small space in the formulation of the overall product. This is of particular value at a time where detergent manufacturers are trying to make their products more compact.

Washing with laundry bars. In many parts of the world, strongly colored and stubborn stains from blood, sebum, food soils, cocoa, and grass are removed with the help of laundry detergent bars.

Such stain removal and washing by hand is one of the more time-consuming and physically demanding domestic tasks which can be made easier with the use of enzymes. After decades of very little performance enhancement for laundry bars, a specially formulated protease that empowers the producer to create products that stand out from non-enzymatic laundry detergent bars is now available, offering effective and effortless washing.

With the protease product Easyzyme® in laundry bars, washing is shortened by at least one rinse and requires much less scrubbing. In addition to obtaining a superior result, laundry bars containing the enzyme may be formulated to be milder to the hands than old-type bars without enzymes.

Washing cold. Most of the energy spent during a household machine wash is used to heat the water. Thus, the most efficient way to save energy and thereby reduce carbon dioxide emissions is to lower washing temperatures.

The wide spectrum of enzymes that are available today, combined with a choice of appropriate other ingredients such as surfactants and bleaching systems specifically selected to work at low temperatures, has enabled manufacturers to produce cold-water detergents.

ENZYMES IN DISHWASHING

Modern dishwashing detergents face increasing consumer demands for efficient cleaning of tableware. Enzymes are key ingredients for effectively removing difficult and dried-on soils from dishes and leaving glassware shiny. Enzymes clean well under mild conditions and thereby assist to reduce clouding of glassware. In addition, enzymes also enable environmentally friendly detergents.

Phosphates have been used in the past in dishwashing detergents to get dishes clean, but they harm the aquatic environment and are increasingly being banned in detergents around the world. The combination of modifying detergent compositions and using multi-enzyme solutions enables detergent manufacturers to replace phosphates without compromising the cleaning performance.

For removal of protein soils, proteases are used; and amylases are used to remove starch soils.

Proteases for cleaning dishes and cutlery. Some of the more difficult soils on dishes and cutlery are blends of egg yolk/milk, egg yolk, whole egg, and egg white as well as minced meat and oatmeal. The reason for this is the content of protease inhibitors in these foods.

The protease Blaze Evity® by Novozymes has been specifically engineered to overcome high levels of protease inhibitors from eggs. These inhibitors effectively inactivate detergent proteases, resulting in reduced cleaning performance not just on the egg stain itself, but on all protein-containing soils in the same dishwasher load.

Amylases for cleaning starch-containing soils from dishes. In automatic dishwashing, most of the soil is physically washed off by the water jets. However, foods usually leave behind thin films of starch-/protein-containing soils. If they are not removed, these films will build up over time. Larger lumps of burnt-on and caked-on soils may also remain. These soils are the main target for enzymes.

The performance of automatic dishwashing detergents is determined by washing artificially soiled items with a range of enzyme dosages. The residual starch films on the dishes here were dyed with an iodine solution to make them more visible.

CURRENT TRENDS FOR ENZYMES WITHIN DETERGENTS

The application of enzymes in detergents makes up the largest single segment of the world market for industrial enzymes. In 2003, the potential market for detergent enzymes was approximately US$700 million, of which Novozymes had a share of more

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The history of enzymes used in detergent

The first enzyme-containing detergent was introduced to the household market as early as 1913. Röhm & Haas in Germany added trypsin extracted from pig pancreas to their detergent Burnus, utilizing a patent of Dr. Otto Röhm.

As the protease trypsin had insufficient activity and poor stability in detergents, the enzyme concept did not catch on until 1963 when Novo launched a more alkali- and builder-stable bacterial protease called Alcalase®. Small detergent producers in Switzerland and the Netherlands were pioneers in the commercial use of Alcalase, which was initially considered useful only for washing blood-stained laundry from hospitals and slaughterhouses.

For almost 20 years, bacterial proteases from different suppliers were the only class of enzymes of real commercial importance.

Then the use of amylases, lipases, and cellulases as detergent ingredients started to take off during the 1980s and grew steadily in importance during the 1990s. Just after the turn of the century, two new enzyme classes entered the detergent market: mannanases and pectate lyases.

than 56%. Enzymes on average constitute about 3-5 % of the total raw material costs of detergents – but very different from region to region.

By far the largest volume of detergent enzymes is used in "heavy-duty" laundry detergents for household use (powders, liquids, and also tablets). There is also some penetration into "light-duty" laundry products for the washing of delicate fabrics although some enzymes are too aggressive for wool and silk.

The main task of enzymes in laundry detergents is to remove stains of animal or plant origin. Another important task is to prevent soils from spreading throughout the laundry by redeposition. This benefit is often referred to as "general cleaning" or "whiteness maintenance." Enzymes also provide care effects by acting directly on cotton surfaces, helping garments look new longer.

Repeatedly worn and washed laundry items are often contaminated with invisible residues, especially if they have been washed with detergents containing few enzymes. The residues make textile fibers sticky, attracting soil from the wash water, which results in incomplete cleaning. Multi-enzyme systems efficiently prevent this buildup of soil deposits.

Automatic dishwashing detergents for household use are another increasingly important market segment. The enzyme penetration is highest in Europe, followed by the United States, where the market is growing.

In industrialized countries the leading detergent brands typically contain more than one class of enzymes. Food stains are complex substrates containing protein, starch, and fat all mixed together. By combining different enzymes, soils are removed more efficiently, utilizing synergies between each enzyme's cleaning abilities.

TRENDS DRIVING ENZYME USE

The importance of enzymatic detergency is expected to continue to increase, based on the following trends:

- Reduction of washing temperatures (mainly Europe)
- More detergents without bleach (e.g., color detergents and liquid detergents)
- More compact detergent formulations
- More cost-effective enzymes

Thanks to modern genetic engineering technology, enzymes are becoming increasingly cost efficient and offer higher yields. There are also possibilities to commercialize "custom-made" enzymes with improved economy and application properties.

On the other hand, detergents in most developed markets are facing price erosion, and consequently manufacturers are increasing their efforts to reduce ingredient costs. Competition between leading brands and cut-price supermarket-owned private label detergents may therefore limit the scope for further development in enzyme usage.

To some extent enzymes compete with surfactants; and considerable efforts are made by, for example, Novozymes to demonstrate that reducing enzymes in favor of surfactants typically does not pay off for customers.

There are still sizable potential markets in developing countries where the penetration of enzymes is low, but these markets will gradually expand in line with the rising level of economic development.

Other markets where enzymes have low penetration are detergents for professional laundries and automatic dishwashing in institutions and restaurants. Owing to very high requirements for speed and cleaning efficiency, these market segments use strong chemicals, which have low compatibility with enzymes. Enzymes are, however, still used in their original application—the prewashing of blood-stained laundry from hospitals and slaughterhouses.

KEY CHALLENGE FOR ENZYMES USED IN DETERGENTS

One of the key challenges of enzymes is that they are more sensitive to environmental factors than conventional surfactants and detergents and tend to lose their effectiveness when exposed to high temperatures and harsh chemicals. Both the producer and customer must take into account storage stability requirements such as stability of enzyme activity, microbial stability, physical stability, and the formulation of the enzyme product itself.

All modern detergents face a long journey before they actually are used in the consumers' washing machines. The most important steps are:

1. Production. In production it is crucial that the detergent has the optimal formulation to reach its destination with performance intact.
2. Warehouse. Storage conditions can be tough on detergent formulations. The detergent may sit in a warehouse for a long time, and conditions such as temperature and humidity may lead to efficiency loss.
3. Transportation. Transportation time and storage conditions vary greatly for all detergents. And as in the warehouse, transportation conditions can affect detergent efficiency.

4. Retailer. All detergent producers would like their product to move quickly. The reality, however, is that detergents can sit on the shelf for a long time before purchase, again leading to less efficiency.
5. Consumer. At the final stage it is crucial that the consumer stores the detergent under optimal conditions—and uses it in the right way, for example, correct dosing, appropriate washing temperature, and correct washing cycle.

Altogether, modern detergents are complex and innovative products. Promotional pack sizes, transportation, and storage mean that it may take a long time before the detergent is actually used, and this fact challenges producers to deliver a detergent that performs consistently after its long journey to the consumers' washing machines.

NOVEL STABILIZING ENZYME TECHNOLOGY

Late in 2013 Novozymes introduced a new range of highly robust and stable enzymes enabling detergent producers to deliver more consistent wash performance. The range of new enzyme technology also gives manufacturers even greater formulation flexibility, and it has the brand name Evity®.

Evity is the brand for new range of robust and stable enzymes for liquid and powder detergents.

PROTEASE INHIBITOR IN LIQUID DETERGENTS

For liquid detergents Evity has a new improved boron-free protease inhibitor. The new inhibitor solution makes the protease fully active in the detergent while inhibiting the enzyme while being in the bottle.

Improvements in liquid stability have significant advantages for detergent producers, as they pave the way for leveraging enzymes in detergents. The new inhibitor developed by Novozymes is far more efficient than existing boron-based stabilization systems enabling the inclusion of multiple enzymes in the detergent as well as greater formulation flexibilities with other detergent ingredients.

Tests conducted by Novozymes on different European Union (EU) mid-tier liquid laundry detergents, washing under conditions of 40°C, 75 g/14 L wash, 15°dH - water hardness and samples stored at 30°C, show superior wash performance on individual protease stains after storage.

In total, the novel enzyme technology from Novozymes provides these improvements for liquid detergents:

- Increased protease wash performance after storage
- Increased multi-enzyme performance after storage
- Greater formulation flexibility with other detergent ingredients
- Completely boron-free liquid detergent formulations with great performance

NEW GRANULATE ENZYME TECHNOLOGY

For powder detergents, Evity builds on a new granulate enzyme technology to improve stability of the detergent – laundry as well as automatic dishwash detergents. Granulate enzyme technology simply means that the enzyme concentrate is processed into a granule. This is done to prolong their working life; such immobilized enzymes may go on working for over a year—and even longer. Coating of the enzyme granulate protects the enzyme further from deactivation by other ingredients in the detergents, such as surfactants.

Tests conducted by Novozymes on an EU front-loader under conditions of 40°C, 15°dH, detergent containing bleach, dosage of 65 - 110 g/14 L wash found that standard protease shows great residual wash performance after regular accelerated storage conditions, while protease with the new stabilizer is superior also after tough accelerated conditions.

With the new enzyme stabilization capabilities marketed by Novozymes starting in late 2013, these improvements for granulated enzymes used in detergents have been provided for the industry:

- Wash performance also after storage at tough conditions
- Consistent wash performance, which promotes brand loyalty for the detergent producer
- Longer-lasting, enhanced wash performance via single or multiple enzymes
- Visible and better performance—which is key for consumers.

Peter DybdahlOllendorf Hede is a science manager at the Novozymes Detergent Research Center in Bagsvaerd, Denmark. He has a doctoral degree in chemical engineering from the Technical University of Denmark in Kongens Lyngby, and a graduate diploma in business administration (HD) from Copenhagen Business School.

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Natural fats and oils **in cosmetics**

Khalid Mahmood

Fats and oils have been used since ancient times for a variety of purposes, including food preservation, cooking, beauty, healing, and in spiritual practices. They have also been used in folk medicines, such as Ayurveda, and in traditional Chinese and Western medicine. Traditionally, many cosmetic recipes are oil based. This article highlights the use of various oils, fats, and waxes in modern cosmetics. The three main sources of oils are animals, botanicals, and petroleum. Oils developed through biotechnology are also entering the field.

Fats can be solid or liquid at ambient temperature and are insoluble in water. Oils are fats that are liquid at ambient temperature. Fats belong to a wider group of chemicals called lipids. Lipids also include fat-soluble small or large molecules such as sterols, esters, waxes, and phospholipids. Generally, in a layperson's conversation fats, oils, and lipids refer to the same or similar things.

Almost all ingredients for cosmetic products sold in the United States are named in the Personal Care Products Council (PCPC) publication "International Dictionary of Cosmetic Ingredients & Handbook." The resource is available in print as well as online (http://www.personalcarecouncil.org). The PCPC is a

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- **Disease, aging, and changes in environmental conditions can alter the skin's lipid profile via the loss of physiological components such as waxy lipids, saturated fatty acids, cholesterol, and esters. More importantly, the loss of the skin's ability to retain water results in sagging skin.**
- **An appropriate mixture of oils and fats can prevent the loss of the skin's lipid components and even replenish them. It may also prevent excessive water loss.**
- **This article describes the various functions fats and oils play in modern cosmetic products.**

TABLE 1. Oils and oil-soluble ingredients with origin[a]

Description	Entries analyzed (#)[b]	Vegetable sourced (%)	Animal sourced (%)	Synthetically made (%)	Multiple sources (%)
Essential oils[c]	383	100	0	0	NA
Vegetable oils	453	60	13	3	24
Fatty acids and fatty alcohols	81	37	~7	21	35
Waxes	97	59	8	14	19
Unsaponifiables	27	74	0	26	0
Complex lipids	74	14	4	30	52
Hydrocarbons	149	6	0.5	83	10

[a]Dominant source for each class is shaded green. NA, not applicable.
[b]Number of entries in on-line version of "International Dictionary of Cosmetic Ingredients and Handbook" as of 2013.
[c]Does not include Flavor & Fragrance ingredients.

leading national trade association for the cosmetic and personal products industry with more than 600 member companies.

The "International Dictionary of Cosmetic Ingredients and Handbook" has more than 21,000 entries divided into classes and subclasses for use in cosmetic products. At least seven of those classes describe types of oils (ingredients) available for use in cosmetics and were analyzed for this article. Table 1 provides a snapshot of these seven classes.

FUNCTIONS OF FATS AND OILS IN HUMAN SKIN

Cosmetic products are used to protect and beautify skin, the largest organ of the body. The skin's main function is to protect the body's internal organs and maintain its shape and contours. External stressors and internal processes of chronological aging result in a continuous need for the skin to preserve and defend itself.

Skin is composed of an outer layer of epidermis and an inner layer of dermis. Beneath the dermis and widespread throughout the body is a layer of fatty tissue. Fatty tissue provides support to the organs including skin, maintains a level of hydration, and acts as a reservoir of energy. Skin also comprises a network of collagen and elastin; these structural proteins provide strength and flexibility to the skin. With age, the fatty tissue thins out, along with network of proteins, making them targets for intervention to restore the balance.

Epidermis is the skin layer exposed to external stressors first. It functions as a barrier to keep water in and toxic chemicals out and helps maintain the body's temperature; it contains no blood vessels. Epidermis is the main target of cosmetic products.

Lipids in the epidermal layer comprise waxy lipids such as ceramides, saturated fatty acids, cholesterol, and esters. It is well understood that disease, aging, and change of environmental conditions alter the lipid profile of skin, resulting in a continual need to topically apply an appropriate mixture of oils and fats to compensate for the loss of key skin components.

FUNCTION OF FATS AND OILS IN COSMETICS

Cosmetic products help replenish skin components or prevent the loss of physiological components in order to maintain a healthy balance. Fats and oils may provide active biological benefits in addition to traditional roles of emollient, occlusive, and the like. Some of the functions attributed to oils in a cosmetic formula are tabulated in Table 2. This is not an exhaustive list.

The purpose here is to emphasize various functions oils play in a formula.

Essential oils (see Table 1) are volatile compounds that originate mostly from the aerial parts of botanicals and are used as fragrances or in aroma therapy. Some essential oils are also used as flavors and in folk medicine. Chemically, essential oils are a diverse collection of different chemistries, such as terpenes, aldehydes, phenols, and the like. Some components of essential oils are effective antimicrobial agents and are also suspected to contribute in allergenic reactions to skin.. For example, citral and eugenol are present in many essential oils and are also reported as potential skin allergens (Johansen, 2003; European Union Cosmetics Directive 76/768/EEC-7th amendment, 2003).

Vegetable oils are mainly composed of triglycerides, which comprise a molecule of glycerin and three molecules of fatty acids. Generally, triglycerides come from the seeds of a botanical or from animal fat. They can be liquid or solid at ambient temperatures, based on the type of fatty acid present; for example coconut oil is a white solid and contains mostly saturated fatty acids but soybean oil is a liquid at ambient temperature and contains a mixture of saturated and unsaturated fatty acids.

The three fatty acids of a triglyceride molecule can be the same or different. Fatty acids differ from each other based on carbon chain length and degree of unsaturation. Saturated and unsaturated fatty acids perform important functions in the human body. Vegetable oils, partially hydrolyzed vegetable oils, free fatty acids, and glycerin are all used as cosmetic ingredients for the properties of emollient, occlusive, and viscosity modifiers (Table 2).

Fatty alcohols stabilize emulsions. Waxes and unsaponifiables are relatively smaller categories of cosmetic ingredients but can be very useful in providing a certain feel or texture to the cosmetic formula. Unsaponifiables are by-products of edible oil refining and represent a mixture of free fatty acids, sterols, fat-soluble vitamins, waxes, and phospholipids. Complex lipids are generally comprised of amino alcohols and their derivatives, such as ceramides. The latter are an important structural constituent of epidermis. Most of the ceramides listed in the "International Dictionary of Cosmetic Ingredients & Handbook" are synthetic in origin.

Another class of fatty acids, referred to as essential fatty acids, comprises unsaturated fatty acids that are important for various body functions. They are characterized according to the point or points on the fatty acid carbon chain at which the unsaturated bonds occur. Generally they are referred to as omega fatty acids. Some plants are richer sources of omega fatty acids than others. For example, coconut oil is rich in saturated fatty acids whereas apricot kernel oil is rich in unsaturated (omega) fatty acids with more than 90% content of unsaturated fatty acids . Table 3 lists select sources of omega fatty acids rich in particular omega fatty acids that are also cosmetic ingredients.

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TABLE 2. Functions attributed to oils and fats in skin care products

Traditional roles	Active roles
Emollient	Fragrance
Occlusive	Antimicrobial
Emulsion stabilizers	Anti-oxidant
Viscosity modifiers	Anti-inflammatory
Surfactant	Skin protection
Shine	Sun screen
Skin and hair conditioning	

TABLE 3. Examples of vegetable oils enriched in one of the omega fatty acids

Trivial name	Botanical name of plant source	Enriched with omega-n fatty acids	Total omega contents
Inca inchi oil[a]	*Plukenetia volubilis*	Omega-3 (49%); omega-6 (37%)	95%
Kiwi fruit oil[a]	*Actinidia deliciosa*	Omega-3 (65%); omega-6 (>17%)	>82%
Cranberry oil[a]	*Vaccinium macrocarpon*	Omega-3 (34%); omega-6 (36%)	97%
Raspberry seed oil[a]	*Rubus idaeus*	Omega-6 (54%); omega-3 (32%)	97%
Melon seed oil[b]	*Citrullus vulgaris*	Omega-6 (71.3%)	>80%
Grape seed oil[a]	*Vinis vinifera*	Omega-6 (65%); omega-9 (24%)	96%
Apricot kernel oil[c]	*Prunus armeniaca*	Omega-9 (>70%); Omega-6 (>20%)	92.6%
Kukui nut oil[a]	*Aleurites moluccana*	Omega-9 (78%)	98%
Tamanol seed oil[a]	*Calophyllum inophyllum*	Omega-9 (45%); omega-6 (40%)	85%
Passion fruit oil[a]	*Passiflora edulis*	Omega-9 (35%); omega-6 (60%)	95

[a]Suppliers' data.
[b]Akoh, C.C., and C.V. Nwosu, Fatty acid composition of melon seed oil lipids and phospholipids, *J. Am. Oil Chem. Soc. 69*:314–316 (1992).
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Want more on natural fats and oils in cosmetics? The author of this article has contributed an entire chapter on this topic for the book, *Lipids & Skin Health*, due to be published by Springer later this year.

Hydrocarbons are comprised of hydrogen and carbon atoms. They can be gas, oil, or solid and can be manipulated synthetically to produce even larger chemical and functional diversity. Some hydrocarbons have found their place in cosmetic products, including mineral oil and petroleum jelly. For a whole list of hydrocarbons for cosmetic purposes consult the "International Dictionary of Cosmetic Ingredients and Handbook." Due to their origins in petroleum, most hydrocarbons presently used in cosmetics are considered synthetic ingredients.

Efforts are ongoing to produce hydrocarbons and also glyceride ester oils through biotechnology based on cellulosic feedstocks, which are widely available as a by-product of the agricultural and forestry industries. The isotopic ratio of chemicals generated from cellulosic feedstocks or from microorganisms matches that of the aerobic environment, hence they can be called "natural materials" or "derived from natural materials." Once the processes have been perfected, this technology is expected to create diverse chemicals through this route for the cosmetic industry and beyond.

Khalid Mahmood is a research fellow for Johnson & Johnson Consumer in Skillman, New Jersey, USA. He can be contacted at KMahmoo1@its.jnj.com.

EXTRACTS & DISTILLATES (cont. from page 454)

Optimization of the temperature and oxygen concentration conditions in the malaxation during the oil mechanical extraction process of four Italian olive cultivars

Selvaggini, R., *et al., J. Agric. Food Chem. 62*:3813–3822, 2014, http://dx.doi.org/10.1021/jf405753c.

Response surface modeling (RSM) was used to optimize temperature and oxygen concentration during malaxation for obtaining high quality extra virgin olive oils (EVOO). With this aim, those chemical variables closely related to EVOO quality, such as the phenolic and the volatile compounds, have been previously analyzed and selected. It is widely known that the presence of these substances in EVOO is highly dependent on genetic, agronomic, and technological aspects. Based on these data, the two parameters were optimized during malaxation of olive pastes of four important Italian cultivars using some phenols and volatile compounds as markers; the optimal temperatures and oxygen levels, obtained by RSM, were as follows for each cultivar: 33.5°C and 54 kPa of oxygen (Peranzana), 32°C and 21.3 kPa (Ogliarola), 25°C and 21.3 kPa (Coratina), and 33°C and 21.3 kPa (Itrana). These results indicate the necessity to optimize these malaxing parameters for other olive cultivars.

Detection of Chemlali extra-virgin olive oil adulteration mixed with soybean oil, corn oil, and sunflower oil by using GC and HPLC

Jabeur, H., *et al., J. Agric. Food Chem. 62*:4893–4904, 2014, http://dx.doi.org/10.1021/jf500571n.

Fatty acid composition as an indicator of purity suggests that linolenic acid content could be used as a parameter for the detection of extra/virgin olive oil fraud with 5% of soybean oil. The adulteration could also be detected by the increase of the trans-fatty acid contents with 3% of soybean oil, 2% of corn oil, and 4% of sunflower oil. The use of the ΔECN42 proved to be effective in Chemlali extra-virgin olive oil adulteration even at low levels: 1% of sunflower oil, 3% of soybean oil, and 3% of corn oil. The sterol profile is almost decisive in clarifying the adulteration of olive oils with other cheaper ones: 1% of sunflower oil could be detected by the increase of Δ7-stigmastenol and 4% of corn oil by the increase of campesterol. Linear discriminant analysis could represent a powerful tool for faster and cheaper evaluation of extra-virgin olive oil adulteration.

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


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

July/August 2014

INFORM

International News on Fats, Oils, and Related Materials

SUPPLEMENT

Implementing the FDA Food Safety Modernization Act (FSMA)

The FDA Food Safety Modernization Act (FSMA) gives the US Food and Drug Administration (FDA) a new public health mandate. FSMA, which was signed into law in January 2011, directs FDA to establish standards for adoption of modern food safety prevention practices by those who grow, process, transport, and store food. It also gives FDA new mandates, authorities, and oversight tools aimed at providing solid assurances that those practices are being carried out by the food industry on a consistent, ongoing basis.

FDA is in the midst of the rulemaking and guidance development process required to establish the new prevention-oriented standards, and FSMA implementation teams have developed many ideas for how FDA can better oversee the food industry, strengthen the global food safety system, and enhance protection of public health. Planning has also begun for the next phase of FSMA implementation, which involves making the new public health prevention standards operational and implementing the strategic and risk-based industry oversight framework that is at the heart of FSMA.

FDA's strategic vision is summed up in a guidance document (http://tinyurl.com/FSMA-guidance; excerpted below) intended to guide the next phase of FSMA implementation by outlining broadly the drivers of change in FDA's approach to food safety and the operational strategy for implementing that change, as mandated and empowered by FSMA.

DRIVERS OF CHANGE

Congress enacted FSMA in response to dramatic changes over the last 25 years in the global food system and in our understanding of foodborne illness and its consequences, including the realization that preventable foodborne illness is both a significant public health problem and a threat to the economic well-being of the food system. These food system changes and the new FSMA mandates require transformative change in how FDA does its work.

The central external force driving change is the dramatic expansion in the global scale and complexity of the food system. Hundreds of thousands of growers and processors worldwide are producing food for the US market, using increasingly diverse and complicated processes, managing complex and extended supply chains, and making millions of decisions every day that affect food safety. The burgeoning scale and complexity of the food system make it impossible for FDA on its own, employing its historic approaches, to provide the elevated assurances of food safety envisioned by FSMA and needed to maintain a high level of consumer confidence in the safety of the food supply.

Accompanying this change is the now widely shared understanding that the foundation for reducing the risk of preventable foodborne illness in today's global food system—and providing consumers the assurances of food safety they seek—is action by the food industry. Specifically, food safety depends primarily on the food industry, with top-level management commitment and working in a continuous improvement mode, to: (i) implement science- and risk-based preventive measures at all appropriate points across the farm-to-table spectrum, and (ii) manage their operations and supply chains in a manner that provides documented assurances that appropriate preventive measures are being implemented as a matter of routine practice every day. FSMA is grounded in this understanding of how food safety can be protected in today's global food system.

While FSMA reinforces industry's primary role and responsibility for food safety, it also builds on and strengthens FDA's oversight role in providing technical expertise, setting and fostering compliance with food safety standards, and responding to and learning from problems when they do occur. In fact, more so than ever before, FDA is called upon by FSMA to play a central leadership and operational role in the future global food safety system. Meeting this challenge—and successfully implementing FSMA's new prevention-oriented, systems approach to food safety—necessitates a new strategy for how FDA performs its food safety role and meets its new responsibilities.

AN OPERATIONAL STRATEGY FOR THE FUTURE

The new approach and operational strategy for FDA's food safety program and implementation of FSMA includes these elements:

Advancing public health.

- FDA's primary focus will be on improved public health outcomes—namely reducing the risk of foodborne illness—achieved by fostering broad, consistent industry implementation of modern preventive practices, as called for by FSMA and FDA's implementing rules and guidance.
- FDA will play a central public health leadership role as a catalyst for innovation and action to improve food safety and as a primary source and repository of the science and expertise needed to understand and prevent food safety problems.
- To achieve better public health outcomes, FDA will focus its industry oversight efforts on using a broad array of tools to ensure that firms are consistently implementing effective prevention systems that protect food safety, within their operations and through their supply chains; this will include developing legally sufficient evidence to prove specific rule violations when judicial enforcement is the right remedy, but FDA will focus primarily on assessing whether systems are working effectively to prevent problems and on taking immediate action to protect public health through voluntary corrective action or a range of administrative remedies.

Leveraging and collaborating.

- FDA will leverage the resources and efforts of others by working in partnership to create an integrated global food safety network that includes FDA partner agencies (federal, state, local, tribal, territorial, and foreign agencies), international organizations, the food industry, growers, academic experts, and consumers.
- To optimize the effectiveness, efficiency, and consistency of FSMA implementation domestically, FDA will enhance operational partnerships with states and other government counterparts, as envisioned in FSMA's call for a national integrated food safety system.

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- FDA will build robust data integration and analysis systems and information sharing mechanisms to support active operational partnership and foster mutual reliance with trusted partners.

Strategic and risk-based industry oversight.

- Given the scale and complexity of the global food system and the demand for higher levels of assurance that prevention systems are working properly, FDA will use an expanded oversight tool kit that includes both traditional and new tools, such as:
    - commodity- and sector-specific guidance on implementation of prevention-oriented standards;
    - education and outreach to industry to ensure expectations and requirements are understood;
    - technical assistance to facilitate compliance, especially by small and mid-size operators;
    - regulatory incentives for compliance, such as less frequent or intense inspection for good performers;
    - reliable third-party audits to verify compliance;
    - public education, transparency, and publicity to promote compliance and prevention; and
    - modernized approaches to inspection and enforcement based on the prevention framework and the enhanced inspection and enforcement tools provided by FSMA.</2nd level BL. Return to normal
- To carry out this broader approach to food safety, FDA will expand the skills and capacities of its scientific, technical, and operational staff and change its internal operational practices to enable the agency to make quick decisions and take immediate action when needed to protect public health, using an array of tools, and working more closely with partner agencies to coordinate compliance and enforcement efforts.
- FDA will change its own resource planning and deployment to ensure FDA resources are used optimally in a flexible, risk-based, and efficient manner to achieve better public health outcomes and will develop public health outcome metrics that help measure the impact of its actions.
- FDA will improve the quality and quantity of data it uses in order to fully evaluate and make the most informed, risk-based decisions.

GUIDING PRINCIPLES FOR IMPLEMENTATION IN FOOD AND FEED FACILITIES

General. Implementation of FSMA's preventive controls mandate in food and feed facilities will build on FDA's experience implementing Hazard Analysis Critical Control Point (HACCP) in seafood and juice processing operations, specifically FDA's familiar roles in issuing rules and guidance and conducting inspections to assess and enforce compliance. Implementation of preventive controls must differ, however, due to the much larger number and diversity of covered facilities, FSMA's new records access and administrative enforcement tools, and FDA's commitment to the expanded tool kit for strategic and risk-based industry oversight outlined in the operational strategy.

FSMA provides FDA for the first time an inspection frequency mandate for food and feed facilities, but FSMA's public health prevention framework demands transformative change in how FDA uses its inspection authority and traditional and enhanced enforcement tools to carry out its oversight responsibility and protect public health in the most efficient manner possible.

Inspection and surveillance. FDA will significantly expand its inspection and surveillance tools to include a wider range of inspection, sampling, testing, and other data-collection activities conducted through its own field force and through collaboration with partner agencies and the food industry.

The types and purposes of inspection and surveillance will include:

- Efficiently screening firms for food safety performance to guide risk-based inspection priority, frequency, depth, and approach;
- Providing firms incentives for compliance through enhanced presence in and targeted scrutiny of high-risk firms and products and reduced scrutiny of firms with records of demonstrated good performance;
- Assessing the compliance of individual firms through a range of inspection and sampling techniques used in a strategic, risk-based way to maximize coverage of priority sectors and firms;
- Making in-depth assessments of individual firms when needed to increase the incentive for compliance and determine the need for compliance or enforcement actions;
- Collecting data to inform understanding and analysis of sector-wide hazards, practices, and preventive control deficiencies; and
- Collecting data on compliance rates to evaluate program performance and plan future efforts.

CONCLUSION

FDA will fulfill the vision of FSMA and strengthen food safety protection by applying the principles outlined here across the entire food safety program, while adapting them to the specific challenges posed by implementation of preventive controls, produce safety standards, and FSMA's new import system.

BOOK REVIEW

Processing Contaminants in Edible Oils: MCPD and Glycidyl Esters

Edited by Shaun MacMahon

AOCS Press, Urbana, Illinois, USA, 2014

www.aocs.org

ISBN 978-0-9888565-0-9. 230 pages.

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Amazon electronic version $85.00 USD

Reviewed by Laurence Eyres

Industry, academia, and legislators have awaited the publication of a book such as this for quite some time. Heightened awareness about the presence of fatty acid esters of monochloropropanediol (MCPD) in refined edible oils began in 2006 with a publication by Zelinková and coworkers. This book, which was compiled and edited by Shaun MacMahon, a research chemist with the US Food and Drug Administration (FDA), arose following a key seminar to address this issue at an AOCS conference in 2011. The issue attracted intense scrutiny because of the occurrence of MCPD in infant formulae, with the source being the deodorized vegetable oils used in the blends.

3-Monochloropropanediol (3-MCPD) esters, 2-monochloropropanediol (2-MCPD) esters, and glycidyl esters (GEs) are contaminants that are not present in virgin unrefined oils but can be produced during processing, specifically during high-temperature deodorization.

The book, which consists of seven chapters with contributions from 12 authors, comprises 217 pages of extremely useful information about these contaminants. When the topic of these contaminants emerged, a key question arose as to the source of chlorine atoms. Hypotheses and proposals that seem logical are proposed in the first chapter.

Chlorine atoms are sourced either from chlorides in the soil, from marine origins, or from added fertilizers or pesticides. While the mechanisms of the formation of these contaminants have not been conclusively elucidated, there is evidence suggesting that 3-MCPD esters are formed from iron chloride in the soil and/or natural organochlorine compounds.

Before an accurate risk assessment of these contaminants in food can be made, detailed, accurate, and repeatable analyses must be established. About 50% of the book is dedicated to a systematic and very detailed description of these different analytical methods. They fall into two categories: indirect and direct methods. In the early years of these contaminant analyses, trial indirect methods of transesterification were used and results were ambiguous and distrusted by industry. The chapters on direct methods by both MacMahon and German researchers Alice Thürer and Michael Granvogl summarize the current techniques utilizing liquid chromatography and time-of-flight mass spectrometry. Following accurate direct methods, a great deal of work has subsequently occurred to validate indirect techniques. The establishment of standard AOCS methods (AOCS, 2014) greatly assists in this development. Ranges of levels found in vegetable oils, from 0.5 µg/g (ppm) to 40 µg/g, are presented. Deodorized palm and grapeseed oils appear to have the highest levels recorded.

Mitigation strategies that have been used successfully to decrease the concentrations of these contaminants in edible oils are discussed in the second chapter. These include removing precursor molecules before processing, using alkaline additives before deodorizing, adding ethanol to the oil, and using selective adsorbents.

The fact that MCPD esters begin forming at temperatures exceeding 200°C makes mitigation difficult because deodorizations with physical refining are generally run at temperatures greater than 200°C.

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- Cd 29b-13 Determination of bound monochloropropanediol- (MCPD) and bound 2,3-epoxy-1-propanol (glycidol-) by gas chromatography/mass spectrometry),
- Cd 29c-13 (Fatty-acid-bound 3-chloropropane-1,2-diol (3-MCPD) and 2,3-epoxy-propane-1-ol (glycidol), Determination in oils and fats by GC/MS (differential measurement)), 2014.

It is a small oversight, probably due to timing of the compilation, that the book does not have any extra reported work from edible oil practitioners who have experience in changing process conditions to observe changes in contaminant levels. Such work was presented at AOCS seminars in 2012 and 2013 (De Greyt, 2012). Practical economic techniques suggested by process suppliers such as Desmet are assisting the edible oil industry in reducing levels to acceptable amounts. This practical work will no doubt be presented at future AOCS conferences and seminars

The toxicology of glycidyl esters and of the MCPD fatty acid esters is dealt with in two chapters reporting work on the two classes of compound separately. Any toxic effects are due to the products after metabolism in the gut.

Free 3-MCPD and glycidol have been shown to be carcinogenic in rats, with demonstrated effects on kidneys and reproductive systems. Glycidol is well characterized due to its use in the chemical industry. 3-MCPD and glycidol were classified by the European Scientific Committee on Food in 2001 as a non-genotoxic threshold carcinogen. Toxicology is dealt with in a detailed way in the last two chapters of the book by researchers at Nestlé and at BfR, the Federal Institute for Risk Assessment.

There is no separate chapter on legislation either by the US FDA or the European Food Safety Authority (EFSA), and one may assume that legislators are still working through key issues such as the breakdown rate of the esters by gut lipases into free MCPD and glycidol plus arriving at sensible maximum allowable levels in oils and foods containing them. The final chapter in the book on toxicology summarizes the situation by stating that several important questions remain to be resolved such as the rate of hydrolysis of MCPD esters in humans. Risk assessment can only be done and legislative standards established when analyses become totally reliable and well established in multiple laboratories around the world. Current trading standards, especially for palm oil, are for total glycidyl and MCPD esters to be <2 ppm with <1 ppm for oils destined for infant formulae.

The book is well presented and laid out with a comprehensive index and extensive references with each chapter, and no errors were detected. It is good value for money and should be a foundation work for anyone in this area. The information in this book is rapidly being updated with other reported material in this vital area for edible oil processors and food manufacturers alike (EFSA, 2013).

Laurence Eyres, FNZIFST, runs his own contracting / consulting business for the Food and Dietary Supplements Industries specializing in dairy ,oils and fats and related lipids, product and business development. He has been a member of AOCS since 2002. He can be contacted at eyresy@gmail.com.

Thermally induced **isomers in the UK**

Ray Cook

In March 2006, *Inform* published a short article in which I raised concerns about the high levels of thermally induced isomers entering the Western diet. These thermally induced isomers were linked to the widespread introduction of physical refining of rapeseed and soybean oils. At that time it was widely reported that up to 37% trans isomers, of α-linolenic acid (ALA) could be formed in physically refined oil.

Including the thermally induced isomers of linoleic acid, the overall trans levels in these oils were around 4%, That, coupled with the reduction in fish oil consumption in the modern diet, raised health concerns in many quarters. One particularly relevant work—the Trans LinE study, funded by a European agency—set out to evaluate the impact of a diet high in trans ALA. The study highlighted that ALA isomers could be metabolized to long-chain omega-3 fatty acids containing these isomers, proving that this essential fatty acid isomer could be misidentified as linoleic acid and confirming other research work. The report also showed the negative impact of the isomers on blood platelets and cholesterol. It was region specific, with the Mediterranean group least affected and the Scottish group most affected.

In 2006, the UK the body responsible for ensuring food safety in the oils and fats sector and appropriate labelling was the Food Standards Agency (FSA).

I conducted a lengthy correspondence with the FSA over this issue, but their view was that the levels to be found in refined vegetable oils were not a safety matter. They also made the erroneous comparison with ruminant fats, using the fact that levels of trans oleic acid are considerably higher in these fats.

In other European countries, similar concerns were being raised. Denmark in particular wanted to introduce a statutory limit of 1.0% max trans level in any processed oil, used in the food industry. This action was strongly opposed by most other EU members, including the UK represented by the FSA. The final view was that it should be left to voluntary self-regulation by the manufacturers to reduce trans fats in oils and food products, and if Demark went alone with a statutory limit it would constitute a trade barrier, contrary to EU policy.

In the intervening years since 2006, there has been a steady lobby of the UK government regarding the dangers of trans fats in food. This had led to the virtual removal of hydrogenated oils and fats in the food industry, but no legislation.

Roll on to November 2013, and the news from the USA that the FDA is proposing a ruling to remove GRAS status from all artificially produced trans fats.

With the latest information I again contacted the FSA to ascertain their latest thinking on this matter in the light of the FDA ruling. This is the response I received:

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The FSA does not have an official view on this.

The key point is that Department of Health-(DoH) / Public Health England are now responsible for Nutrition, and consequently for ingredients such as trans-fats. The FSA would have been responsible in 2002, but following restructuring, after the last change of government, policy for Nutrition moved to Department of Health and recently a new body has been set up called Public Health England, an executive agency of DoH.

I contacted Public Health England, which also confirmed that they had no view on this matter. They tried to reassure me that they were monitoring trans levels in foods. They produced a meaningless chart which demonstrated that trans levels, in a variety of foodstuffs, had indeed fallen during the past 10 years. However, the analysis did not include ALA, but simply reflected the shift away from hydrogenated ingredients. hey also emphasised their belief that the industry was carrying out its own self-regulation and that no new regulations on labelling or trans content was necessary.

Under the circumstances, I decided it would be a worthwhile exercise to carry out my own study of the current state of play in the UK.

In March 2014, I purchased 12 bottles of refined rapeseed oil, representing store labels and main branded products from major supermarkets in the UK. I then arranged for a blind independent analysis to be carried by Reading Scientific Services, which conducted a detailed GLC analysis and evaluated the samples for trans fatty acids content in all forms.

The results were a pleasant surprise. Nine of the samples had a total trans level of 0.5%, one, from a German owned supermarket was 1.0%, and one which was Tesco's own label Organic refined rapeseed oil was 1.4%. The final sample, which was cold pressed crude rapeseed oil (included as a control), was not surprisingly 0%

Some of the products had probably been produced from the same refinery, but they also included brands of Dutch and German origin. This result was confirmation that the industry has indeed embarked on a corrective course of action. It would appear that refiners are now adopting low temperature deodorization and sacrificing steam distillation, in favour of partial alkali refining.

Although the level was not exceptionally high I did contact Tesco, as they are the UK's largest food retail chain and pointed out that they were marketing a premium product with a relatively high level of trans fatty acids, compared to others on the market.

Tesco advised that they arrange independent quality evaluations of their oils and fats every six months. They sent me their results for the past six years, and it was disquieting to note that the results appeared suspicious. In nearly all cases they were showing polyunsaturated trans isomers at less than 0.1%. This is a virtually impossible result for a refined rapeseed oil, and it left me in doubt as to the validity of their monitoring. This fact was conveyed to Tesco, which replied that they will look into their results.

I am raising this particular issue, as it represents a negative element in what otherwise is an extremely laudable story.

Apparently the European refiners have accepted that thermally induced trans isomers are potentially a health hazard and over the past decade they have quietly set about changing their refining methods to correct the situation. A maximum standard of 1.0% trans, appears to be easily achievable.

In the United States, the situation has been much more transparent and the regulatory authorities have taken positive steps to make everyone aware of their rulings. This is not the case in the UK. By sitting on their hands the FSA and the Department of Health have left the situation wide open to future abuse by suppliers, who may remain ignorant of the dangers of trans fats. Without any mandatory labelling or control limits the authorities are also leaving the door open to imports with high levels of trans fatty acids.

I am not an advocate of excessive legislation but this is one area where there is a strong argument for statutory controls and transparency.

Ray Cook is in Pershore, England. He can be contacted at Ray Cook raycook.avon@talktalk.net.

EXTRACTS & DISTILLATES

Solid-phase extraction approach for phospholipids profiling by titania-coated silica microspheres prior to reversed-phase liquid chromatography–evaporative light scattering detection and tandem mass spectrometry analysis

Bian, J., *et al., Talanta 123*:233–240, 2014, http://dx.doi.org/10.1016/j.talanta.2014.02.001.

A novel strategy for selectively adsorbing phospholipids (PL) on titania-coated silica core-shell microspheres (TiO_2/SiO_2) was developed. The TiO_2/SiO_2 microspheres were prepared through water-vapor-induced internal hydrolysis and then characterized by scanning electron microscopy, ultraviolet-visible spectroscopy, X-ray diffraction, and measurements of Brunauer-Emmett-Teller surface area. Analyses showed that the titania layer was uniformly distributed onto the surface of silica particles. The TiO_2/SiO_2 microspheres were employed as sorbent in solid-phase extraction (SPE), and their absorptive ability was investigated by reversed-phase liquid chromatography–evaporative light-scattering detection (RPLC–ELSD). Important factors that affect the extraction, such as loading buffer, eluting buffer, and elution volume, were investigated in detail and optimized by using standard samples. Results reveal that the developed SPE approach had higher recoveries for PL than that based on pure TiO_2 particles. The proposed SPE method was used for extraction of PL from serum and showed great potential for identifying more kinds of endogenous PL metabolites by ultra-performance liquid chromatography with quadrupole time-of-flight mass spectrometry. The proposed SPE method with the composite sorbent was used to screen PL from a biological matrix with high selectivity and efficiency. This approach is a promising method for selective extraction of PLs in lipidomics or phospholipidomics.

A systematic survey of lipids across mouse tissues

Jain, M., *et al., Am. J. Physiol. Endocrinol. Metab. 306*:E854–868, 2014, http://dx.doi.org/10.1152/ajpendo.00371.2013.

Lipids are a diverse collection of macromolecules essential for normal physiology, but the tissue distribution and function for many individual lipid species remain unclear. Here, we report a mass spectrometry survey of lipid abundance across 18 mouse tissues, detecting 1,000 mass spectrometry features, of which we identify 179 lipids from the glycerolipids, glycerophospholipids, lysophospholipids, acylcarnitines, sphingolipids, and cholesteryl ester classes. Our data reveal tissue-specific organization of lipids and can be used to generate testable hypotheses. For example, our data indicate that circulating triglycerides positively and negatively associated with future diabetes in humans are enriched in mouse adipose tissue and liver, respectively, raising hypotheses regarding the tissue origins of these diabetes-associated lipids. We also integrate our tissue lipid data with gene expression profiles to predict a number of substrates of lipid-metabolizing enzymes, highlighting choline phosphotransferases and sterol *O*-acyltransferases. Finally, we identify several tissue-specific lipids not present in plasma under normal conditions that may be of interest as biomarkers of tissue injury, and we show that two of these lipids are released into blood following ischemic brain injury in mice. This resource complements existing compendia of tissue gene expression and may be useful for integrative physiology and lipid biology.

Unsaturated fatty acids, desaturases, and human health

Lee, H., and W.J. Park, *J. Med. Food 17*:189–197, 2014, http://dx.doi.org/10.1089/jmf.2013.2917.

With the increasing concern for health and nutrition, dietary fat has attracted considerable attention. The composition of fatty acids in a diet is important since they are associated with major diseases, such as cancers, diabetes, and cardiovascular disease. The biosynthesis of unsaturated fatty acids (UFA) requires the expression of dietary fat-associated genes, such as *SCD, FADS1, FADS2,* and *FADS3,* which encode a variety of desaturases, to catalyze the addition of a double bond in a fatty acid chain. Recent studies using new molecular techniques and genomics, as well as clinical trials, have shown that these genes and UFA are closely related to physiological conditions and chronic diseases; it was found that the existence of alternative transcripts of the desaturase genes and desaturase isoforms might affect human health and lipid metabolism in different ways. In this review, we provide an overview of UFA and desaturases associated with human health and nutrition. Moreover, recent findings of UFA, desaturases, and their associated genes in human systems are discussed. Consequently, this review may help elucidate the complicated physiology of UFA in human health and diseases.

Olives and olive oil are sources of electrophilic fatty acid nitroalkenes

Fazzari, M., *et al., PLOS ONE*, http://dx.doi.org/10.1371/journal.pone.0084884, 2014.

Extra virgin olive oil (EVOO) and olives, key sources of unsaturated fatty acids in the Mediterranean diet, provide health benefits to humans. Nitric oxide (•NO) and nitrite

CONTINUED ON NEXT PAGE

(NO_2^-)-dependent reactions of unsaturated fatty acids yield electrophilic nitroalkene derivatives (NO_2-FA) that manifest salutary pleiotropic cell signaling responses in mammals. Herein, the endogenous presence of NO_2-FA in both EVOO and fresh olives was demonstrated by mass spectrometry. The electrophilic nature of these species was affirmed by the detection of significant levels of protein cysteine adducts of nitro-oleic acid (NO_2-OA-cysteine) in fresh olives, especially in the peel. Further nitration of EVOO by NO_2^- under acidic gastric digestive conditions revealed that human consumption of olive lipids will produce additional nitro-conjugated linoleic acid (NO_2-cLA) and nitro-oleic acid (NO_2-OA). The presence of free and protein-adducted NO_2-FA in both mammalian and plant lipids further affirms a role for these species as signaling mediators. Since NO_2-FA instigate adaptive anti-inflammatory gene expression and metabolic responses, these redox-derived metabolites may contribute to the cardiovascular benefits associated with the Mediterranean diet.

Liposomes: versatile and biocompatible nanovesicles for efficient biomolecules delivery

Mallick, S., and J.S. Choi, *J. Nanosci. Nanotechnol. 14*:755–765, 2014, http://dx.doi.org/10.1166/jnn.2014.9080.

Since the revolutionary discovery that phospholipids can form closed bilayered structures in aqueous systems, liposomes have become a very interesting topic of research. Because of their versatility and amazing biocompatibility, the use of liposomes has been widely accepted in many scientific disciplines. Their applications, especially in medicine, have yielded breakthroughs with anticancer-drug carriers over the past few decades. Specifically, their easy preparation and various structural aspects have given rise to a broadly usable way to internalize biomolecules such as drugs, DNA, RNA and even imaging probes. This review article reports recent developments in liposomal drug delivery and gene delivery and thoroughly covers the synthesis and different kinds of liposomal surface modification techniques that have resulted in higher stability and efficiency with respect to the use of liposomes in tumor cell targeting, site-specific release, and extending blood retention times.

Cholesterol as a causative factor in Alzheimer's disease: a debatable hypothesis

Wood, W.G., *et al.*, *J. Neurochem. 129*:559–572, 2014, http://dx.doi.org/10.1111/jnc.12637.

High serum/plasma cholesterol levels have been suggested as a risk factor for Alzheimer's disease (AD). Some reports, mostly retrospective epidemiological studies, have observed a decreased prevalence of AD in patients taking the cholesterol-lowering drugs, statins. The strongest evidence causally linking cholesterol to AD is provided by experimental studies showing that adding/reducing cholesterol alters amyloid precursor protein (APP) and amyloid beta-protein (Aβ) levels. However, there are problems with the cholesterol–AD hypothesis. Cholesterol levels in serum/plasma and brain of AD patients do not support cholesterol as a causative factor in AD. Prospective studies on statins and AD have largely failed to show efficacy. Even the experimental data are open to interpretation given that it is well established that modification of cholesterol levels has effects on multiple proteins, not only APP and Aβ. The purpose of this review therefore was to examine the above-mentioned issues, discuss the pros and cons of the cholesterol–AD hypothesis, look at the involvement of other lipids in the mevalonate pathway, and consider that AD may impact cholesterol homeostasis. This review covers articles ranging from human to cell culture studies, both *in vitro* and *in vivo*. Among others, we review models of how Aβ could act on a membrane and of how Aβ might be perturbing cholesterol in a cell.

Identification of fatty acid steryl esters in margarine and corn using direct flow injection ESI-MS^n ion trap-mass spectrometry

Hailat, I., and R. Helleur, *Int. J. Mass Spectrom. 362*:24–31, 2014, http://dx.doi.org/10.1016/j.ijms.2014.02.017.

An approach for identification of steryl esters using flow injection ESI-MS^2 and ESI-MS^3 ion trap mass spectrometry has been developed. Sterols and other lipids extracted from samples of margarine and corn using hexane were subjected to solid phase extraction. The steryl ester fraction was eluted with hexane/diethyl ether (98:2, v/v). In ESI-MS experiments, fatty acid steryl esters were easily detected as ammoniated adducts $[M+NH_4]^+$ using ammonium acetate as dopant. Steryl esters including molecular isomers could be identified using ESI-QIT MS^2 by the facile ester cleavage whereby the charge resides with the steryl moiety. For positive confirmation of the sterol group, ESI-QIT MS^3 was carried out on the intact steryl fragmentation cation. The resulting CID spectra of the steryl cation were found to be unique and similar to those from APCI-QIT MS^2 CID of free sterol standards. All major steryl esters were identified in both margarine (12 esters) and corn (7 esters) extracts. Based on the ion intensity of the ESI-MS spectra the major steryl esters in margarine were: β-sitostery1 stearate, β-sitosteryl oleate, β-sitosteryl linoleate, campesteryl stearate, and campesteryl linoleate. In corn they were: β-sitosteryl oleate, campesteryl stearate, campesteryl oleate, and stigmasteryl linoleate. This method can be very useful for rapid and complete identification of fatty acid steryl esters extracted from other biological samples.

Sphingolipids in colon cancer

García-Barros, M., *et al.*, *Biochim. Biophys. Acta 1841*:773–782, 2014, http://dx.doi.org/10.1016/j.bbalip.2013.09.007.

Colorectal cancer is one of the major causes of death in the Western world. Despite increasing knowledge of the molecular signaling pathways implicated in colon cancer, therapeutic outcomes are still only moderately successful. Sphingolipids, a family of N-acyl linked lipids, not only have structural functions but also are implicated in important biological functions. Ceramide, sphingosine and sphingosine-1-phosphate are the most important bioactive lipids, and they regulate several key cellular functions. Accumulating evidence suggests that many cancers present alterations in sphingolipids and their metabolizing enzymes. The aim of this review is to discuss the emerging roles of sphingolipids, both endogenous and dietary, in colon cancer and the interaction of sphingolipids with WNT/β-catenin pathway, one of the most important signaling cascades that regulate development and homeostasis in intestine.

Conversion of a *Rhizopus chinensis* lipase into an esterase by lid swapping

Yu, X.-W., *et al., J. Lipid Res.* 55:1044–1051, 2014, http://dx.doi.org/10.1194/jlr.M043950.

In an effort to explore the feasibility of converting a lipase into an esterase by modifying the lid region, we designed and characterized two novel *Rhizopus chinensis* lipase variants by lid swapping. The substrate specificity of an *R. chinensis* lipase was successfully modified toward water-soluble substrates, that is, turned into an esterase, by replacing the hydrophobic lid with a hydrophilic lid from ferulic acid esterase from *Aspergillus niger*. Meanwhile, as a comparison, the lid of *R. chinensis* lipase was replaced by a hydrophobic lid from *Rhizomucor miehei* lipase, which did not alter its substrate specificity but led to a 5.4-fold higher catalytic efficiency (k^*_{cat}/K^*_m) toward *p*-nitrophenyl laurate. Based on the analysis of structure-function relationships, it suggests that the amphipathic nature of the lid is very important for the substrate specificity. This study provides new insight into the structural basis of lipase specificities and a way to tune the substrate preference of lipases.

On the formation of 7-ketocholesterol from 7-dehydrocholesterol in patients with CTX and SLO

Björkhem, I., *et al., J. Lipid Res.* 55:1165–1172, 2014, http://dx.doi.org/10.1194/jlr.P048603.

A new mechanism for formation of 7-ketocholesterol was recently described involving cytochrome P-450 (CYP)7A1-catalyzed conversion of 7-dehydrocholesterol into 7-ketocholesterol with cholesterol-7,8-epoxide as a side product. Some patients with cerebrotendinous xanthomatosis (CTX) and all patients with Smith-Lemli-Opitz syndrome (SLO) have markedly increased levels of 7-dehydrocholesterol in plasma and tissues. In addition, the former patients have markedly upregulated CYP7A1. We hypothesized that these patients may produce 7-ketocholesterol from 7-dehydrocholesterol with formation of cholesterol-7,8-epoxide as a side product. In accord with this hypothesis, two patients with CTX were found to have increased levels of 7-ketocholesterol and 7-dehydrocholesterol, as well as a significant level of cholesterol-7,8-epoxide. The latter steroid was not detectable in plasma from healthy volunteers. Downregulation of CYP7A1 activity by treatment with chenodeoxycholic acid reduced the levels of 7-ketocholesterol in parallel with decreased levels of 7-dehydrocholesterol and cholesterol-7,8-epoxide. Three patients with SLO were found to have markedly elevated levels of 7-ketocholesterol as well as high levels of cholesterol-7,8-epoxide. The results support the hypothesis that 7-dehydrocholesterol is a precursor to 7-ketocholesterol in SLO and some patients with CTX.

Pathological roles of ceramide and its metabolites in metabolic syndrome and Alzheimer's disease

Yuyama, K., *et al., Biochim. Biophys. Acta 1841*:793–798, 2014, http://dx.doi.org/10.1016/j.bbalip.2013.08.002.

The public health burden of metabolic syndrome (MetS), a multiplex risk factor that arises from insulin resistance accompanying abnormal adipose conditions, and Alzheimer's disease (AD), the most common form of dementia, continues to expand. Current available therapies for these disorders are of limited effectiveness. Recent findings have indicated that alterations in sphingolipid metabolism contribute to the development of these pathologies. Sphingolipids are major constituents of the plasma membrane, where they are known to form several types of microdomains, and are potent regulators for a variety of physiological processes. Many groups, including ours, have demonstrated that membrane sphingolipids, especially ceramide and its metabolites such as ceramide 1-phosphate, have roles in arteriosclerosis, obesity, diabetes, and inflammation associated with MetS. Aberrant sphingolipid profiles have been observed in human AD brains, and accumulated evidence has demonstrated that changes in membrane properties induced by defective sphingolipid metabolism impair generation and degradation of amyloid-β peptide (Aβ), a pathogenic agent of AD. In this review, we summarize current knowledge and pathophysiological implications of the roles of sphingolipids in MetS and AD, to provide insight into the sphingolipid metabolic pathways as potential targets for therapy of these diseases.

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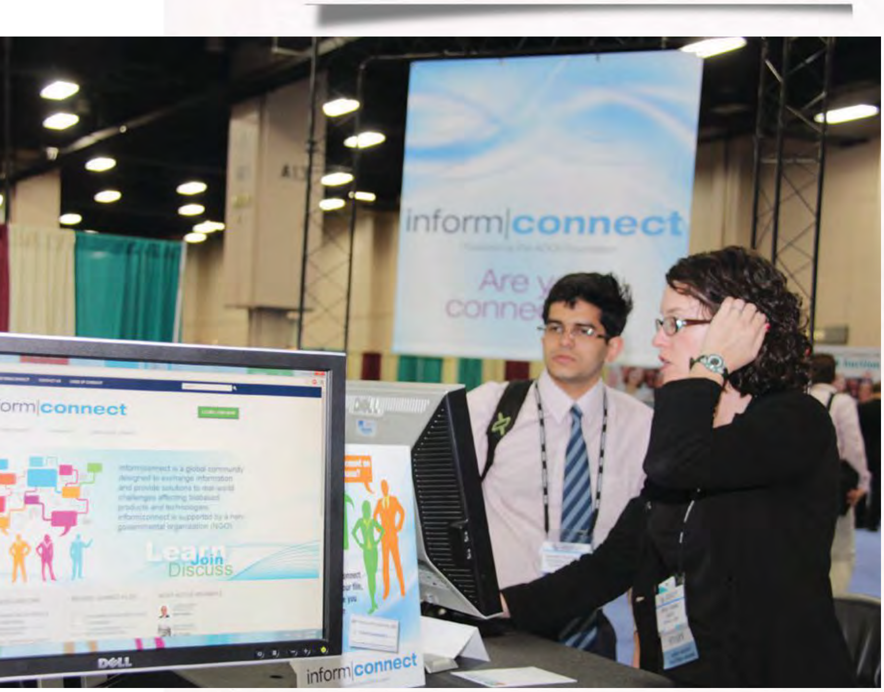


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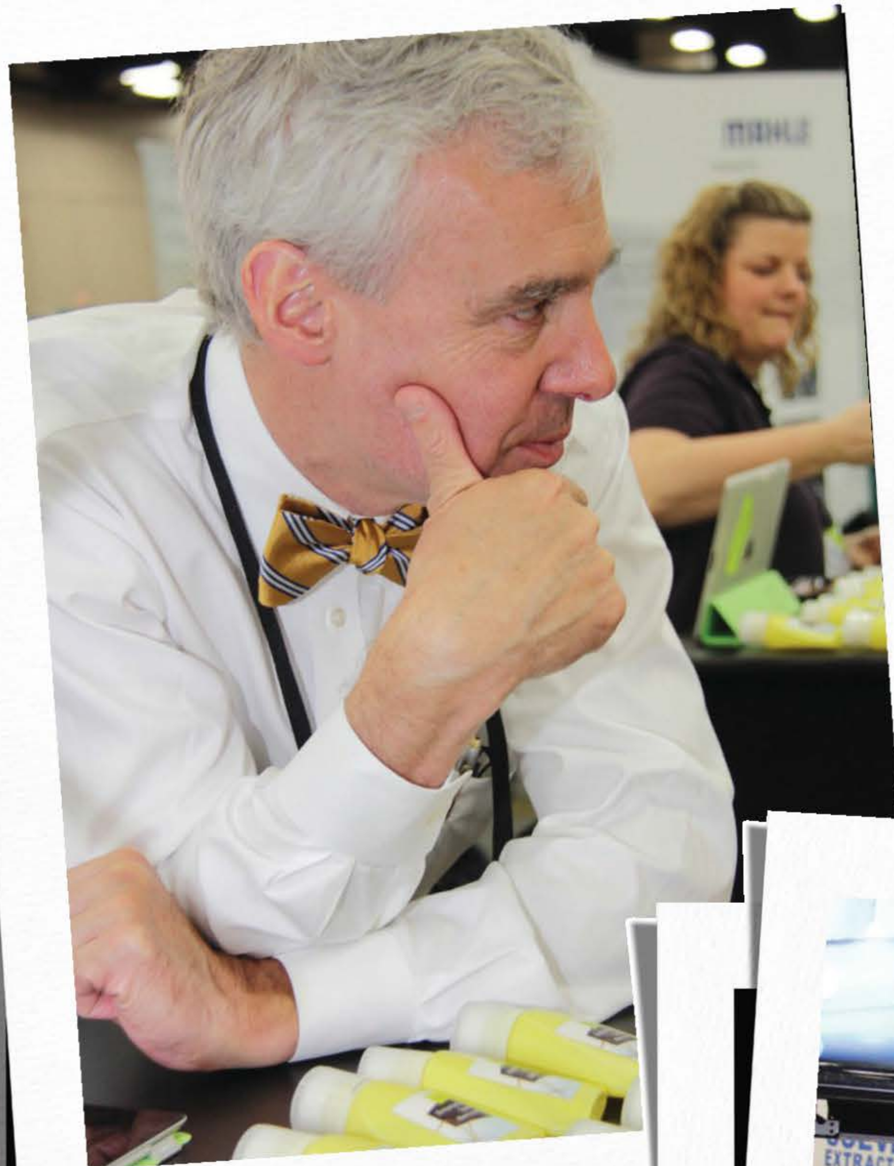


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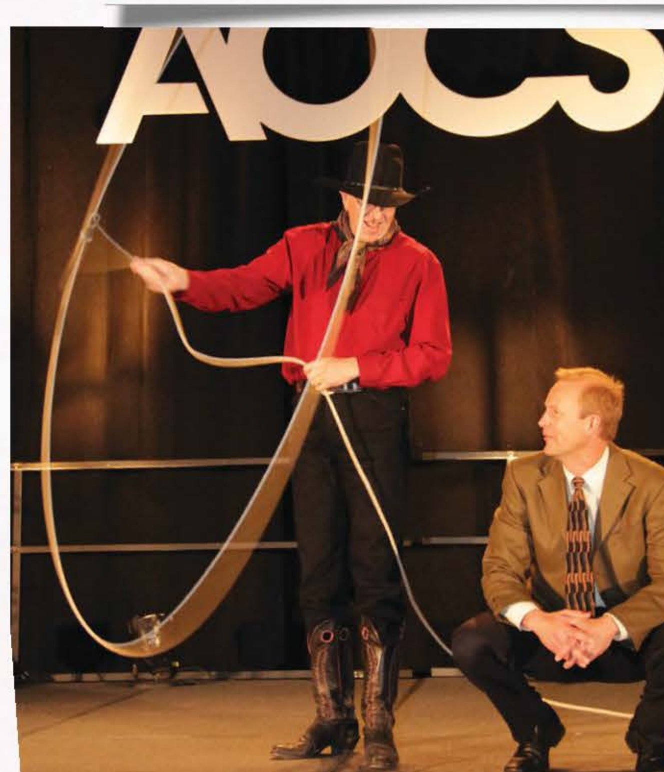
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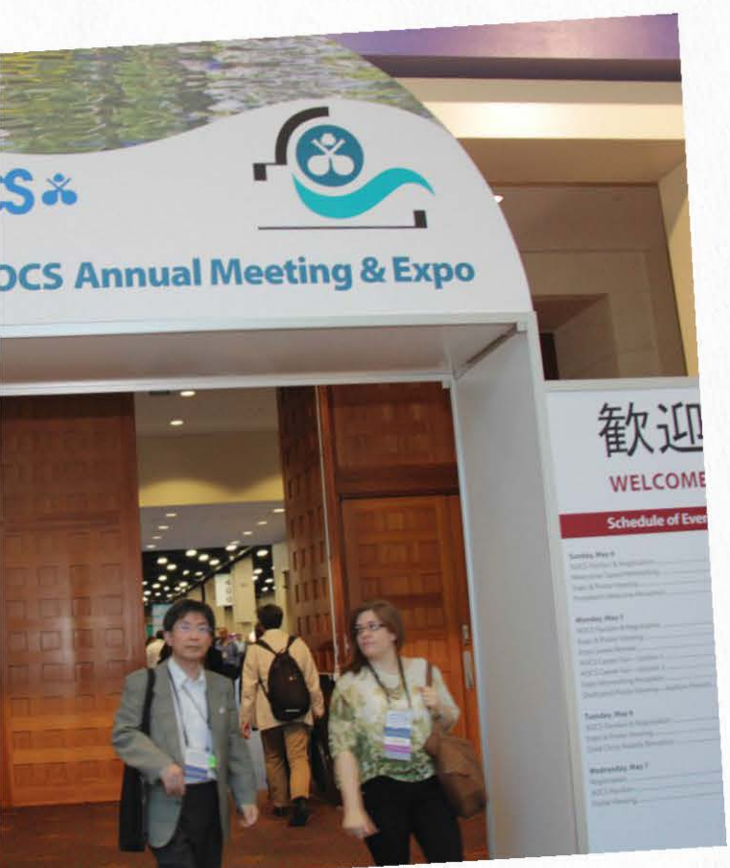
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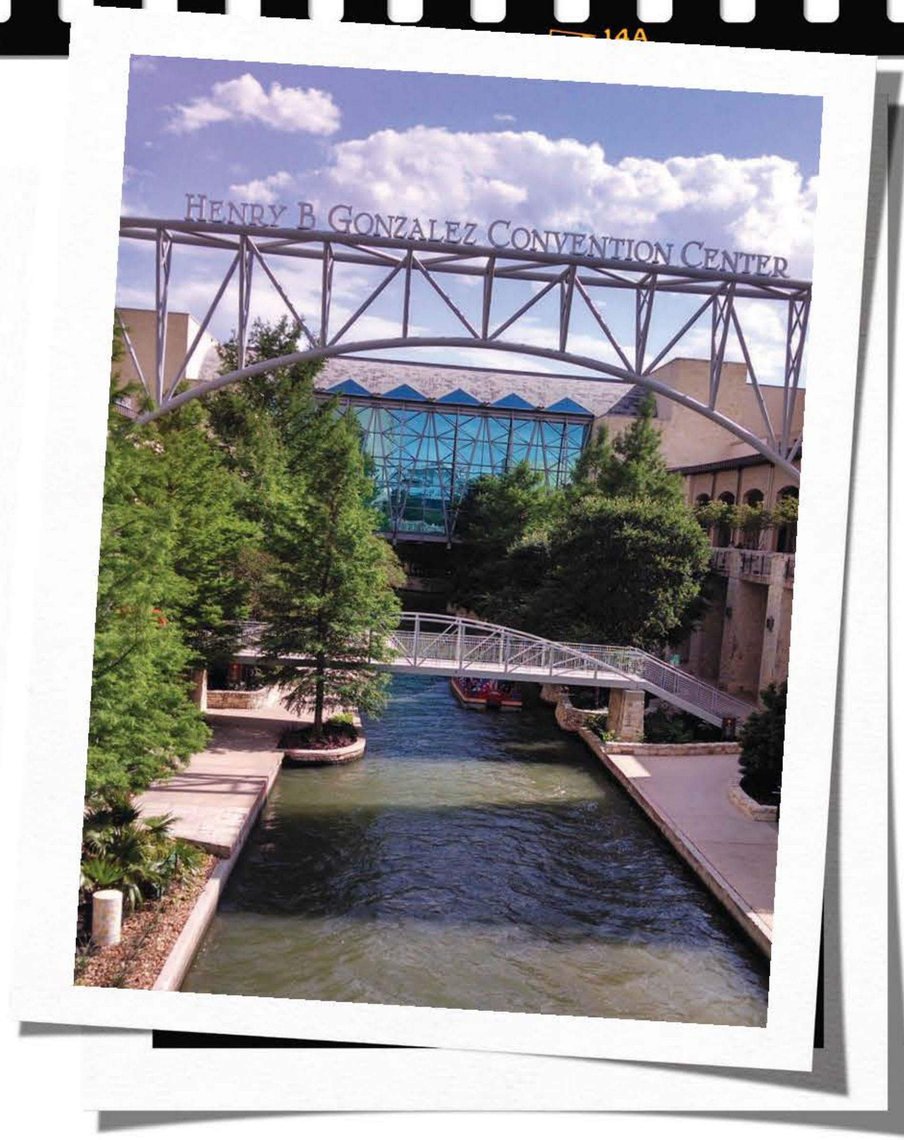
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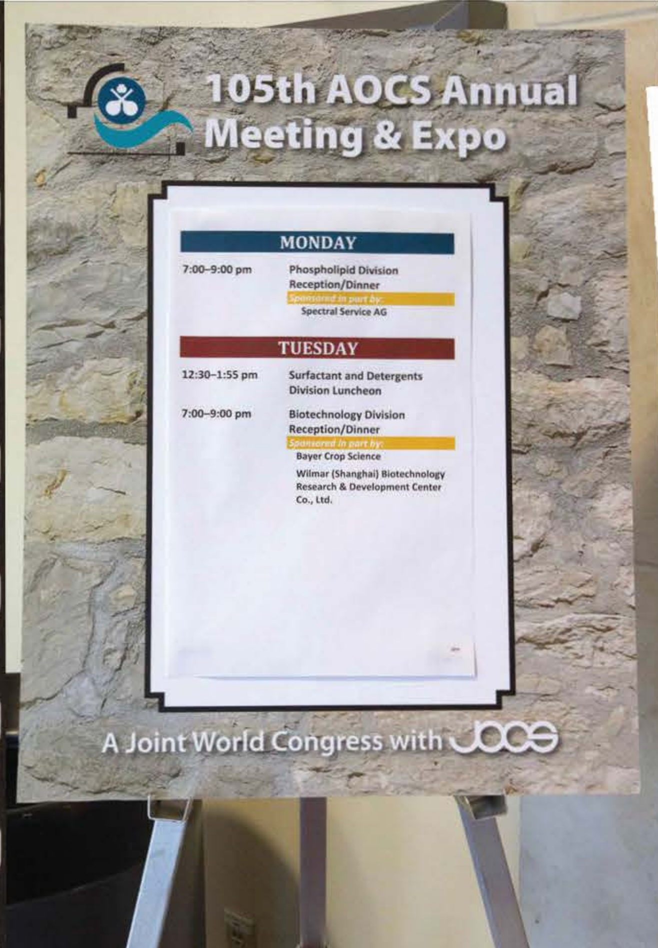
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