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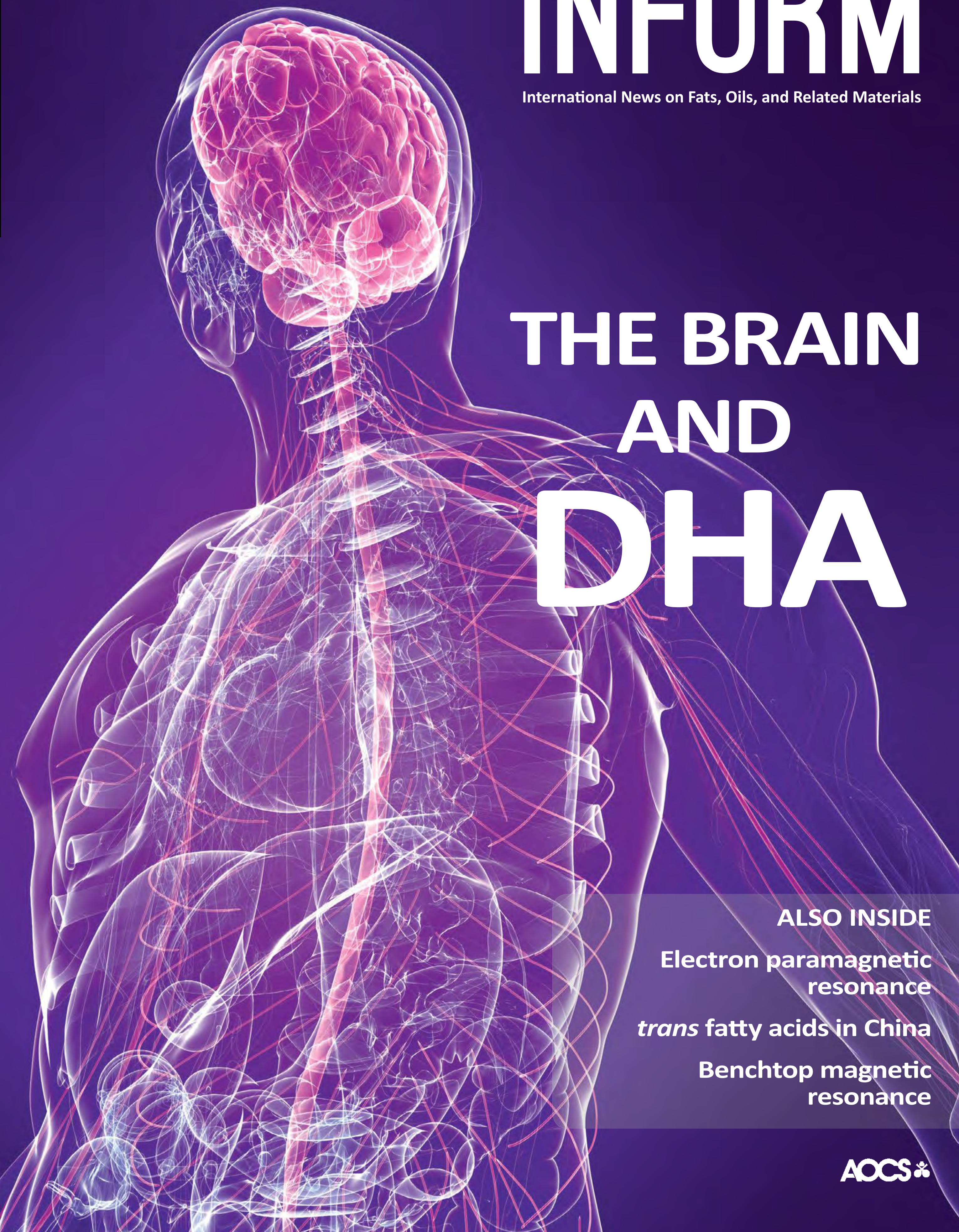

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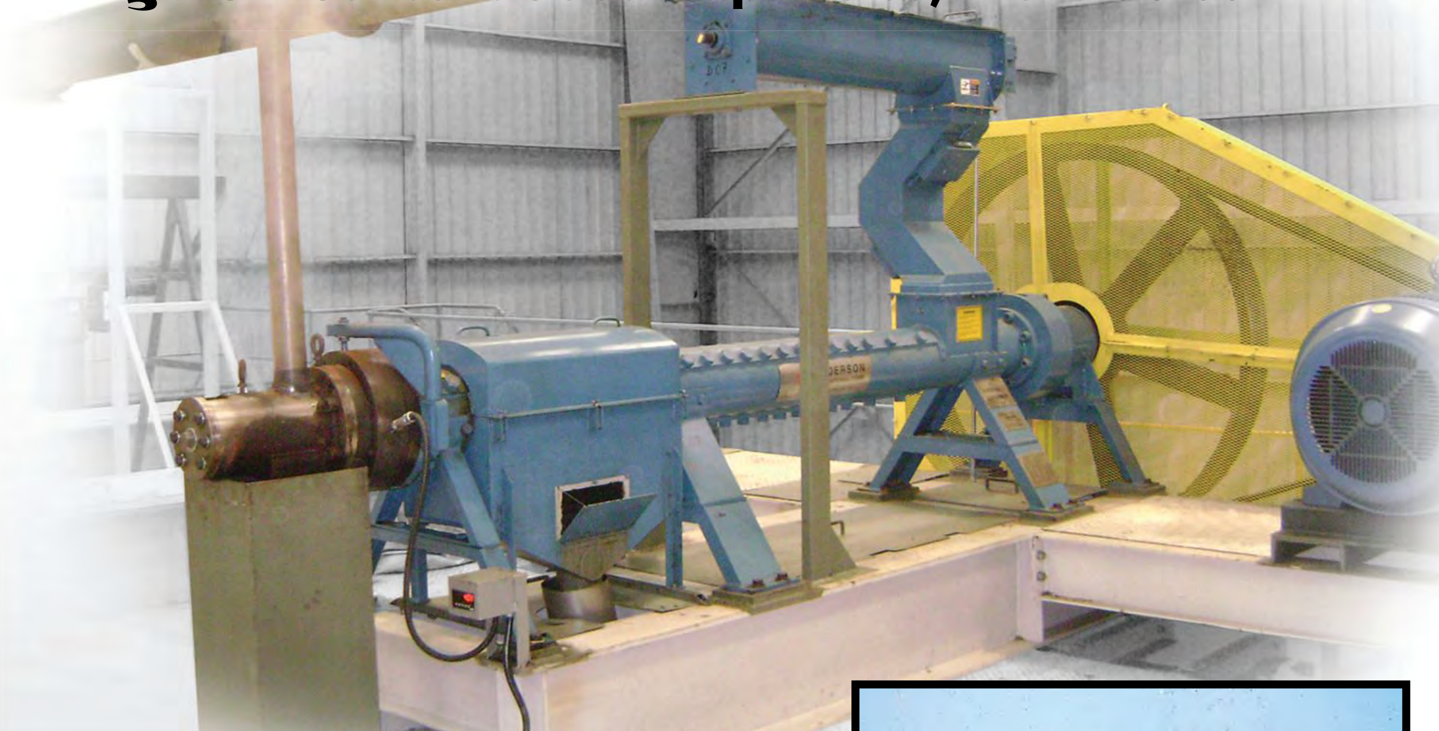

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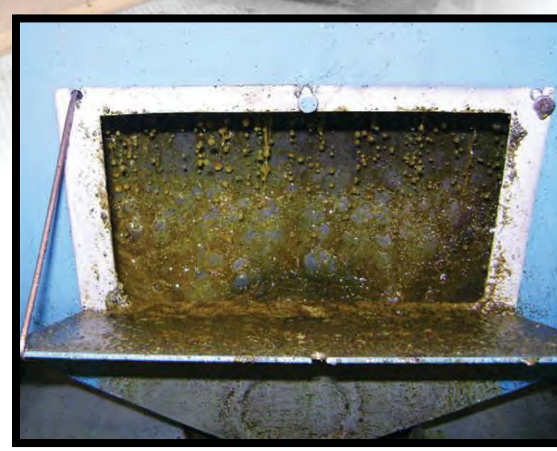

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Docosahexaenoic acid (DHA) function and metabolism in the NERVOUS SYSTEM

Norman Salem, Jr.

There has been great interest in the nutrition community for quite a while in the omega-3 fatty acids docosahexaenoic acid (C22:6n-3, DHA) and eicosapentaenoic acid (C20:5n-3, EPA) due to their promise of health benefits. These two fatty acids are the key components of fish oil used as dietary supplements or for food and beverage fortification. DHA and arachidonic acid (C20:4n-6, ARA) are the two principal long-chain polyunsaturated fatty acid nutrients added to infant formulas. These fatty acids support nervous system development from both a compositional and a functional standpoint. This article will focus mainly on the role of DHA in the brain.

- **DHA's presence in the brain**
- **the effects of depletion and repletion**
- **benefits throughout the life cycle**

BRAIN DHA CONTENT

It has been known since the pioneering work of O'Brien in the 1960s that DHA is highly concentrated in the brain (1). It is found mainly in phospholipids and within this lipid class, principally in phosphatidylethanolamine (PE) and phosphatidylserine (PS), much less so in phosphatidylcholine (Table 1, page 8). In PE and PS, it has been estimated that 50–75% of the molecules contain DHA in the brain gray matter. There is very little DHA in brain neutral lipids, sphingomyelin, glycolipids, or in the nonesterified fatty acid form. Cellular and subcellular fractionation studies demonstrate that DHA is concentrated in most types of brain cells but at low levels in myelin. When present in a cell, it is generally found in most of the organelles within the cell and is not confined to the plasma membrane. In this respect it may be considered to be cell specific in its localization rather than organelle specific.

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TABLE 1. DHA content in various biological tissues (1).

Tissue	% DHA	
	PS	PE
Human brain gray matter	36.6	24.3
Rat brain synaptosomal membrane	34.1	32.4
Rat brain synaptic vesicle	37.0	30.6
Human retina	18.5	22.2
Bovine rod outer segment	37.7	38.7
Ovine spermatoza	--	40.5
Rat hind leg muscle	15.9	36.1
Rat heart	11.8[a]	23.3
Rat liver	10.7[a]	15.6

PS, phosphatidylserine; PE, phosphatidylethanolamine; ALA and EPA levels are nil in the CNS

DHA DEFICIENCY AND REPLETION STUDIES

One of the key ways in which we know that a nutrient is important for physiological function is to deplete it from a particular organ and then determine whether there is a loss of function. Since the brain tenaciously retains DHA even in the face of starvation, it has proven difficult to substantially deplete brain DHA from an adult mammal by dietary deprivation. An animal literature has accumulated over the past three decades or so in which all omega-3 fatty acids are removed from the diet of the mother and her offspring studied for functional deficits. A variety of functional deficits occur in the low-DHA brain as demonstrated by a variety of behavioral tasks including Y-maze performance, active avoidance tasks and shock avoidance, brightness discrimination, olfactory discriminations, and spatial task acquisition (1). A variety of parameters related to visual function including electroretinographic assessment of amplitude and implicit times to visual stimuli as well as measures of visual acuity and recovery from dark adaptation are abnormal in the DHA-deficient retina. In addition, a variety of changes in biochemical parameters in the brain have been noted including the bioactive compounds neuroprotectin, BDNF (brain-derived neurotrophic factor), and NGF (nerve growth factor).

In one such study, rats were maintained for two generations on an omega-3-deficient diet and tested for their ability to make olfactory discriminations, a sensory modality in which rodents excel (2). Once the task had been acquired, the reinforced stimulus was reversed in order to test reversal learning. This was followed by a series of similar reversals to determine if the rats could acquire a learning set, i.e., a tendency to respond in a way that will produce a successful solution to a particular problem; that is, to make only one error and then to understand that the other aroma was the one now being reinforced. This type of learning had generally been ascribed only to primates as it represents a higher level of cognition. Catalan *et al.* (2) observed that rats fed omega-3 fatty acids and with adequate brain DHA could acquire a learning set if it was presented in the olfactory modality. However, animals with low brain DHA could not acquire the learning set even after 20 reversals.

It may be questioned whether DHA was truly the sole nutrient responsible for the loss of neural functions in the omega-3 fatty acid deficiency. This question was addressed by creating the omega-3 deficiency and then studying the return of brain function when the nutrient was repleted through dietary supply. Moriguchi *et al.* (3) gave rats an omega-3-deficient diet for three generations, and then they were allowed to recover their brain DHA to varying degrees in nine separate groups. Their performance then was assessed in the Morris water maze, a task related to spatial memory. The brain DHA-deficient rats performed poorly on the spatial memory task and took a longer time to find a platform in a pool of water. However, rat pups born DHA-deficient but who had been repleted starting at birth performed just as well as animals who had been maintained on an omega-3-containing diet. This dietary treatment was capable of restoring the brain DHA to "normal" levels. More generally, the performance on the behavioral task correlated with the level of DHA in the brain in the various groups repleted with omega-3 fatty acids for varying lengths of time.

Conversely, the performance was inversely correlated with the level of brain docosapentaenoic acid (22:5n-6, DPAn-6), the fatty acid that reciprocally replaces DHA when omega-3 fatty acid sources are not available in the diet (1) (Fig. 1). This experiment establishes conclusively that the deficit in brain function as measured by the Morris water maze was due to the loss of brain DHA and, moreover, that the effect was reversible if the brain DHA was restored. A rather amazing specificity of the brain requirement for DHA was later

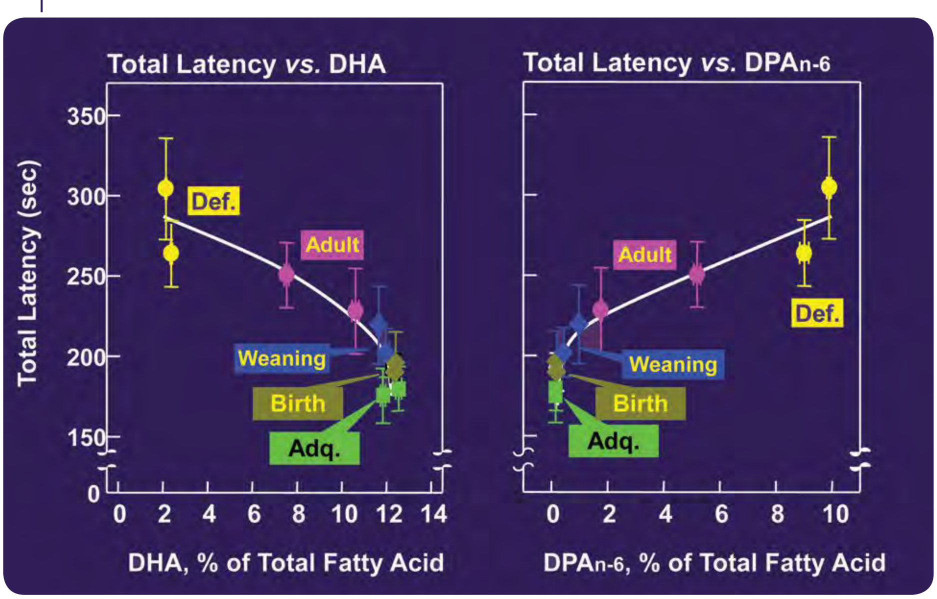

FIG. 1. Dependence of spatial task performance on the Morris water maze on brain content of DHA and inverse relationship with DPAn-6 (3).

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established by the demonstration that DPAn-6 feeding could not substitute for DHA in supporting spatial task performance.

BENEFITS THROUGHOUT THE LIFE CYCLE: INFANTS, CHILDREN, ADULTS, AND THE ELDERLY

There is now a large literature supporting the benefits of DHA for infant development, particularly in support of nervous system development. Hoffman *et al.* (4) recently reviewed this literature for term infants. They summarize several positive visual and cognitive outcomes in correlation with bloodstream DHA including developmental indices, speech perception, mental processing, visual acuity, and stereo-acuity (the ability to detect differences in distance using stereoscopic cues). Stronger evidence is gained in randomized, controlled trials of DHA generally tested together with ARA- vs. vegetable oil-supplemented control infant formulas. Many of these same parameters relating to cognition and visual acuity have been shown to benefit by DHA/ARA supplementation. It is true that several studies have found a null effect of supplementation; this may be due to many factors including too low a dose of DHA, an excess of EPA which may antagonize ARA, absence of ARA, an underpowered study, or too much variability in the measurements made. Hoffman *et al.* also summarize some of the recommendations made by expert bodies where from 0.2 to 0.5% of DHA and 0.2 to 0.7% of ARA have been advised for inclusion in infant formulas. Generally, ARA should exceed the DHA level. For example, in 1994 the FAO/WHO expert panel recommended 0.35% for DHA and 0.75% for ARA in term formulas. For preterm infants, many of the same parameters show a benefit for DHA/ARA supplementation of the diet. The data are more uniform in support of a benefit for the preterm infants who are born at a less advanced stage of development when brain and retinal DHA is accumulating very rapidly during explosive growth.

Ryan *et al.* recently reviewed benefits of DHA for children (5). As for newborn infants, the literature indicates a role for continued intake of DHA in support of neurodevelopment from both epidemiological and interventional studies. For example, higher fish intake during pregnancy was associated with better verbal and combined IQ scores, better prosocial behavior, better visuospatial performance and better developmental scores in children. In interventional studies where the child is directly supplemented with DHA, increases in IQ scores, hand and eye coordination, verbal learning, vocabulary scores, and in neural imaging measures of activation were observed. There were also several indications of a benefit for neurodevelopment for children with phenylketonuria. In a very recent large, randomized, controlled trial of 362 normal 7–9-year-old children, Richardson *et al.* demonstrated a benefit for reading scores of children in the lowest quintile as well as a benefit for several parent-rated behaviors (6). These are clearly important benefits to both parents and their children.

In adults, there are unequivocal benefits for increased long-chain omega-3 fatty acid intakes for one of the biggest killers—cardiovascular disease (CVD). Many epidemiological studies have shown an association of fish eating with lower incidence of CVD and its various measures. In addition, support for a cardiovascular benefit is obtained from *in vitro* and mechanistic studies (7). Both EPA and DHA exert powerful effects that affect CVD risk factors including serum triglycerides lowering, cardiac diastolic filling, arterial compliance (a measure of an artery's tendency to resist recoiling toward its original dimensions after a distending or compressing force has been removed), or lower levels of inflammatory mediators such as cytokines, reduced platelet aggregation, lower blood pressure, lower heart rate, and an increase in both low density lipoprotein and high density lipoprotein particle size (7). These omega-3 fatty acids are associated with lower risk of fatal cardiac events and lower risk of atrial fibrillation, suggesting effects for cardiac arrhythmias. In addition in a large, randomized, controlled trial of 485 older adults DHA provided a benefit for episodic memory and verbal recognition memory-related tasks (8).

A recent meta-analysis, which attempted to statistically combine the results of 20 large clinical studies, purported to deny the benefit of omega-3 fatty acids for cardiovascular disease (9). It is unfortunate that the authors overinterpreted the significance of their results and lack of findings. In fact, their evidence would have demonstrated a positive effect of omega-3 on cardiovascular disease outcomes had they not used a threshold for statistical significance of $p < 0.0063$. Many have

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Can fish oil heal severe brain injuries?

News about a teenager who had made a remarkable recovery from a serious brain injury after being given intravenous doses of fish oil made the rounds in October 2012. *CNN.com* was the first media outlet to report on this unusual case.

In March 2010, 17-year-old Bobby Ghassemi was in a car crash that severely damaged his brain. He suffered a coma, and part of his skull had to be removed to alleviate pressure from injury-related fluid buildup. Ten days later, the teenager was still in a coma, and there was no way to know when, how much, or even if he would recover.

In desperation, his father tracked down a US Army colonel who had been researching the effect of omega-3s on suicide in soldiers. At the colonel's suggestion, the teen's parents urged the doctors to give their son nutritional doses of fish oil. Two weeks after receiving the fish oil, Bobby exhibited signs that he was emerging from his coma. Four weeks later, he was moving his hands and leg. Three months after his accident he was well enough to attend his high school graduation, and in August 2012, his doctors published a paper about the case in *The American Journal of Emergency Medicine*. More details can be found at http://www.cnn.com/2012/10/19/health/fish-oil-brain-injuries/index.html?hpt=hp_bn12.

TABLE 2. The origin of organ and tissue DHA in the rat: metabolism of ALA vs. incorporation of preformed DHA (11)

Tissue	Origin of Organ DHA (% in whole organ) from ALA	from Preformed DHA
Heart	9	91
Plasma	10	90
Lung	8	92
Kidney	9	91
Testes	11	89
Skin	7	93
Skeletal Muscle	9	91
Bone	8	92
Brain	9	91
Liver	10	90
Brown Adipose	7	93
White adipose	8	92
Visceral Adipose	9	91

Total Body DHA, mg/whole rat	
8 d	15 mg
28 d, ALA diet	13 mg
28 d, ALA+DHA diet	156 mg

noted that meta-analyses have a low sensitivity to detect significant effects owing to differences in many important variables between studies to be "averaged." This particular study also had the shortcomings that the patients had already been treated with the modern standard of care and the many drugs entailed in that care, so it is very difficult to detect the benefits of a dietary supplement that may, after all, be most efficacious in the *prevention* of that disease. Greater dosages of long-chain omega-3 fatty acids and longer trials are also more conducive to observing supplement benefits for those who already have CVD, and such criteria were not employed in the Rizos *et al.* study. It is unfortunate that the authors did not understand the limitations of their study and provided the public with advice that conflicts with that of the most prominent expert bodies who recommend EPA/DHA intake for CVD patients (7).

OMEGA-3 FATTY ACID METABOLISM IN ANIMALS AND HUMANS

If DHA is essential to support brain function, then where will we get it from? Clearly it can be consumed in the diet preformed in rich sources such as fish, as supplements, fortified foods, and perhaps organ meats. The question that is often asked, though, is: To what extent can the C_{18} and C_{20} omega-3 fatty acid precursors to DHA support organ DHA content via *in vivo* metabolism? It has long been appreciated that rodents can perform this type of metabolism to a greater extent than can higher mammals including primates and humans. There have been two recent whole-body studies of α-linolenic acid (18:3n-3, ALA) metabolism in rodents. Lin and Salem studied the incorporation of a single dose of stable isotope-labeled ALA as well as similarly labeled linoleic acid (18:2n-6, LA) into 25 rat tissues either intact or as one of the omega-3 or omega-6 fatty acid metabolites, respectively, over a period of 25 days (10). They observed that about 78% of both labels were catabolized; 16–18% was incorporated as the C_{18} precursor into tissues, principally adipose, skin and muscle; and only 2.6% (LA) and 6% (ALA) were converted into C_{20} and C_{22} metabolites. In the rat, most of the LA metabolites were found in the ARA fraction and most of the ALA metabolites were represented by DHA. Labeled ARA accumulated in the liver and other internal organs. The labeled DHA accumulated mainly in the liver, brain, heart, and kidney over time.

DeMar and colleagues studied rat pups fed ALA or ALA + DHA during rapid development between 8 and 28 days of age (11). They compared stable isotope ALA metabolism in many tissues in both dietary situations, effectively dividing up the whole body. In the base diet, animals were fed no omega-3 fatty acids except for 1 wt% of deuterated ALA so that all metabolites formed via *in vivo* metabolism would then be labeled with deuterium and could be selectively measured by mass spectrometry. A second group was similarly treated except that 2 wt% of (unlabeled) DHA was added to the diet. When this preformed DHA was incorporated into tissues, it would be measured as unlabeled DHA. The results showed that about 90% of all organ DHA was simply incorporated from the preformed DHA and only about 10% of the DHA had been metabolized from ALA (Table 2). Thus, even in the rat with its greater capacity for essential fatty acid metabolism, preformed DHA provides the predominant pool of this nutrient while ALA metabolism is perhaps a backup system that may be used in times of limited dietary supply of DHA.

Animal studies of DHA deficiency in the brain and retina have demonstrated that DHA is an essential nutrient and that a variety of losses in function occur when its level drops.

The study indicates that about 90% of all organ DHA in the rat is derived from preformed DHA when it is available in the diet. It is also of critical importance to note how the developing rats fed ALA as their only omega-3 source failed to accumulate any whole-body DHA whereas the DHA-fed pups had a 10-fold increase in whole-body DHA. What was observed in the former group fed only ALA was that a few organs accumulated DHA at the expense of many other organs (11).

Human beings are also capable of complete conversion of ALA to DHA *in vivo*; this has been demonstrated using stable isotope labels and sensitive mass spectrometric measurements in premature and term infants and in adult males and females on various diets as well as during aging, and in smokers and alcoholics (12). The International Society for the Study of Fatty Acids and Lipids has published a scientific statement concerning human ALA metabolism (12). This panel of international experts concluded that ALA metabolism to DHA occurs in humans of all ages but is very limited; metabolism of ALA to EPA and DPAn-3 is of a somewhat greater magnitude but still relatively ineffective compared to consumption of preformed long-chain omega-3 fatty acids. Consumption of preformed DHA is necessary to support higher levels of organ and bloodstream DHA.

CONCLUSIONS

DHA is highly concentrated in nervous system tissues mainly in amino-phospholipids where it is found in most types of brain cells but not in myelin. Animal studies of DHA deficiency in the brain and retina have demonstrated that DHA is an essential nutrient and that a variety of losses in function occur when its level drops. Dietary supplementation in infants leads to benefits throughout life for brain development, in children for reading and behavior, in adults for cardiovascular health, and during aging for memory and executive function maintenance. Animal studies indicate that about 90% of organ DHA originates from preformed DHA incorporation when this nutrient is present in the diet and only 10% from *in vivo* ALA metabolism. Human beings appear to have minimal capacity for *in vivo* ALA conversion although DHA formation is detectable when highly sensitive stable isotope/mass spectrometric assays are used. Human organ and blood stream DHA content is best supported by preformed DHA.

Norman Salem, Jr. has spent his entire research career working on essential fatty acids, focusing upon DHA—the first 30 years with the Intramural Research Program of the US National Institutes of Health and the past five years with DSM Nutritional Products (Columbia, Maryland, USA) where he is now the Corporate Scientist for Nutritional Lipids. He has published about 250 research papers and chapters and was the recipient of the 2002 Nicholas Pelick/AOCS Award and the 2010 Alexander Leaf Lifetime Achievement Award from the International Society for the Study of Fatty Acids & Lipids (ISSFAL). He can be contacted at norman.salem@dsm.com.

ISO headquarters in Geneva, Switzerland. Courtesy of ISO.

AOCS: supporting international standards

Catherine Watkins

Trade standards improve efficiency of production and ease international commerce. They can also affect profitability. A case in point: One small change to the AOCS protein determination methods has maintained revenue for the soy protein ingredient and feed industries; that revenue represents more than two billion dollars since 2010.

- AOCS has worked since its founding in 1909 to develop methods and standards on behalf of the oils and fats community.
- Today's global marketplace makes international standards critical to the smooth flow of trade.
- International standards increase efficiency and minimize waste, expense, and unnecessary effort.

Nicolas Deak, platform lead at Solae, the DuPont-owned soy ingredients company based in St. Louis, Missouri, USA, takes up the story.

"Solae heard in 2009 that the Chinese government had proposed a change to its regulatory standard for measuring protein content in several foods, including soy," Deak explains. Specifically, China planned to lower the nitrogen-to-protein conversion factor used to calculate protein content in soy from the globally recognized conversion factor of 6.25 to 5.71. The proposal was based on the presence of the 5.71 conversion factor in a table appended to several AOCS protein determination methods.

In brief, the 5.71 conversion factor came from research—since disproved—that was published in 1931 and memorialized in the AOCS methods. Using the lower factor, however, results in a 9.2% reduction in the calculated protein content of soy products and a corresponding reduction in revenue for the soy ingredients and feed industries.

Deak and Solae led the effort to build an industrywide coalition within AOCS to standardize trade policy and regulations in order to maintain 6.25 as the nitrogen-to-protein conversion factor for soy. AOCS convened an expert panel under the aegis of the AOCS Uniform Methods Committee (UMC) in March 2010. The panel—with representatives from academia, government, and industry—agreed that the table should be removed from AOCS methods. The UMC reviewed the panel's recommendation at the AOCS Annual Meeting & Expo in May 2010. A motion to remove the table was put forth and approved. In the end, China changed the conversion factor back to 6.25 for highly refined soy proteins but not for meal.

The importance of standards and methods—and laboratory proficiency—to a company's bottom line is echoed by John Hancock, technical manager of London-based FOSFA International (Federation of Oils, Seeds and Fats Associations).

"It is sometimes difficult for analytical chemists to have a feel for the impact of their results," he noted. "For example, the oil content of seeds is an important parameter as it is often this that determines the contract price of the commodity.

"The precision data for ISO 659:2009 Oilseeds—Determination of Oil Content give a repeatability limit for sunflowerseeds of about 0.4," Hancock continued. "Thus, the same technician with the same equipment running the same test on the same sample within a short interval of time will not get a bigger difference between two results of more than 0.4% in more than 5% of cases. But with sunflowerseeds at about $600/metric ton [in July 2012], for a consignment of 15,000 metric tons, this 0.4% is equivalent to $36,000."

METHOD DEVELOPMENT AND VALIDATION

The soy protein case study illustrates how AOCS members and their needs shape the organization's work on standards and methods. Another example that traces how and why new methods are developed concerns glycidyl esters (GE) in foods.

GE are process contaminants generated during the processing of edible oils, most probably during deodorization. Many questions remain regarding their toxicity, formation, detection, and mitigation. Indirect methods developed to characterize GE and related process contaminants returned inconsistent results; clearly, a direct method was needed.

Development of a validated direct method, however, became critical once the German risk assessment agency, BfR (Bundesinstitut für Risikobewertung), named GE as a possible safety risk in March 2009. That was followed in September 2009 by the removal by Japan's Kao Corp.—as a precautionary measure—of its diacylglycerol oils and related products from the market in both Japan and the United States because of the presence of GE in them.

Although glycidol (2,3-epoxy-1-propanol) is listed as "probably carcinogenic to humans" by the International Agency for Research on Cancer (IARC), no data exist on the metabolic fate of GE in the human gut. Therefore, IARC has classified GE as "not classifiable as to carcinogenicity to humans."

It was in the midst of all these swirling questions that AOCS established an Expert Panel on Process Contaminants in December 2009. Slightly more than two years later, in May 2012, AOCS and the Japan Oil Chemists' Society (JOCS) released the first validated direct method for GE in edible oils, AOCS/JOCS Official Method Cd 28-10. The method marked the first analytical collaboration between the two organizations.

The joint method determines glycidyl fatty acid esters in edible oils using two solid-phase extraction steps and liquid chromatography–mass spectrometry. The method was tested through two pre-studies and a full collaborative study that consisted of nine blind-duplicate samples and included participation from laboratories in Canada, China, France, Germany, Japan, Malaysia, the United Kingdom, and the United States. The results were statistically analyzed according to the AOAC-IUPAC Harmonized Protocol (AOCS M 1-92 and M 4-86).

IN THE BEGINNING

AOCS was created in 1909 by nine cottonseed oil analysts who recognized the need for industry standards, methods, and laboratory proficiency in support of oil trade. The first book of official methods appeared in 1928 and was small enough to fit in an oil analyst's back pocket. The sixth edition, which was published in 2009, weighs more than 5.5 kilograms and can serve as a stand-in for weight-training equipment if need be. (This may be one reason many companies opt for an e-access subscription.)

The first AOCS method, as described in George Willhite's history of AOCS (*Inform 19*:307–312, 2008), was less than precise. One sentence reportedly read: "The proper amount of lye of the desired strength is then added and the mixture stirred vigorously for five minutes."

The importance of word choice and word order in method development cannot be overemphasized, as FOSFA's John Hancock notes: "Some chemical methods of analysis used to say, for example, 'weigh accurately approximately 10g of the sample.' This seems to be a contradiction and could be confusing. Thus, it was replaced with: 'Weigh, to the nearest 0.001 g, approximately 10 g of the sample.' This is much clearer and indicates exactly what is required."

What began as a largely regional, one-industry effort in the United States to develop and promote oils and fats standards is

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Scientific standards are the pits

Scientific standards should be objective, but on occasion they can also be highly personal. According to www.dimensions.com, Daniel Fahrenheit, the inventor of the first modern thermometer, based his temperature scale on three reference points. An article he wrote in 1724 details his standard-setting process. He used a mixture of ice, salt, ammonium chloride, and water for the zero point, or 0°F. The melting or freezing point was set at 32°F, using a mixture of ice and water. The third point, 96°F, was set by holding the thermometer under the armpit of his wife.

TABLE 1. AOCS participation in ISO by the numbers

ISO entity	AOCS' responsibilities
ISO/TC 34: Food products	**Administers US position/TAG & WG**
ISO/TC 34 Working Groups (WG)	
WG 4: Cocoa	Administers US position; coordinates experts
WG 12: Application of ISO 9001: 2000 in agriculture	Acts as convener
WG 14: Vitamins, carotenoids and other nutrients	Administers US position; coordinates experts
WG 15: Nutrition and dietetics services	Administers US position
US TAG Expert Group on Sustainability	Will administer US position[a]
Advisory Group to deal with collaborative studies for analytical standards	Will administer US position[a]
ISO/TC 34/SC 2: Oleaginous seeds and fruits and oilseed meals	**Administers US position/TAG & WG; AOCS in liaison**
WG 1: Harmonization with GAFTA	Coordinates experts
WG 2: Revision of ISO 542 Oilseeds Sampling	Coordinates experts
ISO/TC 34/SC 4: Cereals and pulses	**AOCS in liaison**
ISO/TC 34/SC 11: Animal and vegetable fats and oils	**Administers US position/TAG &WG; AOCS in liaison**
ISO/TC 34/SC 16: Horizontal methods for molecular biomarker analysis	**Administers US position/TAG & WG; AOCS in liaison and holds secretariat**
WG 3: Varietal identification	Coordinates experts
WG 4: Plant pathogens	Coordinates experts
WG 5: Qualitative methods	Serves as US TAG project leader/ coordinates experts
ISO/TC 34/SC 17: Management systems for food safety	**Administers US position/TAG &WG; AOCS in liaison**
WG 4: Joint ISO/TC 34/SC 17–ISO/ TC 234 WG on aquaculture	Coordinates experts
WG 5: Food packaging manufacturing	
WG 6: Transport and storage	Coordinates experts
WG 7: Guidance on the application of ISO 22000	Coordinates experts

[a]No experts identified yet.

now a global enterprise as AOCS participates in an alphabet soup of global, national, and regional standards-development organizations, seeking always to further the interests of its members, member companies, and constituents. Primary among the international groups are the International Organization for Standardization (ISO) and the Codex Alimentarius Commission.

Because AOCS has its headquarters in the United States, it also participates in US-based standard-setting organizations such as ASTM International (most notably on biodiesel standards) as well as the American National Standards Institute (ANSI), which is the dues-paying National Member Body representing the United States within ISO. AOCS also works on harmonization of standards with the American Association of Cereal Chemists International (AACC International) and American Organization of Analytical Chemists International (AOAC International).

INTERNATIONAL STANDARDS HARMONIZATION

International standards are voluntary and are developed by consensus, which explains why development sometimes seems to proceed at glacial speed. Soliciting the views of all interested parties, including manufacturers, vendors and users, consumer groups, testing laboratories, governments, professionals, and research organizations takes time. The fact that divergent interests make compromise at worst difficult and at best slow adds to the challenge.

Participation in the development of standards—whether national or international—provides organizations with access to all versions of standards under development. Involvement also gives early warning about future industry and regulatory changes—and a chance to influence the scope and nature of those changes.

ISO. The International Organization for Standardization (ISO, from *isos*, or "equal," in Greek; Geneva, Switzerland) is a network of national standards institutes (known as National Standards Bodies, or NSB) from more than 160 countries. In consultation with all stakeholders, ISO sets voluntary international standards on everything from best management practices to food safety. Around 1,000 of the current total of about 19,000 ISO standards deal with food.

The bulk of the work done by ISO is conducted by its roughly 2,700 technical committees, subcommittees, and working groups. Each technical committee and subcommittee is headed by a Secretariat from an NSB.

The NSB choose whether to be a participating, or voting, member (P-member) of a particular committee or working group or an observing member (O-member). P-members participate actively in the work and must vote on all questions submitted to vote within the committee. O-members can only observe but can make comments about documents in development.

As the US member of ISO, ANSI accredits US Technical Advisory Groups (TAG). These groups develop and transmit, via ANSI, US positions on activities and ballots of the technical committees, subcommittees, and policy committees. These technical issues include the approval, reaffirmation, revision, and withdrawal of ISO standards.

ISO's Technical Committee 34 (TC 34) on Food Products sets standards for human and animal food and feed as well as animal and vegetable propagation materials. The committee handles work on standards for everything from terminology, to sampling, to methods of testing and analysis, to product specifications, and even requirements for packaging, storage, and transportation.

AOCS coordinates the work of TC 34's US TAG, including some projects (such as Working Group 12 on the application of ISO 9001:2000 quality management systems in agriculture) not directly related to fats and oils. Even though AOCS is an international organization, because it is physically located in the United States, it must work on behalf of its members and constituents through the US TAG, counseling ANSI—based on input from participating experts—how to vote on issues related to fats and oils. AOCS members from other countries interested in standards development should work as experts with their own countries' ISO member bodies.

It is important to note that corporate and individual membership revenue does not subsidize AOCS' work on internationals standards. Rather, participation fees paid by the TAG participants, as well as corporate donations, cover all indirect and most direct expenses.

TC 34 has 14 subcommittees. As shown in Table 1, AOCS administers the US TAG for Subcommittee (SC) 2 (Oleaginous seeds and fruits), SC 11 (Animal and vegetable fats and oils), SC 16 (Horizontal methods for molecular biomarker analysis), and SC 17 (Food safety management systems) and most of their Working Groups (WG).

Some international and regional organizations also make active contributions to the development of ISO standards as recognized liaisons to TC, SC, and WG. As such, they can submit comments and suggest work items but cannot vote. For example, organizations operating in the liaison capacity with SC 2 (Oleaginous seeds and fruits and oilseed meals) range from standards development organizations such as AOAC International and AOCS to implementers of standards such as the World Customs Organization. Liaisons apply to participate and are accepted by vote of the P-members. In addition to coordinating the US TAG and communicating its positions to ANSI, AOCS can also represent its global membership through its liaison activities. AOCS

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BRIEFS

As part of the Canadian Food Inspection Agency's (CFIA) routine testing of various food products, a study released in October 2012 found that all vegetable oils and cheeses that CFIA had tested for dioxins and dioxin-like compounds were safe. Dioxins and dioxin-like compounds are a group of chemicals with similar biological and chemical properties. They have been associated with a wide range of human illnesses, including certain types of cancers. The full report is available at http://inspection.gc.ca.

■■■

Canada has entered into the Trans Pacific Partnership (TPP), a trade agreement being negotiated by 11 countries, including Canada, Mexico, Australia, Brunei, Chile, Malaysia, New Zealand, Peru, Singapore, the United States, and Vietnam. "The TPP includes several countries with a strong interest in the efficient trade of canola and other agricultural products," commented Patti Miller, president of the Canola Council of Canada.

■■■

Cargill will build a "world scale" canola refinery at its canola processing facility in Clavet, Saskatchewan, the company recently announced. The refinery is expected to be completed in time for the 2014–2015 canola harvest. The Clavet canola crush facility was first built in 1996 and later expanded in 2009. It currently is the largest canola processing facility in Canada, the company said, and is capable of processing 1.5 million metric tons of oilseed per year.

■■■

In October 2012, Archer Daniels Midland Co. received the Best Beverage Ingredient Concept prize for its isolated soy protein line CLARISOY® at the 2012 InterBev Awards ceremony in Las Vegas, Nevada, USA. The InterBev Awards, organized by FoodBev Media Ltd., are presented biennially at the InterBev Tradeshow.

■■■

Bronze AOCS Corporate Member AK Biotech Co. Ltd. in Ulsan, South Korea, has changed its name to AK & MN BioFarm Co. Ltd. The company can be reached by phone: +82 522594500; fax: +82 522594560; email: akbio10@gmail.com. ■

NEWS & NOTEWORTHY

Omega-3 market

Global consumer spending on EPA/DHA-fortified products will jump from $25.4 billion in 2011 to $34.7 billion in 2016, for a compound annual growth rate of 6.4%.

Those statistics on the market for the long-chain polyunsaturated fatty acids found in coldwater fatty fish such as tuna and sardines come from a new report, *The Global Market for EPA/DHA Omega-3 Products*, from Packaged Facts. Packaged Facts is a market research firm based in Rockville, Maryland, USA.

By geographic region, North America currently accounts for 43% of consumer sales, but Asia-Pacific is projected to jump to a close second-place position by 2016.

These figures, based on research commissioned by the Global Organization for EPA and DHA Omega-3 (GOED; a trade association based in Salt Lake City, Utah, USA), cover six categories of packaged consumer products: infant formula; fortified foods and beverages; nutritional supplements; pharmaceuticals; clinical nutrition products; and pet food, treats and supplements.

Expanding public awareness of health benefits from consumption of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) will spur continued growth in the global market for EPA/DHA omega-3 products.

According to David Sprinkle, publisher of Packaged Facts, other factors that will continue to create a growth environment for EPA/DHA omega-3 products include:

- Consumer interest in functional food and fortified product line expansions;
- Increasing demand for fortified infant formula owing to population growth and a rising middle class in emerging economies;
- Continued popularity of EPA/DHA omega-3 nutritional supplement products, including krill oil and vegetarian algae-based supplements;
- Introduction of pharmaceutical-grade products into South America and approval of generic pharmaceuticals in existing markets;
- Expansion of clinical nutrition market opportunities for disease- and disorder-specific formula applications, created through additional R&D and aggressive marketing by ingredient suppliers; and
- Production of premium pet foods for companion animals.

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Cargill to expand dielectric fluids business

Cargill announced in October 2012 that it will expand its line of ester fluids across Europe by mid-2013.

The company said it will add manufacturing capacity to support its recently acquired brand of Envirotemp™ dielectric fluids. This portfolio of esters meets the specifications of a wide range of transformer applications, according to Cargill.

To support the expansion, Cargill will build a new facility or expand one of its current facilities in Western Europe. A site selection process is under way and a decision was expected by January 2013. "Cargill intends to complete similar efforts around the world to satisfy its global customers' ongoing and increasing demand for cost-effective, innovative dielectric fluid solutions," the company said in a statement.

Cargill purchased the global Envirotemp FR3 dielectric fluid brands and licensed the applicable patents from Cooper Power Systems in June 2012. Cargill's Industrial Oils & Lubricants (IOL) business unit manufactures the FR3 fluid and other specialty K-class ester fluids used in a wide range of transformers and other electrical applications. FR3 fluid is currently installed in over 500,000 transformers on six continents, Cargill noted. The IOL unit has manufactured FR3 fluid since 2004.

DGF approves virgin rapeseed sensory panels

After two years of training, the German Society for Fat Science (Deutsche Gesellschaft für Fettwissenschaft, or DGF) has approved two panels of experts in the north and south of the country that will conduct sensory evaluations of virgin rapeseed oil using DGF methodology.

The program is aimed not only at evaluating quality in the marketplace but also at helping producers to strengthen their quality assurance efforts.

"The DGF sensory method is not only an instrument to do sensorial quality description, but also the basis for the DGF-Rapeseed oil medal (see www.dgfett.de/rapsoelmedaille)," Euro Fed Lipid noted.

The northern panel is located at the KIN Food Institute in Neumünster, while the southern panel is hosted by muva [a laboratory center offering analytics] in Kempten.

ADM/Wilmar partnership made final

Archer Daniels Midland Co. (ADM; Decatur, Illinois, USA) and Wilmar International Ltd. (Singapore) announced in October 2012 that they have completed regulatory approvals for their partnerships in global fertilizer and European vegetable oil. The two companies have also launched their partnership in global ocean freight.

Through the three partnerships, which will be based in Rolle, Switzerland, ADM and Wilmar will collaborate on purchasing and distribution in the global fertilizer business; partner in the sale and marketing of vegetable oils and fats in Europe; and work together to improve the utilization and management of their oceangoing fleets, with each company initially contributing two ships to the effort.

Collaboration between ADM and Wilmar began in the mid-1990s, when they jointly built a network of soybean processing operations in China. Today, ADM owns a 16% equity stake in Wilmar.

EC publishes list of authorized flavorings

The European Commission (EC) has published its list of flavoring substances authorized for use in foods.

Effective October 22, 2012, Regulation EU 872/2012 provides a roster of more than 2,500 substances evaluated by the European Food Safety Authority (EFSA) and deemed safe for human food uses, while Regulation EU 873/2012 establishes transitional measures for other flavorings, such as those made from nonfood sources, that are still under review. Flavoring substances not found on the list "will be banned after an 18-months phasing-out period," the EC noted in a statement.

To prepare the new regulations, EFSA's Scientific Panel on Food Contact Materials, Enzymes, Flavorings and Processing Aids (the CEF Panel) initially considered approximately 2,800 substances already on the EU market as well as 197 additions. Although the majority of substances reportedly did not present safety concerns, the CEF Panel recommended removing seven substances from commerce and asked for further data

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SUSTAINABILITY WATCH

Responsible soy comes to China

Two large soybean farms in China will begin working with the nongovernmental organization Solidaridad toward producing the first responsibly produced soybeans in China. Solidaridad focuses on creating fair and sustainable supply chains and is based in Utrecht, Netherlands.

Calling the agreement a "breakthrough," Solidaridad noted that China is the single largest consumer and importer of soybeans as well as the fourth-largest producer. "In a country where nongovernmental organizations have little influence, achieving higher benefits for farmers with reduced environmental impact is challenging," the group said in a statement. "Bringing two large farms . . . under the rules of the international standard for responsible soy [as developed by the Round Table for Responsible Soy, or RTRS] is unique."

The project will begin with the Sinograin North and Nenjiang farms in Heilongjiang Province. These farms cover a total area of 50,000 hectares and employ 3,000 workers.

These large farms already have support programs for regional smallholder farmers, Solidaridad said. The next step is for smallholders to use the RTRS standard. There are 28,000 smallholders in the area with average land ownership of 0.4 hectares, Solidaridad noted.

By 2015, the program is expected to result in:

- A 10% reduction in costs owing to lower input of herbicide and fertilizers,
- A better market price as a result of the introduction of better soybean varieties and meal with higher levels of protein,
- A 10% increase in revenue per farm as a consequence of higher crop quality, and
- A 20% growth in income for local smallholders.

Gert van der Bijl, international program manager for soy at Solidaridad, hopes the new program is just a first step for the Chinese market: "If we can show that the Solidaridad approach and working with RTRS improves the livelihood of farmers and reduces the environmental impact, we hope that we can do more and expand our activities to support soy farmers on the Chinese market."

What's in a word?

"I'm beginning to hate the word 'sustainability,'" Unilever's chief sustainability officer, Gail Klintworth, recently told businessgreen.com. She continued: "Everybody has a different view of what that word means and it's very clear that even the word 'green' is potentially a problem. People really pigeonhole discussions around one particular issue and the broader interrelationships between all the factors that determine sustainable growth get missed. You spend far too long explaining what you're talking about because everyone has their own interpretation of what that word means."

Wal-Mart ups the ante

Wal-Mart Stores, Inc. announced a new series of sustainability initiatives at an event in Beijing in late October 2012.

The world's largest retailer pledged that by the end of 2017, it will buy 70% of the goods it sells in its US stores and Sam's Club outlets only from suppliers who use the company's Sustainability Index to evaluate and share the sustainability indices of their products. Beginning in 2013, Walmart will use the index to "influence the design of its US private label products," the company said in a statement.

Further, the Walmart Foundation will grant $2 million to fund The Sustainability Consortium (TSC; an independent research consortium) and assist in its efforts in introducing TSC in China.

Sustainable chocolate

"Creating a sustainable [cacao] sector that can meet the chocolate industry's long-term demand for cocoa, the essential raw material for chocolate, while providing economic opportunities to cacao farmers will require billions of dollars in agricultural investments across research, third-party certification, and technology transfer to farmers," according to chocolate manufacturer Mars, Inc.

Earlier this year, the company announced that it had met its 2011 goal of purchasing 10% of its total cocoa supply as certified sustainable, and in 2012 it will exceed its original target of 20%, which the company said makes it the largest user of certified cocoa in the world.

Based on current buying arrangements, Mars projects that this equals nearly 90,000 metric tons of certified cocoa purchased during 2012. ■

on 400 others. Industry can submit data on these pending applications before the deadlines established in the new list, which will apply as of April 22, 2013, and undergo annual updates. The list is available at http://tinyurl.com/EFSA-List.

Oilseed crushing plant auctioned

Maas Companies of Rochester, Minnesota, USA, was scheduled to sell the former Northwood Mills Oilseed Plant, a state-of-the-art oilseed processing facility outside of Grand Forks, North Dakota, USA, at a foreclosure auction on November 27, 2012.

Construction of the facility was completed in May of 2007, Maas said in a statement. Originally, the plant crushed soybean and canola; sunflowerseed, corn germ, and flax were added later. "The plant utilizes an extrusion/expelling process and could be operational for a multitude of inputs with little or no equipment modifications," the auction notice says, adding that the plant has a fully integrated control system. The plant had a daily output of 200–300 short tons (180–270 metric tons)/day, according to www.grainnet.com.

USITC investigates olive oil

The US International Trade Commission (USITC) is investigating the global competitiveness of the US olive oil industry, the *Olive Oil Times* reported in October 2012.

Olive oil consumption is up by about 40% in the past 10 years, but most US consumers buy imported oil, according to a statement from USITC. The USITC will examine the practices of major olive oil suppliers from 2008–2012, with an emphasis on the United States, Spain, Italy, and North African producers. The study will focus on four areas:

- An overview of the commercial olive oil industry in the United States and major supplier countries, including production of olives for olive oil processing, planted acreage and new plantings, processing volumes, processing capacity, carry-over inventory, and consumption;
- An examination of the international market for olive oil, including US and foreign supplier imports and exports of olive oil in its various forms, olive oil trade between the European Union and North African countries, and a history of the tariff treatment and classification of olive oil;
- A qualitative and, to the extent possible, quantitative assessment of the role of imports, standards and grading, prices, and other factors on olive oil consumption in the US market; and
- A comparison of the competitive strengths and weaknesses of the commercial olive production and olive oil processing industries in the major producing countries and the United States, including factors such as industry structure, input production costs and availability, processing technology, product innovation, government support and other government intervention, exchange rates, and marketing regimes, plus steps each respective industry is taking to increase its competitiveness.

The USITC is an independent government agency that investigates trade issues. The Commission was scheduled to hold a public hearing on December 5, 2012, and will issue its final report by August 12, 2013. ■

BRIEFS

A new company in Lakeland, Florida, USA, called StayGreen Oil, LLC, has established a cloud-based marketplace for recycled oils. The company lets sellers list the location of their leftover oil—whether it's leftover fast-food cooking oil or used motor oil—on an online auction platform, with the goal of getting top dollar by tapping into a wide network of buyers. Co-founder Brian Davis explained, "The easiest way to put it is, it's the StubHub or eBay for used oil." The StayGreen marketplace is free for buyers and sellers to register and interact through public auctions or via private requests for proposals. In a company statement, co-founder Michael Griffith said, "There currently exists a growing global demand for re-refined basestocks derived from used engine oils and an increased call for used cooking oils required for biodiesel production. StayGreen Oil is the only system of its kind and will revolutionize the way the market interacts to fill these needs."

■■■

On September 30, 2012, a 10 meter long fin whale weighing 6.8 metric tons (MT) died after being stranded on a beach near Woodbridge, Suffolk, UK. According to the newspaper *The Telegraph*, the Suffolk Coastal District Council, which was responsible for removing the carcass, "decided to do something 'useful' with the body instead of dumping it on a landfill site or towing it out to sea to rot." The Council arranged to have the carcass placed in a sealed container and transported to a local rendering firm. The owner of the rendering firm estimated the body could produce 2 MT of oil, for use in producing 2,000 liters of biofuel. The residue after removal of the blubber was incinerated at a power station to produce electricity.

■■■

The first retailer officially to sell E15 (15% alcohol, 85% gasoline) in the state of Iowa (USA) reported strong acceptance of the newly available fuel. Linn Co-op Oil Company, in Marion, began selling E15 to drivers owning a 2001 or newer car, sport utility vehicle, or light-duty truck in

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BIOFUELS NEWS

A trailing Lockheed T-33 "sniffs" the emissions of a Falcon 20 jet flying alternately on 100% biofuel and conventional petroleum-based aviation fuel. Credit: National Research Council of Canada.

Milestone for aviation

The National Research Council (NRC) of Canada flew the first civilian jet powered by 100% unblended biofuel on October 29, 2012. A Dassault Falcon 20 twin-engine jet—one of NRC's specifically equipped and best suited planes for this challenge—flew over Ottawa, Canada's capital, followed by a second aircraft, a Lockheed T-33, which collected information on the emissions generated by combusting the biofuel. Systems onboard the Falcon 20 allowed the NRC research team to switch back and forth between 100% biofuel and conventional petroleum-based aviation fuel, establishing the ability to make comparisons on the performance of the fuel in the same plane at (nearly) the same time.

Feedstock for the fuel originated from more than 40 farmers, working on 2,430 hectares in western Canada, who grew *Brassica carinata* under contract with Agrisoma Bioscience Inc. (Ottawa, Canada). The oil from the *B. carinata* seeds was converted to ReadiJet™ by Applied Research Associates (ARA; Albuquerque, New Mexico, USA) in cooperation with Chevron Lummus Global (CLG) under contract to the US Air Force Research Laboratory. ARA's catalytic hydrothermolysis process converts plant oils into a crude oil intermediate, and CLG's catalysts upgrade the crude oil intermediate into on-specification finished fuels (http://tinyurl.com/100percent-Biobased).

EU limits food-based biofuels

The European Commission (EC) presented new proposals in mid-October 2012 to enhance the sustainability and minimize climate impacts of biofuels produced in the European Union. Agricultural organizations and those promoting the use of biodiesel and bioethanol claimed the proposals will destroy the European biofuel industry, whereas environmental non-government organizations said the proposals did not do enough.

One of the more contentious proposals reduced to 5% the share of first-generation biofuels in transport, from the 10% target for 2020 set in the 2009 Renewable Energy Directive issued by the EC. The purpose of

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late September. Jim Becthold, service manager of the co-op, said, "During our open house event [to introduce E15] I saw countless new faces from all over the county. Also, a great deal of our customers specifically asked for E15" (http://tinyurl.com/E15-Iowa).

■■■

Green Jet Fuel™ produced by UOP LLC, a Honeywell company (Des Plaines, Illinois, USA), powered demonstration flights by five different Gulfstream aircraft traveling from the Gulfstream headquarters in Savannah, Georgia, to Orlando, Florida for the National Business Aviation Association convention in October. Both engines of the aircraft were fueled by a 50:50 blend of Green Jet Fuel and petroleum-derived jet fuel. The renewable fuel was made with camelina oil. This was the first time Gulfstream's entire fleet has flown on renewable jet fuel.

■■■

The news agency Reuters reported on November 7, 2012, that overcapacity had led Cargill to close its biodiesel plant in Hamburg, Germany, which was designed to produce 120,000 metric tons (MT) of biodiesel annually. Cargill's other German biodiesel plant near Frankfurt, with a capacity of 250,000 MT, remained open. Consumption of biodiesel in the country fell in 2012 following Germany's implementation of a tax on the green fuel. According to Reuters, about half of Germany's biodiesel plants had stopped work or declared insolvency at the beginning of 2012 (http://tinyurl.com/Cargill-biodiesel). European Union plans to cap the use of food-based biofuels (see accompanying article) will likely lead to further closures.

■■■

The European Union (EU) began investigating accusations that Argentina and Indonesia are dumping biodiesel in Europe. The complaint was lodged by the European Biodiesel Board (EBB). According to the European Commission (November 10, 2012), "It is alleged that the producers have benefited from subsidies granted by the Governments of Argentina and Indonesia." The EBB presented evidence that the volume and prices of the imported biodiesel resulted "in substantial adverse effects on the overall performance and financial situation of the EU industry" (see http://tinyurl.com/EU-pdf). ■

this change is "to stimulate the development of alternative, second-generation biofuels from non-food feedstock, such as wastes or straw.

A second proposal that received wide attention was the requirement for the inclusion of estimated impacts of land conversion—Indirect Land Use Change (ILUC)—when assessing the greenhouse gas performance of biofuels.

In a statement from the EC, Commissioner for Climate Action Connie Hedegaard said, "For biofuels to help us combat climate change, we must use truly sustainable biofuels. We must invest in biofuels that achieve real emissions cuts and do not compete with food." She added, "We are of course not closing down first-generation biofuels, but . . . future increases in biofuels must come from advanced biofuels" (http://tinyurl.com/EU-RED-5percent).

Algal biodiesel goes retail in USA

On November 13, 2012, Propel Fuels and Solazyme Inc. jointly announced the introduction of algae-derived biodiesel for retail sale in four California cities (Redwood City, San Jose, Berkeley, and Oakland). Solazyme (South San Francisco, California, USA) converts plant sugars into oils by feeding them to microalgae in a standard industrial fermentation (which, for the purpose of this introduction, was manufactured at Solazyme's facility in Peoria, Illinois, USA). This oil is then converted to Soladiesel®BD.

Propel Fuels (Redwood City, USA) has a network of retail renewable fuel locations in the San Francisco Bay area. The month-long pilot program was the industry's first opportunity to test consumer response to this advanced renewable fuel. The B20 (20% biodiesel + 80% petrodiesel) fuel was sold at about $4.25 per gallon, the same price as conventional diesel fuels.

Solazyme + ADM (or Bunge) = oil

ADM. In mid-November 2012, Solazyme, which obtains oil from algae growing fermentatively on sugar, announced it will expand its product capacity through partnerships with Bunge Ltd. and with Archer Daniels Midland Co. (ADM).

The South San Francisco, California (USA)-based Solazyme plans to open a plant in 2014 at ADM's advanced fermentation plant at Clinton, Iowa (USA). The plant is being designed to produce 20,000 metric tons (MT) of oil in its first year, and subsequently production may be expanded to 100,000 MT per year. Intentions are to sell these oils primarily to industrial and nutritional markets in North America.

According to the terms of the agreement, ADM's wet mill, which is next to the fermentation plant, will provide dextrose for Solazyme's algae to grow on; and ADM's cogeneration facility, which is partially fired with renewable biomass, will provide steam and power for the fermentation. Once retrofitting and permitting for the Clinton plant are completed, commercial production is projected to begin in early 2014.

Bunge. Solazyme and Bunge Ltd. (White Plains, New York, USA) have entered into a joint venture (JV) expansion framework agreement (Solazyme Bunge Renewable Oils) to increase capacity from the 100,000 MT annual production currently under construction in Brazil adjacent to Bunge's Moema sugarcane mill to 300,000 MT by 2016. The companies also intend to expand the portfolio of oils to be produced out of their Brazilian JV facility.

Developments in aviation fuel

At the end of the third quarter, Algae-Tec Ltd. (Perth, Australia) and the German air carrier Lufthansa announced their plans to build a large-scale algae-to-aviation biofuels production facility in Europe, adjacent to an industrial CO_2 source.

Lufthansa has agreed to arrange 100% funding for the project. Algae-Tec will receive license fees and profits from the project, which Algae.Tec will manage. As part of the agreement, Lufthansa has committed to a long-term offtake agreement of at least 50% of the crude oil produced at an agreed price. The location for the facility had not been announced as of press time.

In a similar vein, China Petroleum and Chemical Corp. (Sinopec), one of China's biggest energy companies, and Airbus announced that they are developing and promoting renewable aviation fuel production for regular commercial use in China. Airbus provides technical expertise gained in past certification processes with the European Union and US fuels standard bodies

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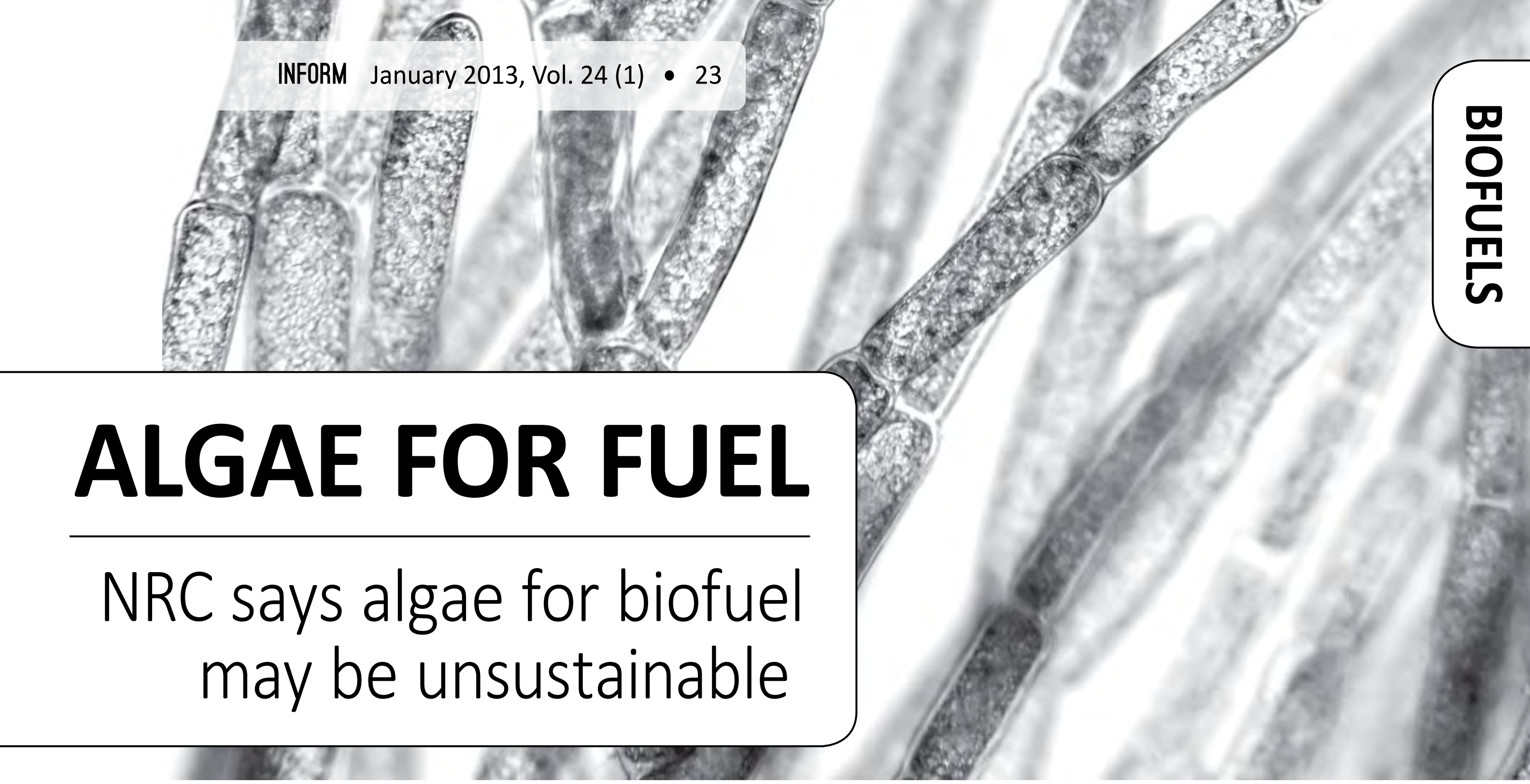

ALGAE FOR FUEL

NRC says algae for biofuel may be unsustainable

The National Research Council, which is part of the US National Academies, released a report entitled *Sustainable Development of Algal Biofuels in the United States* (www.nap.edu/catalog.php?record_id=13437) on October 24, 2012. The report concludes that scaling up the production of biofuels made from algae to meet at least 5%, or approximately 39 billion liters, of US transportation fuel needs—if only current technologies and knowledge are considered—would place unsustainable demands on energy, water, and nutrients.

The report summary pointed out: "[T]hese concerns are not a definitive barrier for future production, and innovations that would require research and development could help realize algal biofuels' full potential."

The committee that wrote the report said that concerns related to large-scale algal biofuel development differ depending on the pathways used to produce the fuels. The committee focused its sustainability analysis on pathways that to date have received active attention. Most of the current development involves growing selected strains of algae in open ponds or closed photobioreactors using various water sources, collecting and extracting the oil from algae or collecting fuel precursors secreted by algae, and then processing the oil into fuel. The report did not address the economics or the costs of algal biofuels, as specified in the assignment given to the committee.

The committee pointed out the following five high-level concerns for large-scale development of algae biofuel.

Water. The committee found that producing the amount of algal biofuel equivalent to 1 liter of gasoline requires 3.15–3,650 liters of freshwater, depending on whether the algae (or cyanobacteria) need to be harvested to be processed to fuels or whether they secrete fuel products. Replenishing water lost from evaporation in growing systems is a key factor in producing algae in freshwater systems. Water use could also be a serious concern in an algal production system that uses freshwater without recycling the "harvest" water.

According to National Resources Defense Council energy policy analyst Cai Steger, who is part of the committee that wrote the report, "[G]etting 5% of our fuel from algae could consume up to 123 billion liters of freshwater (and using other studies, many multiples of that). For comparative purposes, that would represent nearly 10% of current total US freshwater consumption" (http://tinyurl.com/H20-NRC-Steger).

Nutrients. Carbon dioxide availability would be a concern, whether from virgin sources or waste streams such as flue gas. To produce 39 billion liters of algal biofuels [US consumption of fuels for transportation was about 284 billion liters in 2010] would require 6–15 million metric tons (MMT) of nitrogen and 1–2 MMT of phosphorus if the nutrients are not recycled. These requirements represent 44–107% of the total nitrogen use and 20–51% of the total phosphorus use in the United States. On the other hand, recycling nutrients or using wastewater from agricultural or municipal sources could reduce nutrient and energy use.

Land. The area and the number of suitable and available sites for algae to grow could limit the production of algal biofuels. Appropriate topography, climate, proximity to water supplies, and proximity to nutrient supplies would have to be matched carefully to ensure successful and sustainable fuel production and avoid costs and energy consumption for transporting those resources to cultivation facilities. The cost

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and in the selection of sustainable feedstocks. The partners are also establishing a sustainable alternative fuel value chain in China, to help speed up its commercialization, and will use 100% domestic resources and refining capabilities.

US EPA denies RFS waiver request

The US Environmental Protection Agency (EPA) denied requests for waivers to the Renewable Fuels Standard (RFS) on November 16, 2012. Governors in several states had asked the EPA in August to waive the standard, which requires mandatory blending of renewable fuels in gasoline to a certain level. Several groups argued that, given this year's drought, ethanol production from corn (for use in blending with gasoline) was driving up the price of corn for use in food. This year, the RFS calls for blending of 15.2 billion gallons of renewable fuels.

Gina McCarthy, assistant administrator for EPA's Office of Air and Radiation, said: "We recognize that this year's drought has created hardship in some sectors of the economy, particularly for livestock producers. But our extensive analysis makes clear that Congressional requirements for a waiver have not been met and that waiving the RFS will have little, if any, impact" (http://tinyurl.com/NoWaiver-EPA).

The EPA said it found that suspending the RFS would reduce corn prices by only 1%, which did not meet the criterion of "severe economic harm" that would allow a waiver.

New method for algae → biofuel

Current methods for harvesting algae for use as feedstock for biofuel, such as sedimentation, microfiltration, centrifugation, air flotation, and flocculation, are not inexpensive owing to the costs of pumping and processing large amounts of water.

Martin Poenie and co-workers at the University of Texas at Austin (USA) have explored the possibility of using resins that reversibly bind algae as a means to harvest and concentrate the organisms. Their strategy takes advantage of the negative surface charge on algae, which bind to weak anion exchange resins as a function of pH.

They found the performance of commercial resins was inadequate, which they attributed to nonspecific or non-pH dependent binding as well as instances of poor binding capacity.

The researchers then generated a series of resins, incorporating one of three different functional groups: dimethylamine, imidazole, and pyridine. They found that binding capacity correlated positively with increasing pK_a of the weak base component of the resin while reversibility correlated inversely with pK_a. According to the summary presented in their paper (Jones, J., *et al.*, Resins that reversibly bind algae for harvesting and concentration, *Environ. Prog.*, doi: 10.1002/ep.11697, 2012), "The best of these resins bind about 10% of their weight in algae, show 100% reversibility and reusability and the ability to concentrate algae from dilute suspension to 30 grams per liter."

In a second paper, Poenie and co-workers took anion exchange resins on which algae (*Neochloris oleoabundans* and a marine *Chlorella*, KAS 603) had been bound and eluted them with sulfuric acid/methanol. In the process the resin was regenerated, and the algal lipids were converted to biodiesel. The researchers proposed using hydrophobic polymers to remove the biodiesel from the sulfuric acid/methanol mix, which would make the transesterification agent recyclable. For further information see Jones *et al.*, Use of anion exchange resins for one-step processing of algae from harvest to biofuel, *Energies* 5:2608–2625 (2012). ■

ALGAE (continued from page 23)

of suitable sites near urban or suburban centers or coastal recreation areas could be prohibitive.

Greenhouse gas (GHG) emissions. Some studies suggest that algal biofuel production generates less GHG than petroleum-based fuels while others suggest the opposite. These emissions depend on many factors in the production process, including the amount of energy needed to dewater and harvest algae and the electricity sources used.

Return on investment. Algal biofuel production would have to produce sufficiently more energy than is required in cultivation and fuel conversion to be sustainable. For some system designs analyzed, the estimated values for Energy Return in Investment (EROI) ranged from 0.13 to 3.33. The NRC report recommended an EROI of 3× (3 units of energy produced per unit of energy input) for sustainability. For algal biofuels to contribute significantly to future transportation fuels, the committee recommended research and development to improve algal strains, identification of additional algal strains having desired characteristics, improved materials and methods for growing and processing algae into fuels, and reduction of energy requirements for multiple stages of production.

REACTIONS TO NRC REPORT

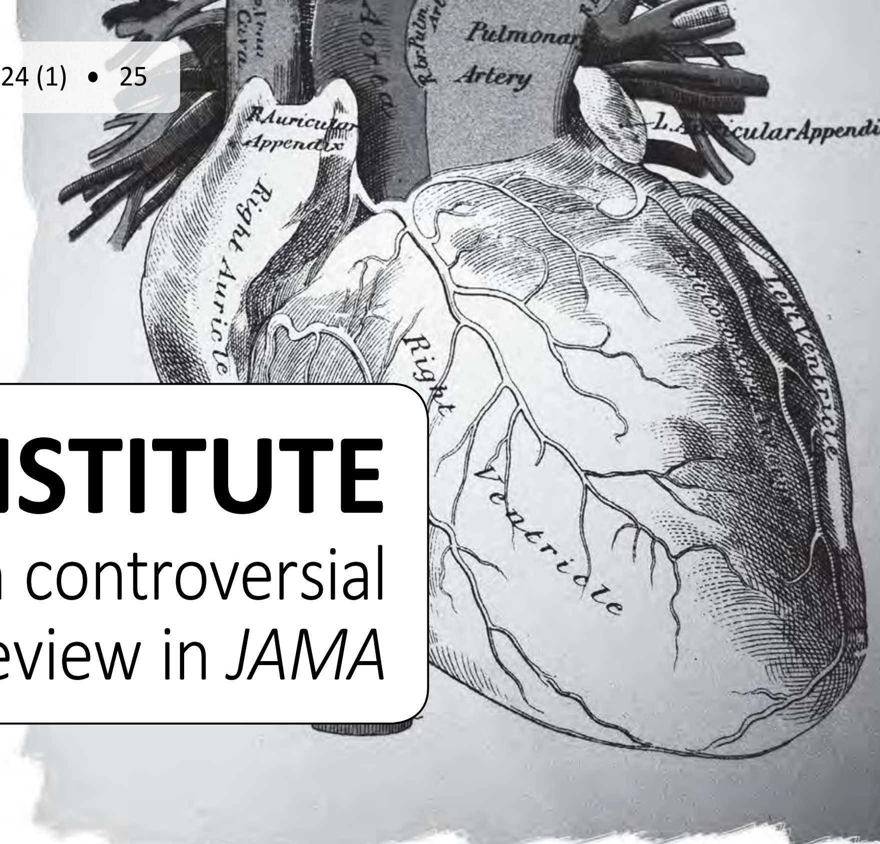
Algal Biomass Organization (ABO). The ABO found encouragement in the statement "[T]hese concerns are not a definitive barrier for future production, and innovations that would require research and development could help realize algal biofuels' full potential" that appeared in the National Research Council Report (see preceding article).

The ABO pointed out (http://tinyurl.com/ABO-algae-sustainable) that use of saline and nonpotable or recycled water is essential to development of commercial algae production and cited studies from the Pacific Northwest National Laboratories indicating that the use of saline water and recycled nutrients would be able to provide up to twice as much advanced biofuels as the goal set by the US Energy Independence and Security Act (2007).

The ABO also pointed out that research is already under way to increase recycling of nutrients in the production of algae. Furthermore, according to ABO, the US Environmental Protection Agency's life cycle analysis found that algae-based diesel reduces greenhouse gas emissions by at least 50%, thus qualifying as an Advanced Biofuel under the Renewable Fuel Standard.

Industry leaders are already achieving NRC's proposed Energy Return on Investment of 3 units of energy produced per unit of energy input.

Friends of the Earth (FOE). This group also found support in this report for their interests in protecting the environment. From topics covered in the report, the FOE emphasized hazards of growing algae that have been genetically modified to produce large quantities of oil, the large quantities of water needed, cross-contamination with the surrounding environment, and spills, as well as the question of the production of food vs. fuel (http://tinyurl.com/FOE-algae-NRC). ■



DHA/EPA INSTITUTE
comments on controversial review in *JAMA*

In September 2012, the *Journal of the American Medical Association* (*JAMA*) published a review and meta-analysis of omega-3 supplementation and cardiovascular events (Rizos, E.C., *et al.*, Association between omega-3 fatty acid supplementation and risk of major cardiovascular disease events: a systematic review and meta-analysis, *JAMA 308*:1024–1033, 2012) that stimulated widespread controversy in the media. Among the numerous commentaries was this one written by AOCS member Bruce Holub for the DHA/EPA Omega-3 Institute (www.dhaomega3.org), and shared here with *Inform*.

Bruce Holub

Numerous systematic reviews and meta-analyses based on randomized clinical trials as reported in peer-reviewed medical journals have been published during the past decade on DHA/EPA (docosahexaenoic acid/eicosapentaenoic acid) omega-3 fatty intakes (via diet and supplementation) and cardiovascular-related outcomes. The majority of these have concluded that there are overall benefits of such enhanced omega-3 intakes using such end points.

The review and meta-analysis by Rizos *et al.* is the most recent to be published on the topic. Based on the eligible clinical trials that they selected for inclusion in their analysis, the authors concluded that omega-3 supplementation was not associated with a lower risk of all-cause mortality, cardiac death, sudden death, myocardial infarction, or stroke.

Without intending to refute the peer-reviewed publication of the present authors, the following brief commentary is offered. In any long-term intervention trial (whether with medication or nutritional supplements), incomplete compliance poses a major challenge such that monitoring compliance with recognized biomarkers is highly recommended. Such a monitoring protocol can identify poor or incomplete compliance.

Also, potential minor side effects and other factors can compromise compliance. Measurements of fatty acid levels (including DHA, EPA, and others) in plasma lipid (or whole blood or serum phospholipid or erythrocytes) can serve as reliable indicators to determine the level of compliance. Such monitoring needs to become a standard protocol in essentially all clinical trials that evaluate the effect of fish oil or DHA/EPA intervention on outcomes. Such monitoring to assess compliance has been absent in most of the studies as reviewed herein by the authors of the *JAMA* review and others.

An example of a published study wherein such fatty acid profiles were measured is that by Burr *et al.* (*Eur. J. Clin. Nutr. 57*:193–200, 2003) as utilized in the recent review by Rizos and colleagues. In the study by Burr *et al.*, which did not support a beneficial effect of increasing DHA/EPA intakes from fish or fish oil on cardiac death in men with angina, measurements of EPA levels in plasma lipid were performed. Interestingly, the reported intake of EPA omega-3 in the fish/fish oil-supplemented group was increased to 474 mg/day during intervention. However, the plasma lipid levels of EPA rose by only 37% by 6 months whereas EPA intakes of much less (such as only 276 mg/day) have resulted in elevations above 80% within 6 weeks in the plasma lipid (Castro *et al.*, *Nutrition 23*:127–137, 2007).

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The pitfalls of meta-analyses

The firestorm that erupted after Stanford University researchers reported in the *Annals of Internal Medicine* (*157*:348–366, 2012) that organic food is no more nutritious than conventionally grown foods is yet another example of the pitfalls of meta-analysis.

Although the Stanford researchers had reviewed many of the same studies that a group of scientists at Newcastle University in England had reviewed previously, the two groups reached opposite conclusions. After reviewing decades of research comparing organic fruits and vegetables to those grown conventionally, the Newcastle team announced its conclusions in April 2011: Organic produce grown without synthetic fertilizers or pesticides was more nutritious, containing, on average, more vitamin C and other phytochemicals that help protect against cancer and heart disease (Brandt, K., *et al.*, Agroecosystem management and nutritional quality of plant foods: the case of organic fruits and vegetables, *Crit. Rev. Plant Sci. 30*:177–197, 2012).

How did the Stanford group reach a seemingly opposite conclusion after reviewing many of the same studies? On October 16, 2012, an article in *The New York Times* titled "Parsing of data led to mixed messages on organic food's value" pointed out that both teams' conclusions were based solely on statistical compilations of earlier work by other researchers, rather than on new field or laboratory work, and that the way the data from such earlier studies are divvied up and combined in a meta-analysis can make a big difference in the conclusions

"Such analyses seek out robust nuggets in studies of disparate designs and quality that offer confounding and often conflicting findings, especially in nutrition and medicine," *The New York Times* reporter, Kenneth Chang, explained. "In the organic food research, some studies reported many measurements, some only a few. Some included several crops grown over multiple years, while others looked at only a few samples."

Thus, the apparent failure of the subjects in the trial of Burr *et al.* to fulfill compliance to the target intakes of DHA/EPA is a significant shortcoming that likely prevails among many of the omega-3 intervention trials.

Strong support for the need to measure circulating omega-3 levels for compliance and expected efficacy of omega-3 supplementation on cardiac events in clinical trials also comes from blood data from the Japan EPA Lipid Intervention Study known as JELIS (Itakura *et al.*, *J. Atheroscler. Thromb*. *18*:99–107, 2011).

In this study, a very wide variance in the elevated circulating concentrations of EPA omega-3 was found between subjects in the treatment group despite assigning all subjects in the EPA group to receive a fixed daily dose of 1,800 mg EPA/day. Those EPA-supplemented subjects showing much higher levels of blood plasma EPA levels exhibited a 20% reduced risk (relative to controls) in the risk of major coronary events, whereas those EPA-supplemented subjects who exhibited much lower levels of blood plasma EPA did not show any reduction in risk.

Despite the various shortcomings, the current review reported the overall relative risks for cardiac death, sudden death, and myocardial infarction to be lower in the omega-3 supplemented groups (relative to placebo controls) by 9, 13, and 11%, respectively (although not reaching statistical significance). In this review, statistical significance was assumed at a *P* value threshold of 0.0063, which is much more rigid than commonly used cut-offs. It should also be pointed out that not having information on background dietary intakes of nondeprived individual subjects or the groups (and their blood levels of omega-3) does not allow for an assessment of the "deprived" vs. "nondeprived" subjects and their relative responses/benefits from omega-3 supplementation.

In this regard, the most recent intervention trial included in the analysis by Rizos *et al.* in their review was the so-called ORIGIN trial (*New Engl. J. Med. 367*:309–318, 2012) wherein supplementation with DHA/EPA omega-3 or "placebo" (controls) to those with (or at risk for) type 2 diabetes did not show a significant difference in outcomes.

Interestingly, the intake of fish/other marine products was not restricted (unlike what is commonly done in such intervention trials) throughout the supplement trial such that the median intake of DHA plus EPA from dietary sources was already substantial at 210 mg/day with a considerable portion of the subjects consuming up to 570 mg/day or more.

Measurements of fatty acid levels (including DHA, EPA, and others) in plasma lipid (or whole blood or serum phospholipid or erythrocytes) **can serve as reliable indicators** to determine the level of compliance.

Interestingly, an extensive review on dose-benefit relations for DHA/EPA intakes and human health from the Harvard School of Public Health (Mozaffarian and Rimm, *JAMA 296*:1885–1899, 2006) concluded that an intake approaching at least 250 mg/day "appears sufficient for primary prevention."

For general health and disease prevention, 500 mg (EPA plus DHA) per person daily is recommended as the position of the American Dietetic Association and the Dietitians of Canada (*J. Am. Diet. Assoc. 207*:1599–1611, 2007).

For those with coronary disease, the American Heart Association Dietary Guidelines (Revision 2000: A Statement for Healthcare Professionals from the Nutrition Committee of the American Heart Association) states: "Consumption of one fatty fish meal per day (or alternatively, a fish oil supplement) could result in an omega-3 intake (i.e., EPA and DHA) of approximately 900 mg/day, an amount shown to beneficially affect coronary heart disease rates in patients with coronary disease" (*Circulation 102*:2284–2299, 2000).

An elevated triglyceride level is a very significant risk factor for cardiovascular disease and associated mortality. Even moderately elevated levels of circulating triglyceride (150–199 mg/100 mL or 1.7–2.2 mmol/L), which are highly prevalent in the population including many people on statin treatment for cholesterol-lowering, carry a significantly increased risk for heart disease and are considered "borderline-high" in the recent scientific statement from the American Heart Association on "Triglycerides and cardiovascular disease" (*Circulation 123*:2292–2333, 2011). In fact, the latter review indicates that, by the age of 40 years, almost half of US males and a considerable portion of females do not have triglyceride levels designated as "desirable" (below 150 mg/100 mL).

As reviewed at www.dhaomega3.org, the degree of triglyceride lowering typically amounts to approximately 7–10% per 1,000 mg of EPA plus DHA daily such that 2,000 mg or 3,000 mg can be expected to lower blood triglycerides by approximately 14–20% and 21–35%, respectively. Such triglyceride lowering is usually attained within three to four weeks and can be maintained for years with ongoing supplementation.

It should also be pointed out that, in addition to any cardio-protective effects, higher intakes of DHA/EPA omega-3 via diet or supplementation throughout various stages of life (motherhood, childhood, middle age, advanced age) have been found to offer enhanced health and complementary disease prevention and management (including risk factor improvements) related to optimal cognitive development/performance and visual acuity, anti-inflammatory effects, immunological support, reduction in the risk and progression of certain cancers and ocular disorders, beneficial effects on depression, plus other favorable effects based on both epidemiological and interventional studies as published in peer-reviewed medical and nutrition journals. Interestingly, many of the latter clinical trials have been conducted in Japan showing considerable benefits on cardiac-related events (major coronary event, stroke recurrence) and other health outcomes with supplementary levels of long-chain omega-3 fatty acids in a population with daily intakes of DHA plus EPA averaging approximately 1,000–1,200 mg as compared to only 120–150 mg in North America.

Bruce Holub received his Ph.D. from the University of Toronto, Canada, followed by post-doctoral training as an MRC Research Fellow at the University of Michigan (Ann Arbor, USA). He has authored over 250 papers in peer-reviewed journals with a focus on omega-3 fatty acids for health and the prevention and management of chronic disorders. He is currently University Professor Emeritus in the Department of Human Health and Nutritional Sciences at the University of Guelph, Canada, and serves as scientific director of the DHA/EPA Omega-3 Institute while writing updates on omega-3 research at www.dhaomega3.org. He can be reached at bholub@uoguelph.ca.

BRIEFS

A team led by Hemant Poudyal at Australia's University of Queensland examined the cardiovascular, hepatic, and metabolic responses to dietary omega-3 fatty acids—α-linoleic acid (ALA, from chia seed oil), eicosapentaenoic acid (EPA, from fish oil), and docosahexaenoic acid (DHA, also from fish oil)—in a high-carbohydrate, high-fat diet-induced model of metabolic syndrome in 95 male Wistar rats. The researchers investigated changes in the fatty acid composition of plasma, adipose tissues, liver, heart, and skeletal muscle after supplementation.

"The same dosages of ALA and EPA/DHA produced different physiological responses to decrease the risk factors for metabolic syndrome," they reported. "ALA did not reduce total body fat but induced lipid redistribution away from the abdominal area and favorably improved glucose tolerance, insulin sensitivity, dyslipidemia, hypertension, and left ventricular dimensions, contractility, volumes and stiffness. EPA and DHA increased sympathetic activation, reduced the abdominal adiposity and total body fat and attenuated insulin sensitivity, dyslipidemia, hypertension, and left ventricular stiffness but not glucose tolerance." The work appeared in the *Journal of Nutritional Biochemistry* (doi: 10.1016/jjnutbio.2012.07.014, 2012).

■■■

In 2009, the *trans*-fat content in several processed foods in Europe dropped significantly as compared with levels in 2005, according to a study led by Steen Stender of Copenhagen University Hospital in Denmark. Nonetheless, *trans*-fat content in high-*trans* foods such as fried potatoes and microwave popcorn remained high in Eastern Europe. The study appeared in *BMJ Open* (doi: 10.1136/bmjopen-2012-000859, 2012).

■■■

In October 2012, the European Court of Auditors ruled that four agencies—including the European Food Safety Authority (EFSA)—had inadequate management for conflicts of interest. EFSA, the European Aviation Safety Agency, the European Chemicals Agency, and the European Medicines Agency were urged to do more when "screening candidates for conflict of interest before their appointment. ■

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BRIEFS

According to SPINS (Schaumburg, Illinois, USA), a company devoted to providing information and services to grow the natural products industry, expansion of products verified as not being based on genetically modified organisms (GMO) resulted in $2.4 billion in US sales during the period October 2011–September 2012. This represents a 66% increase over the $1.3 billion during 2010–2011. The strongest increase in consumer response to non-GMO products occurred in specialty gourmet retailers (+23%); second-highest was in stores positioning themselves as natural (+20%).

■■■

Fooducate, an iPhone app and website (www.fooducate.com) that was founded in 2010 to help food shoppers in the United States quickly look up nutrition and other product information via bar code scans, announced on October 17, 2012, that it had added a GMO feature to its product. Once a user registers for the "Warn me about GMOs" feature, the app grades ingredients connected to the scanned barcodes as "Non-GMO," "GMO–High Probability," or "GMO–Medium Probability." Users who wish to avoid GMO entirely can ask the app to suggest similar, but non-GMO, products. Information regarding GMO content comes from manufacturers, the Non-GMO Project (www.nongmoproject.org), and elsewhere.

■■■

The European Commission formally authorized the genetically modified corn MIR162 (Agrisure Viptera trait) marketed by Syngenta for use in food and feed (including distillers' dried grains (DDGS) with solubles and corn gluten feed), as well as for import and processing in the 27 countries of the European Union (EU) on October 18, 2012. The EU executive's decision entered into force after its publication in the *Official Journal of the EU* on October 20.

This action provides the opportunity for US products, such as corn gluten feed, as well as DDGS to enter the EU market. Cary Sifferath,

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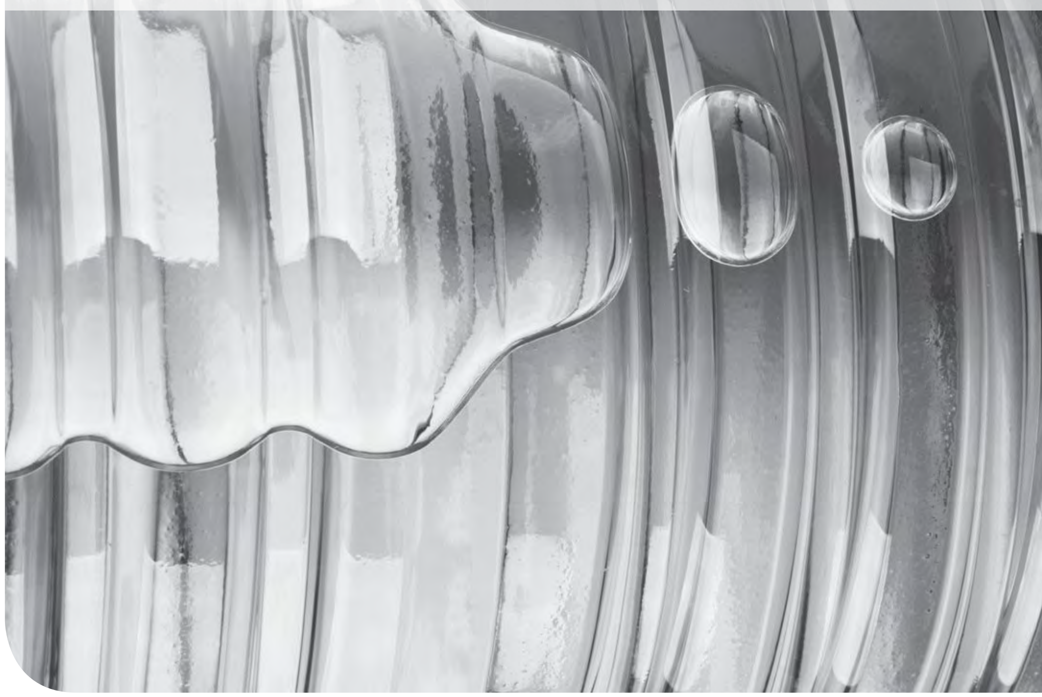
BIOTECHNOLOGY NEWS



Model identifies paths to improved plant oil production

Using a computational model they designed to incorporate detailed information about plants' interconnected metabolic processes, scientists at the US Department of Energy's Brookhaven National Laboratory (Upton, New York) have identified key pathways that appear to "favor" the production of either oils or proteins. The research, published in the journal *Plant Physiology*, may point the way to new strategies to tip the balance and increase plant oil production.

As a step toward that goal, Brookhaven biologist Jörg Schwender and postdoctoral research associate Jordan Hay recently developed a detailed computational model incorporating 572 biochemical reactions that play a role in rapeseed's central metabolism and/or seed oil production, as well as information on how those reactions are grouped together, how they are organized in subcellular compartments, and how they interact. They have used the model to identify which metabolic pathways are likely to increase in activity—and which have to decrease—to convert a "low-oil" seed into a "high-oil" seed.

Such a switch would likely be a tradeoff between oil and protein production, Schwender explained, because with limited carbon and energy resources, "the plant would 'pay' for the increased cost of making more oil by reducing its investment into seed protein" (http://tinyurl.com/BNL-oil).

So far, efforts based on conventional plant breeding and genetics have had very limited success in changing the typical tradeoff of storage compounds in seeds.

"Behind the production of oil and protein in seeds is a complex network of hundreds of biochemical reactions, and it is hard to determine how this network is controlled and how it could be manipulated to change the tradeoff," Schwender said.

Schwender and Hay's computational model of 572 metabolic reactions turns the problem on its head to narrow the search. Instead of manipulating each pathway one by one to see which might tip the balance from protein toward oil, the model postulates the existence of seeds with different oil and protein content to see which of the many reactions are "responsive" to changes in the oil/protein tradeoff.

"This approach allowed us to narrow down the large list of enzyme reactions to the

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US Grains Council senior regional director based in Tunis, praised this approval for allowing the importation of high-protein feed ingredients at a time of crop shortage in Europe and high prices. He went on to point out, however, that the opportunity may be short-lived. New crop biotech events in the United States are not yet approved in Europe. US farmers may plant these products in the second quarter of 2013, meaning they would enter the market in the third quarter, again stalling sales of US co-products in the EU (http://tinyurl.com/Sifferath).

■■■

In the third quarter of 2012, Bronislaw Komorowski, president of Poland, signed an amendment on the law of animal feeding to allow the use of genetically modified (GMO) soybeans in animal nutrition starting in 2016. He described his decision as "economically and socially reasonable" (http://tinyurl.com/Poland-GMOsoy). Polish Minister of Agriculture Mark Kalembe countered, "Poland should be free of GMO products." On the other hand, Kalembe pointed out that banning GMOs in animal feed could lead to the collapse of production. ■

relatively few ones that might be good candidates to be manipulated in future experimental studies," Schwender said. "Our major goal is to computationally predict the least possible number of enzymes that have most control over the tradeoff between oil and protein production."

Of the 572 reactions included in the model, the scientists identified 149 reactions as "protein-responsive" and 116 as "oil-responsive."

"In addition, the model helps us evaluate how sensitive the reactions are in a quantitative way, so we can see which of these are the 'most sensitive' reactions," Schwender said. "This allows us to identify a relatively few possible targets for future genetic manipulation to tip the balance in favor of greater seed oil production."

Some of the reactions identified by the model confirm pathways pointed out in previous research as important for oil synthesis. "But some of the reactions identified by our model have not really been implied so far to be important in the oil/protein tradeoff," Schwender said, suggesting that this could be new ground for discovery.

"These simulation tools may therefore point the way to new strategies for re-designing bioenergy crops for improved production," he concluded.

For further information see Jörg Schwender and Jordan O. Hay, Predictive modeling of biomass component tradeoffs in *Brassica napus* developing oilseeds based on *in silico* manipulation of storage metabolism, *Plant Physiology*: doi:10.1104/pp.112.203927.

California rejects Proposition 37

In the US election held November 6, 2012, voters in the state of California considered Proposition 37, which would have required companies to disclose if foods sold in the state's grocery stores were "genetically engineered" (for raw agricultural commodities) or "may have been entirely or partially produced with genetic engineering" (for processed foods and supplements). The measure failed to pass: 47% of voters voted in favor of the proposition, but 53% voted against it. The issue was widely followed across the country, because it was seen as a bellwether of future actions throughout the United States.

Agribusiness and food companies in general vigorously opposed Proposition 37 and spent $46 million on advertising and lobbying for the "no" campaign—top contributors were Monsanto ($8.1 million), DuPont ($5.4 million), PepsiCo ($2.1 million), Grocery Manufacturers Association ($2.0 million), BASF CropScience and BASF Plant Science (total: $4.0 million), Dow Agrosciences ($2.0 million), and Syngenta ($2.0 million). Contributors to the "yes" campaign raised about $8 million, much of it from organic food companies. For a more comprehensive list of the top contributors as of late October, see http://tinyurl.com/Prop37-contributors or http://tinyurl.com/ContribLists.

Groups that had sponsored Proposition 37 vowed to continue their efforts, concentrating on introducing legislation to force GMO labeling nationwide, rather than state by state.

It is noteworthy that China, Saudi Arabia, South Korea, the countries of the European Union, Japan, Australia, New Zealand, Russia, India, and Chile already have some form of requirement for the labeling of GMO.

Swift response to paper on feeding GMO corn, glyphosate

On September 19, 2012, the Elsevier journal *Food and Chemical Toxicology* released online a paper entitled "Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize" by Gilles-Eric Séralini and co-workers (*50*:3221–3231, 2012; doi: http://dx.doi.org/10.1016/j.fct.2012.08.005). The uproar following the publication of this study has not yet abated.

The study looked for adverse health effects in rats that were fed Monsanto's NK603 corn, which was developed to resist the herbicide glyphosate. (The European Commission approved NK603 for use in feed and other

CONTINUED ON PAGE 47

BRIEFS

Clariant (Muttenz, Germany) has introduced a range of dyes and pigments that meet the requirements of the Nordic Ecolabel known as the "Nordic Swan" as well as the EU Ecolabel, the company announced in a statement released in late October 2012. "Eco-labels help consumers to choose products [that] have a reduced environmental impact and have become an important marketing and quality tool to demonstrate that the highest environmental standards are fulfilled," commented Clariant's Norbert Merklein, vice president Business Segment Plastics & Special Applications.

■■■

Reform of the US Toxic Substances Control Act would increase the Environmental Protection Agency's enforcement costs by 30% annually, according to the Congressional Budget Office (CBO), as reported by *Chemical Week* magazine. The bill would also cost companies about $1 million per chemical for compliance purposes, CBO said. "Because a large number of entities would likely be affected by the new requirements, CBO estimates that the aggregate cost of the private-sector mandates would probably exceed the annual threshold established in the Unfunded Mandates Reform Act," the report added. (See the complete report at www.cbo.gov/publication/43651.)

■■■

Executive Vice President–Chief Operating Officer Lawrence S. "Larry" Peiros, 57, has announced his retirement from the Clorox Co. effective April 1, 2013. Effective January 1, 2013, the company will have two chief operating officers: Benno Dorer, 48, and George Roeth, 51. Dorer currently is senior vice president–Cleaning Division & Canada and will be promoted to executive vice president & chief operating officer–Cleaning, International and Corporate Strategy. He will have responsibility for the Laundry, Home Care and International business units as well as take on responsibility for corporate strategy and growth. Roeth, currently senior vice president–Specialty Division, will be promoted to executive vice president and chief operating officer–Household and Lifestyle.■

SURFACTANTS, DETERGENTS, & PERSONAL CARE NEWS

"Hygiene hypothesis" a bust?

A new report from the UK-based International Scientific Forum on Home Hygiene (IFH) "dismantles the myth that the epidemic rise in allergies in recent years has happened because we're living in sterile homes and overdoing hygiene," in the group's words.

But far from saying microbial exposure is not important, the report—which has not been peer-reviewed—concludes that losing touch with microbial "old friends" may be a fundamental factor underlying rises in an even wider array of serious diseases. In addition to allergies, numerous other chronic inflammatory diseases (CID) such as type 1 diabetes and multiple sclerosis seem to stem from impaired regulation of the immune system. Deficiencies in microbial exposure could be key to increases in both allergies and CID, proposes IFH.

The report reviews evidence accumulated over more than 20 years of research since the "hygiene hypothesis" was first proposed and suggests that the original notion is not correct.

Presenting the report findings in Liverpool in October 2012 at Infection Prevention 2012, the national conference of the UK and Ireland's Infection Prevention Society, co-author of the report and honorary professor at the London School of Hygiene and Tropical Medicine Sally Bloomfield said: "The underlying idea that microbial exposure is crucial to regulating the immune system is right. But the idea that children who have fewer infections because of more hygienic homes are then more likely to develop asthma and other allergies does not hold up."

Another co-author of the report, Rosalind Stanwell Smith, also from the London School of Hygiene and Tropical Medicine, said: "Allergies and CID are serious health issues and it is time we recognized that simplistically talking about home and personal cleanliness as the cause of the problem is ill

CONTINUED ON NEXT PAGE

advised, because it is diverting attention from finding workable solutions and the true, probably much more complex, causes."

Graham Rook, also co-author of the report, who developed the "old friends" hypothesis, said: "The rise in allergies and CID seems at least partly due to gradually losing contact with the range of microbes our immune systems evolved with, 'way back in the Stone Age. Only now are we seeing the consequences of this, doubtless also driven by genetic predisposition and a range of factors in our modern lifestyle—from different diets and pollution to stress and inactivity. It seems that some people now have inadequately regulated immune systems that are less able to cope with these other factors."

Stanwell Smith explains why this has happened: "Since the 1800s, when allergies began to be more noticed, the mix of microbes we've lived with, and eaten, drunk, and breathed in has been steadily changing. Some of this has come through measures to combat infectious diseases that used to take such a heavy toll in those days—in London, one in three deaths was a child under five. These changes include clean drinking water, safe food, sanitation and sewers, and maybe overuse of antibiotics. Whilst vital for protecting us from infectious diseases, these will also have inadvertently altered exposure to the 'microbial friends' [that] inhabit the same environments."

But we have also lost touch with our "old friends" in other ways: Our modern homes have a different and less diverse mix of microbes than rural homes of the past, the IFH notes. This has nothing to do with cleaning habits, for even the cleanest-looking homes still abound with bacteria, viruses, fungi, molds, and dust mites. The change has occurred mainly because microbes come in from outside, and the microbes in towns and cities are very different from those on farms and in the countryside.

"The good news," says Bloomfield, "is that we are not faced with a stark choice between running the risk of infectious disease, or suffering allergies and inflammatory diseases. The threat of infectious disease is now rising because of antibiotic resistance, global mobility, and an aging population, so good hygiene is even more vital to all of us."

"How we can begin to reverse the trend in allergies and CID isn't yet clear," notes Rook. "There are lots of ideas being explored but relaxing hygiene won't reunite us with our 'old friends'—just expose us to new enemies like *E. coli*."

"One important thing we can do," says Bloomfield, "is to stop talking about being too clean and get people thinking about how we can safely reconnect with the right kind of dirt."

IFH is a nonprofit organization whose core activities are supported through an unrestricted educational grant provided by consumer products manufacturers Unilever and Reckitt Benckiser. Other organizations that have contributed to the funding of IFH include Procter & Gamble, GOJO, Johnson & Johnson Consumer Companies Inc., and Milton Pharmaceutical Co.

ACI named "Association of the Year"

The Cleaning for a Reason Foundation, a nonprofit charitable organization that provides free housecleaning to US women undergoing treatment for cancer, honored the American Cleaning Institute® (ACI) with its Association of the Year Award in October 2012. The Foundation is based in Lewisville, Texas, USA.

"Since 2008, the American Cleaning Institute has been a strong, effective, and strategic partner with Cleaning for a Reason," said the group's president and founder, Debbie Sardone. "They have raised our foundation's profile throughout the cleaning products industry and helped us gain critically important financial support in the business community. We are very grateful for their continued work on our behalf."

To date, Cleaning for a Reason has worked with more than 1,000 cleaning service providers who have performed 12,000 free, professional house cleanings to improve the lives of women undergoing cancer treatment. That reflects over $3 million worth of donated cleaning services.

ACI recently presented a check to the foundation for $18,000, much of which was raised during charitable events at ACI's Annual Meeting & Industry Convention. ACI is a trade association based in Washington, DC, USA, and was formerly known as The Soap & Detergent Association.

Dow and DuPont announce cutbacks

The Dow Chemical Co. (Midland, Michigan, USA) announced in October 2012 that it will close roughly 20 manufacturing facilities in the United States, Belgium, the Netherlands, Spain, the United Kingdom, and Japan. Dow also said it will slash about 2,400 jobs as part of a restructuring plan aimed at coping with slowing economic growth.

The cuts amount to about 5% of the company's workforce worldwide, according to a statement from Dow, which added that the actions are expected to result in approximately $500 million of annual operating cost savings by the end of 2014. Further reductions in capital spending and investments are expected to save an additional $500 million. Altogether, the company said it expects to save $2.5 billion.

"The reality is, we are operating in a slow-growth environment in the near term and, while these actions are difficult, they demonstrate our resolve to tightly manage operations particularly in Europe and mitigate the impact of current market dynamics," Andrew Liveris, Dow's chairman and CEO, said in a statement.

DuPont Co. also announced a restructuring plan at the end of October 2012 that included 1,500 layoffs after its earnings fell short of expectations. "For the quarter, volumes were down in all regions except Latin America, led by a 10% decline in the Asia-Pacific region," the Associated Press (AP) news service reported. DuPont's sales for the previous quarter dropped 15% in Asia-Pacific and the Europe, Middle East, and Africa region, the report noted.

FTC releases green marketing guidelines

The US Federal Trade Commission (FTC) has updated its environmental marketing guidelines, or Green Guides, for the first time since 1998 (see http://tinyurl.com/green-guide-FTC).

"Very few products, if any, have all the attributes consumers seem to perceive from such claims, making these claims nearly impossible to substantiate," the commission said.

The Green Guides do not address products that claim to be organic, sustainable, or "natural." Organic products are covered by regulations set by the US Department of Agriculture. As for products claiming to be sustainable or natural, the commission said it had no way to define and substantiate those claims.

According to the guidelines, products claiming to be biodegradable must "completely break down and return to nature" within one year. Further, companies must conduct life cycle analyses to prove, for instance, that damage done by long-distance shipping does not outweigh the benefits of using recycled material. The guidelines also caution about the use of certifications and seals that purportedly document a product's claims.

"A marketer's use of an environmental certification or seal of approval likely conveys that the product offers a general environmental benefit if the certification or seal does not convey the basis for the certification or seal, either through the name or some other means," the guidelines state.

"Because it is highly unlikely that marketers can substantiate general environmental benefit claims, marketers should not use environmental certifications or seals that do not convey the basis for the certification."

"Every marketer ought to be looking at [the guidelines] carefully," Christopher A. Cole, a partner in the advertising and marketing practice at the law firm Manatt, Phelps & Phillips in New York City, told *The New York Times*. "These are not laws, but they are guidance. You ignore them at your peril."

Production breakthroughs for ethylene glycol

A metal-organic compound encapsulated in the nanosized pores of a crystalline solid selectively converts epoxides to diols in high yield under mild reaction conditions and with far less need for excess reagents, according to researchers at China's Dalian Institute of Chemical Physics. The finding may help reduce costs and energy use in the production of ethylene glycol and related products.

Ethylene glycol and other diols are key starting materials used to manufacture polyester resins, antifreeze, cosmetics, liquid detergents, surfactants, paints and coatings, and other products. Glycols are typically produced commercially via hydration of epoxides.

Ethylene glycol, for example, is made industrially through reaction of ethylene oxide and water, usually at elevated temperatures and in the presence of a 20-fold or larger excess of water. Those conditions lead to high, selective conversion of ethylene oxide to ethylene glycol.

But because of the large water excess, the product solution typically contains only 10 wt% ethylene glycol, which has a boiling point of 197°C. The diol must be separated through energy-intensive distillation. Researchers have evaluated various alternative catalytic reactions, but they produce ethylene glycol nonselectively if the water-to-ethylene oxide ratio is less than 10.

The Dalian team, which was led by Bo Li, reports development of a catalyst that converts ethylene oxide to ethylene glycol readily at greater than 98% selectivity under mild conditions (40°C) at a water-to-ethylene oxide ratio of less than two. They report similar results for several epoxides.

The team prepared the catalyst, a Co^{3+} complex with the chelating ligand salen, by encapsulating the metal-organic compound in FDU-12, a nonporous silica material. They show that closely confining multiple catalyst molecules in the nanopores greatly enhances catalytic performance. The group narrowed the nanopore entrances via silylation reactions to prevent the catalyst from being leached from the silica by the reaction solution.

The work has "strong potential for industrial application," says Zaiku Xie, director general of research at Sinopec, a major oil company in China. Because the catalyst is encapsulated in a solid, it is easily separated from the product and recycled, further enhancing the green and sustainable appeal of this work, he adds.

The study appeared in the journal *Angewandte Chemie* (doi: 10.1002/anie.201203774, 2012). ■

PEOPLE NEWS
INSIDE AOCS

The AOCS Asian section leadership meeting was held on October 29, 2012, in Sonoma, California, USA, in conjunction with the meeting of the International Society of Biocatalysis and Agricultural Biotechnology. Those in attendance were (left to right) Ching Hou, Suk Hoo Yoon, Vic Huang (chair of the Asian section), and Kazuo Miyashita.

Cantrill appointed chief science officer

Richard Cantrill is now chief science officer and technical director of AOCS, reporting directly to **Patrick Donnelly**, CEO of AOCS.

"Cantrill is responsible for all Technical Services activities including methods development and maintenance, laboratory proficiency, and accreditation. His special emphasis is on horizontal method development of food standards and special liaison with governmental and nongovernmental organizations," said Donnelly.

Cantrill joined AOCS in 1996 as technical director. "With more than 35 years of experience in lipid science and technology, he has been instrumental in the AOCS official methods program and influential in industry collaboration for food safety, food quality, and global trade," added Donnelly.

Cantrill earned a B.Sc. in biochemistry with special honors and a Ph.D. in brain lipid synthesis from the University of Sheffield (UK). He is a member of the Food Ingredients Expert Committee of the Food Chemicals Codex, a member of the Joint Expert Committee on Food Additives and Contaminants of the United Nations' Food and Agricultural Organization and World Health Organization, and represents AOCS on a number of International Organization for Standardization and other international committees.

EuroFedLipid news

At the Euro Fed Lipid Congress held September 23–26, 2012, in Kraków, Poland, AOCS member **Christopher Dayton** of Bunge (White Plains, New York, USA) presented the opening lecture, entitled "The biotechnology processing revolution in fats and oils." The European Lipid Technology Award was presented to AOCS member **Frank Veldkamp**, of Mahle Industrial Filtration (Lochem, Netherlands). He talked on "Filtration: then and now. What's new?"

Florence Lacoste of ITERG (Pessac, France) received the Chevreul Medal, sponsored by the Société française pour l'étude des lipides, during the congress. Lacoste talked on "Undesirable substances in vegetable oils: anything to declare?" Other lectures included "Modern fats and the modern mind: mealtimes and mental illness," given by **Joseph R. Hibbeln** (National Institute on Alcohol Abuse and Alcoholism–National Institutes of Health, Bethesda, Maryland, USA), who won this year's Normann Medal; and "Lipid-mediated signaling as a source of new medicine," presented by **Daniele Piomelli** (University of California, Irvine, USA), winner of this year's European Lipid Science Award.

New officers for SEA

The Solvent Extractors' Association (SEA) of India announced their officers for the years 2012–2013 at the end of the third quarter, 2012. President is **Vijay Data**, who also serves as managing director of Vijay Solvex Ltd., of Alwar, Rajasthan. The new vice president is **Pravin S. Lunkad**, chief executive officer of Pranav Agro Industries Ltd., Pune, Maharashtra. Serving as secretary is **Nimish K. Patel**, who is managing director of N.K. Industries Ltd., Ahmedabad, Gujarat, and **Anil Modi**, managing director of Modi Naturals Ltd., Pilibhit, Uttar Pradesh, is treasurer.

New title for Richar

AOCS member **Tom Richar**'s new title is Associate Principal Scientist with Mondelez International. He describes his responsibilities as "same job—different company name," reflecting the division of Kraft Foods on October 2, 2012, into Kraft Foods and Mondelez International. The slimmed-down Kraft Foods is still involved in consumer packaged food and beverages; meanwhile Mondelez is concentrating on snack foods. Market predictions are that Mondelez is well positioned to grow at an annual rate of 13% over the next five years (http://tinyurl.com/mondelez-growth).

Spackler named CEO at AGP

The Board of Directors of Ag Processing Inc. (AGP) named **Keith Spackler** as its chief executive officer and general manager in September. He had been serving as the cooperative's chief financial officer and group vice president. He succeeded **Marty Reagan**, who retired. Spackler joined AGP in 1985 as manager of business analysis and over the past 27 years has served in various positions of leadership at the cooperative.

AGP, headquartered in Omaha, Nebraska, USA, is the largest farmer-owned soybean processor in the world. It is owned by 180 local and regional cooperatives representing over 200,000 farmers from 16 states throughout the United States.

Presentation of Export Performance Award to Mecpro Heavy Engineering Ltd. (left to right: Aman Chadha, chairman, EEPC; Singh Badal, chief minister, Punjab; Kamna Raj Agarwal, regional chairperson (Northern Region); Sukhbir; and Rajan Skhariya, managing director, Mecpro.

Mecpro recognized

EEPC India (formerly, Engineering Export Promotion Council) presented its Export Performance Award to Mecpro Heavy Engineering Limited at a function on September 28, 2012. The award was accepted by AOCS member **Rajan Skhariya**, managing director for Mecpro, from **Sukhbir Singh Badal**, Chief Minister, Punjab for its export performance during the year 2009–2010. Mecpro (New Delhi, India) is a turnkey plant and machinery supplier and technology provider in the edible oil industry. It has successfully executed over 160 projects, both in India and abroad, during the last 26 years of its existence.

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AOCS CORPORATE MEMBER PROFILE

This profile has been provided by the following Bronze Level AOCS Corporate Member:

Canadian Food Inspection Agency
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The aim of the Canadian Food Inspection Agency (CFIA) is to excel as a science-based regulator, trusted and respected by Canadians and the international community. As such, CFIA is dedicated to safeguarding food, animals, and plants, which enhances the health and well-being of Canada's people, environment, and economy.

CFIA uses a risk-based approach to verify that domestically produced and imported products meet Canadian standards and regulations. Compliance and enforcement actions occur all along the supply chain, and they involve numerous stakeholders and jurisdictions. Laboratory testing takes place from coast to coast in International Organization for Standardization/International Electrotechnical Commission 17025-accredited laboratories.

The creation of the CFIA in 1997 clearly reinforced the division of federal powers between the Minister of Agriculture and Agri-Food, and the Minister of Health. The Minister of Agriculture and Agri-Food, through the CFIA, is responsible for animal and plant health standards and related inspection activities. With regard to food, the CFIA conducts all federal food inspection activities while Health Canada establishes policies and standards relating to the safety and nutritional quality of food sold in Canada. In addition, Health Canada assesses the effectiveness of the CFIA's activities related to food safety.

CFIA participates in AOCS through testing of the authenticity of fats and oils, analysis of animal feeds and feed ingredients through microscopy, and testing of foods for the verification of nutrition labeling.

As a benefit of corporate membership in AOCS, companies are entitled to provide a 250-word profile for inclusion on a space-available basis in Inform *magazine. For more information, contact Nicole Philyaw at nicolep@aocs.org.*

AOCS MEETING WATCH

April 3–4, 2013. AOCS Oils and Fats World Market Update 2013, Ukrainian House, Kiev, Ukraine. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; http://worldmarket.aocs.org

April 28–May 1, 2013. 104th AOCS Annual Meeting & Expo, Palais des congrès de Montréal, Montréal, Québec, Canada. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; http://AnnualMeeting.aocs.org

July 16–17, 2013. AOCS Technical Services Workshop: Laboratory Methods, Des Moines, Iowa, USA. Information: Gina Clapper (email: ginac@aocs.org).

August 20–23, 2013. 15th Latin American Congress and Exposition on Fats and Oils, Sheraton Santiago Hotel and Convention Center, Santiago, Chile. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; http://lacongress.aocs.org

May 4–7, 2014. 105th AOCS Annual Meeting & Expo, The Henry B. Gonzalez Convention Center, San Antonio, Texas, USA. Information: phone: +1 217-693-4821; fax: +1 217-693-4865; email: meetings@aocs.org; http://aocs.org/meetings

October 6–9, 2014. Montreux 2014: World Conference on Fabric and Home Care, Montreux Music & Convention Centre, Montreux, Switzerland. Information: email: meetings@aocs.org ; phone: +1 217-693-4821; fax: +1 217-693-4865; http://Montreux.aocs.org

May 3–6, 2015. 106th AOCS Annual Meeting & Expo, Rosen Shingle Creek, Orlando, Florida, USA. Information: phone: +1 217-693-4821; fax: +1 217-693-4865; email: meetings@aocs.org; http://aocs.org/meetings

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 webform. Submission is free. No third-party submissions, please. If you have any questions or comments, please contact AOCS Marketing at valoried@aocs.org.

New appointment at Eurofins QTA

Eddie Hall became sales manager, renewable fuels for Eurofins QTA, Cincinnati, Ohio, USA, during the third quarter. He reports to AOCS member **Kangming Ma**. Hall joined QTA in 2003 and has been serving as technical support specialist until this new appointment. His responsibilities will include expanding QTA's presence in renewable fuel and related market segments.

France joins CPM Roskamp Champion

Martin France joined CPM Roskamp Champion (Waterloo, Iowa, USA) as an oilseed application specialist in September 2012. His primary responsibilities are providing sales, field, and service support to US and Canadian oilseed customers. He will perform equipment audits; provide instruction and training; oversee equipment setups and startups; and provide equipment upgrade recommendations for Roskamp Champion's oilseed preparation equipment.

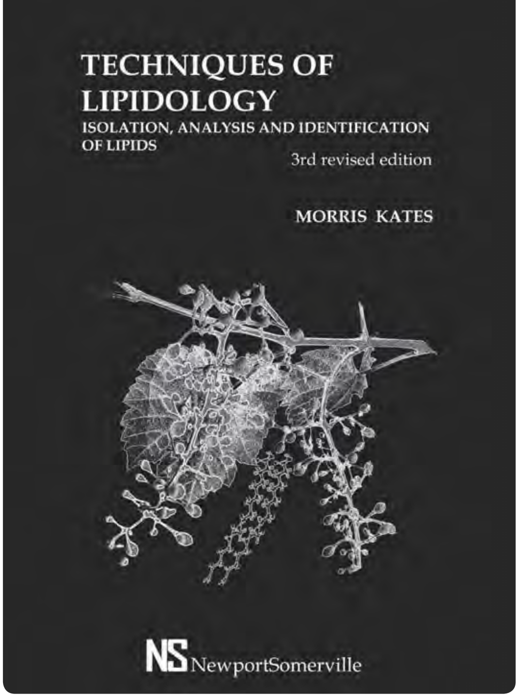
Roskamp makes flaking mills and cracking mills and Champion produces hammermills used in the oilseed processing industry.

Rotsaert now COO of Solazyme

In October **Jean-Marc Rotsaert** moved from AAK, where he was the president and CEO of the US business, to Solazyme, Inc. (South San Francisco, California, USA). In his new position Rotsaert is the company's chief operating officer (COO). In that role, he will be responsible for leading Solazyme's operations, including the continued expansion of the tailored oils sales and marketing organization with a focus on the industrial and nutritional markets.

Commenting on this hiring, Jonathan Wolfson, CEO of Solazyme, said, "Jean-Marc is a proven leader who has a deep understanding of the international and domestic triglyceride oils market. His impressive track record of success in leading business through rapid growth is ideally suited for Solazyme at a time when we are scaling our commercial operations." ■

BOOK REVIEW



Techniques of Lipidology: Isolation, Analysis and Identification of Lipids, Third Edition
Morris Kates, Newport Somerville Innovation, Ltd., 2010
422 pages, $235.87, ISBN 978-0-9813757-0-0

This is the third edition of *Techniques of Lipidology: Isolation, Analysis and Identification of Lipids*; the second appeared in 1984. Although several excellent textbooks on lipid analysis were published in the mid-2000s, this review will be a discussion of the salient points of the Kates text.

The book covers lipid analysis in depth, but the focus is on lipid biochemistry rather than, for example, on food chemistry. Its seven chapters cover lipid classification, analytical instrumentation, extraction, general analytical techniques, separations, radioisotope techniques, and the identification of specific lipid components. The first chapter is long: 80 pages. It contains ~200 structural diagrams of various simple and complex lipids. There are numerous references that indicate where many of the complex and unusual lipid components were first identified. Several tables on various lipids groups are included.

This initial chapter is followed by a short introductory chapter (~14 pages) on instrumentation that includes one or more vendors for each instrument. The second brief chapter (~10 pages) focuses on classical extraction techniques. Additional information on the new instrumental extraction techniques would have been helpful (such as supercritical fluids, automated and accelerated solvent extraction, and the like). Chapter 2 is short. It begins with brief discussions on very basic techniques, including solvents, glassware, rotary evaporators, and stirrers. It ends with a series of short discussions on several analytical instruments, their desired specifications, and a list of several vendors that could supply the equipment. The third chapter on extraction is very brief as well. The chapter covers sample types, with a focus on biological samples (microbial cells, animal tissues, plant tissues, blood cells, egg yolks, storage lipids, and so forth). If you work with biological samples, this chapter could be helpful, although the references are limited and out of date. None of the new supercritical fluid or accelerated solvent extraction techniques are discussed.

Chapter 4 is long and detailed (~70 pages) with a wealth of information on a wide variety of lipid component analyses, including plasmalogens, N-acyl-containing lipids, glycerol ethers, and sulfur-containing lipid material. It starts with good sections on nitrogen, sugar, cholesterol, and the like and quickly advances to the analysis of complex lipid components or component mixtures. The chapter ends with informative subsections on ultraviolet-visible spectroscopy, infrared spectroscopy (IR), nuclear magnetic resonance (NMR), and mass spectroscopy (MS). If your main area of research includes lipid analytical biochemistry, this chapter makes the book worth purchasing.

Chapter 5 covers the separation of lipid mixtures using methods that include solvent fractionation, various open column chromatographic methods, high-performance liquid chromatography methods, various thin-layer chromatography methods, gas-liquid chromatography methods—primarily qualitative and quantitative analysis, rather than fractionation—finishing with a short section on MS.

Chapter 6 covers a very important analytical tool widely used in biochemistry: radioisotopes. The chapter starts with a list of available radioisotope-labeled precursors for metabolic labeling of lipids, and that is followed by several methods for synthesizing various radioactively labeled lipid components. Another technique discussed is the production of radioactively labeled lipid components produced via the growth of the appropriate bacteria, yeast, algae, higher plant, or cell/tissue culture. The radioactivity measurement of the labeled lipids is discussed briefly.

The final chapter is a long discourse (~100 pages) on the identification of individual lipids and lipid components. Included are numerous details on the identification of lipid classes, using methods to identify double-bond position/configuration. Individual moieties contained in fatty alcohols, long-chain ketones, long-chain aldehydes, free fatty acids, various lipid esters, and glycerol ethers are addressed. The analysis of complex polar lipids from various sources (microbial, plant, and animal) is discussed. A variety of analytical techniques are covered in detail, including NMR, IR, and MS. Enzymatic methods used to help fully identify lipid components and moieties are discussed as well. The chapter ends with subsections on the analysis of various complex lipids, such as sphingolipids and cerebrosides. More than 800 references on lipid analysis are listed at the end of the book.

The book would be useful for those interested in lipid biochemistry and related analyses. It is not a food lipid analysis text; rather it is focused on analytical biochemistry in the area of lipid chemistry. ■

William E. Artz has been an AOCS member since the late 1970s and has nearly 30 years of experience in fat/oil chemistry and research.

EXTRACTS & DISTILLATES

Characterization of lipids and lignans in brewer's spent grain and its enzymatically extracted fraction

Niemi, P., *et al.*, *J. Agric. Food Chem. 60*: 9910–9917, 2012.

Brewer's spent grain (BSG), the major side stream of brewing, consists of the husks and the residual parts of malts after the mashing process. BSG was enzymatically fractionated by a two-step treatment with carbohydrate- and protein-degrading enzymes, which solubilized 66% of BSG. BSG contained 11% lipids, which were mostly triglycerides, but also a notable amount of free fatty acids was present. Lipids were mostly solubilized due to the alkaline pH applied in the protease treatment. The main fatty acids were linoleic, palmitic, and oleic acids. Several lignans were identified in BSG, syringaresinol and secoisolariciresinol being the most abundant, many associated with the cell wall matrix and released by the alkaline-protease treatment.

Antioxidants and physical integrity of lipid bilayers under oxidative stress

Liang, R., *et al.*, *J. Agric. Food Chem. 60*:10331–10336, 2012.

Giant unilamellar vesicles (GUVs of diameter 5–25 μm) of soy phosphatidylcholine (PC), resistant to intense light exposure (400–440 nm, ~15 $mW{\cdot}mm^{-2}$), underwent budding when containing chlorophyll *a* (Chl*a*) in the lipid bilayer ([PC]/[Chl*a*] = 1500:1). On the basis of image heterogeneity analysis using inverted microscopy, a dimensionless entropy parameter for the budding process was shown to increase linearly during an initial budding process. Lipophilic β-carotene (β-Car; [PC]/[β-Car] = 500:1) reduced the initial budding rate by a factor of 2.4, while the hydrophilic glycoside rutin ([PC]/[rutin] = 500:1) had no effect. Chl*a* photosensitized oxidation of PC to form linoleoyl hydroperoxides, further leading to domains of higher polarity in the vesicles, is suggested to trigger budding. The average dipole moment (μ) of linoleic acid hydroperoxides was calculated using density functional theory (DFT) to have the value of 2.84 D, while unoxidized linoleic acid has μ = 1.86 D. β-Carotene as a lipophilic antioxidant and singlet-oxygen quencher seems to hamper oxidation in the lipid bilayers and delay budding in contrast to rutin located in the aqueous phase. The effect on budding of GUVs as a detrimental process for membranes is suggested for use in assays for evaluation of potential protectors of cellular integrity and functions under oxidative stress.

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JAOCS

JOURNAL OF THE AMERICAN OIL CHEMISTS' SOCIETY

Journal of the American Oil Chemists' Society (November)

- Analysis of sesamin, asarinin, and sesamolin by HPLC with photodiode and fluorescent detection and by GC/MS: application to sesame oil and serum samples, Schwertner, H.A., and D.C. Rios
- Monitoring the epoxidation of canola oil by non-aqueous reversed phase liquid chromatography/mass spectrometry for process optimization and control, Anuar, S.T., Y.Y Zhao, S.M. Mugo, and J.M. Curtis
- Oxidative stabilities of enzymatically interesterified fats containing conjugated linoleic acid, Adhikari, P., P. Hu, and Z. Yafei
- Lipase-catalyzed acidolysis of olive oil with *Echium* oil stearidonic acid: optimization by response surface methodology, Bilgiç, S., and N.S Yeşilçubuk
- Iron oxide catalysts supported on porous silica for the production of biodiesel from crude jatropha oil, Suzuta, T., M. Toba, Y. Abe, and Y. Yoshimura
- Biocatalytic conversion of coconut oil to natural flavor esters optimized with response surface methodology, Sun, J., J.H. Chin, W. Zhou, B. Yu, P. Curran, and S.-Q. Liu
- Lipase-catalyzed concentration of stearidonic acid in modified soybean oil by partial hydrolysis, Kleiner, L., L. Vázquez, and C.C. Akoh
- Physico-chemical properties of marine phospholipid emulsions, Lu, F.S.H., N.S. Nielsen, C.P. Baron, L.H.S. Jensen., and C. Jacobsen
- Fatty acid composition of non-starch and starch neutral lipid extracts of Portuguese sourdough bread, Rocha, J.M., P.J. Kalo, and F.X. Malcata
- Improving fatty acid composition of lipids synthesized by *Brachionus plicatilis* in large-scale experiments, Birkou, M., D. Bokas, and G. Aggelis
- Water-blown rigid biofoams from soy-based biopolyurethane and microcrystalline cellulose, Luo, X., A. Mohanty, and M. Misra
- Properties of biobased epoxy resins from epoxidized soybean oil (ESBO) cured with maleic anhydride (MA), España, J.M., L. Sánchez-Nacher, T. Boronat, V. Fombuena, and R. Balart
- Controlling product composition of metathesized triolein by reaction concentrations, Li, S., L. Hojabri, and S.S. Narine
- Analysis of ceramides in soy sauce oil, Yamaguchi, H., and Y. Ogawa
- Preparation and characterization of sustainable polyurethane foams from soybean oils, Gu, R., S. Konar, and M. Sain
- A visual titration method for the determination of the acid number of oils and fats: a green alternative, Aricetti, J.A., and M. Tubino
- Effect of support acidic properties on sulfur tolerance of Pd catalysts for partial hydrogenation of rapeseed oil-derived FAME, Numwong, N., A. Luengnaruemitchai, N. Chollacoop, and Y. Yoshimura

JOURNAL OF SURFACTANTS AND DETERGENTS

AOCS JOURNALS

PUBLICATIONS

Journal of Surfactants and Detergents (November)

- Mechanistic studies of particulate soil detergency: II: hydrophilic soil removal, Rojvoranun, S., S. Chavadej, J.F. Scamehorn, and D.A. Sabatini
- Application of rhamnolipid in the formulation of a detergent, Bafghi, M.K., and M.H. Fazaelipoor
- Synthesis of didodecylmethylcarboxyl betaine and its application in surfactant–polymer flooding, Cui, Z.-G., X.-R. Du, X.-m. Pei, J.-z. Jiang, and F. Wang
- Effect of mixed nanobubble and microbubble liquids on the washing rate of cloth in an alternating flow, Ushida, A., T. Hasegawa, N. Takahashi, T. Nakajima, S. Murao, *et al.*
- Synthesis and surface active properties of a novel linear dodecyl diphenyl ether sulfonate gemini surfactant, Hujun, X., L. Qicheng, C. Dandan, and L. Xiaoya
- Synthesis, characterization and properties of new lauryl amidopropyl trimethyl ammoniums, Liu, H., F. Li, B. Xu, G. Zhang, F. Han, *et al.*
- Synthesis and surface properties study of a series of cationic surfactants with different hydrophobic chain lengths, Badache, L., Z. Lehanine, and W.N. Abderrahmane
- Synthesis, surface active, and thermodynamic parameters of novel quaternary ammonium salts, Asadov, Z.H., R.A. Rahimov, G.A. Ahmadova, and K.A. Mammadova
- Effect of long-chain length on the surface activities of zwitterionic imidazolium-based surfactants: 1-carboxymethyl-3-alkylimidazolium inner salts, Ni, B.-q., J. Hu, X.-f. Liu, H. Chen, and Y. Fang
- Synthesis, surface, thermodynamic properties of some biodegradable vanillin-modified polyoxyethylene surfactants, Sayed, G.H., F.M. Ghuiba, M.I. Abdou, E.A.A. Badr, S.M. Tawfik, *et al.*
- Surface activity and cleavability of gemini surfactants featuring hydrophilic spacer groups, Su, S.-K., L.-H. Lin, and Y.-C. Lai
- 2-[(*E*)-{(1*S*,2*R*)-1-hydroxy-1-phenylpropan-2-ylimino}methyl]phenol for inhibition of acid corrosion of mild steel, Kesavan, D., M.M. Tamizh, N. Sulochana, and R. Karvembu
- Thermodynamics of micellization of sulfobetaine surfactants in aqueous solution, Cheng, C.-j., G.-m. Qu, J.-j. Wei, T. Yu, and W. Ding
- Effect of organic additives on the phase separation phenomenon of amphiphilic drug solutions, Rub, M.A., A.M. Asiri, D. Kumar, A. Khan, A.A.P. Khan, *et al.*
- Surface and solution properties of amphiphilic drug-nonionic surfactant systems, Kabil-ud Din, G.A. Al-dahbali, A.Z. Naqvi, and M. Akram
- Adsorption, desorption, and adsolubilization properties of mixed anionic extended surfactants and a cationic surfactant, Panswad, D., D.A. Sabatini, and S. Khaodhiar
- Effects of dodecyl trimethyl ammonium bromide surfactant on decolorization of Remazol Blue by a living *Aspergillus versicolor* strain, Gül, Ü.D., and G. Dönmez
- Determination of sodium dodecyl sulfate (SDS) and biosurfactants sorption and transport parameters in clayey soil, Harendra, S., and C. Vipulanandan
- Comment on "Degradation of two persistent surfactants by UV-enhanced ozonation," Heinze, J.E.

Lipids

Lipids (November)

- Docosahexanoic acid improves chemotherapy efficacy by inducing CD95 translocation to lipid rafts in ER^- breast cancer cells, Ewaschuk, J.B., M. Newell, and C.J. Field
- Fish oil supplementation reduces cachexia and tumor growth while improving renal function in tumor-bearing rats, Coelho, I., F. Casare, D.C.T. Pequito, G. Borghetti., R.K. Yamazaki, *et al.*
- Oleic acid attenuates *trans*-10,*cis*-12 conjugated linoleic acid-mediated inflammatory gene expression in human adipocytes, Reardon, M., S. Gobern, K. Martinez, W. Shen, T. Reid, *et al.*
- High serum palmitic acid is associated with low antiviral effects of interferon-based therapy for hepatitis C virus, Miyake, T., Y. Hiasa, M. Hirooka, Y. Tokumoto, T. Watanabe, *et al.*
- Decreased plasma cholesterol concentrations after PUFA-rich diets are not due to reduced cholesterol absorption/synthesis, Ramprasath, V.R., P.J.H. Jones, D.D. Buckley, L.A. Woollett, and J.E. Heubi
- Key fatty acid combinations define vascular smooth muscle cell proliferation and viability, St-Denis, C., I. Cloutier, and J.-F. Tanguay
- *In-vitro* toxicological and proteomic analysis of furan fatty acids which are oxidative metabolites of conjugated linoleic acids, Lengler, I., T. Buhrke, E. Scharmach, and A. Lampen
- Transcriptional regulation of desaturase genes in *Pichia pastoris* GS115, Yu, A.-Q., T.-L. Shi, B. Zhang, L.-J. Xing, M.-C Li.
- Fast transmethylation of serum lipids using microwave irradiation, Lin, Y.H., J.D Loewke., D.Y. Hyun, J. Leazer, and J.R. Hibbeln

Interactions between α-tocopherol and rosmarinic acid and its alkyl esters in emulsions: synergistic, additive, or antagonistic effect?

Panya, A., *et al.*, *J. Agric. Food Chem. 60*:10320–10330, 2012.

Many antioxidants can interact to produce synergistic interactions that can more effectively inhibit lipid oxidation in foods. Esterification of rosmarinic acid produces a variety of compounds with different antioxidant activity due to differences in polarity and thus differences in partitioning in oil, water, and interfacial regions of oil-in-water (O/W) emulsions. Therefore, rosmarinic acid and rosmarinate esters provide an interesting tool to study the ability of antioxidant to interact in O/W emulsions. In O/W emulsions, rosmarinic acid (R-0) exhibited the strongest synergistic interaction with α-tocopherol while butyl (R-4) and dodecyl (R-12) rosmarinate esters exhibited small synergistic interaction and eicosyl rosmarinate esters (R-20) exhibited slightly antagonistic interaction. Fluorescence quenching and electron paramagnetic resonance (EPR) studies showed that water-soluble rosmarinic acid (R-0) exhibited more interactions with α-tocopherol than any of the tested esters (R-4, R-12, R-20). This was also confirmed in O/W emulsions where R-0 altered the formation of α-tocopherol quinone and α-tocopherol increased the formation of caffeic acid from R-0. This formation of caffeic acid was proposed to be responsible for the synergistic activity of R-0 and α-tocopherol since the formation of an additional antioxidant could further increase the oxidative stability of the emulsion.

Comparison of analytical and sensory lipid oxidation parameters in conventional and high-oleic rapeseed oil

Petersen, K.D., *et al.*, *Eur. J. Lipid Sci. Technol. 114*:1193–1203, 2012.

Headspace-solid-phase microextraction–gas chromatography was used to identify in total 55 volatile lipid oxidation compounds in thermally stressed conventional and high-oleic rapeseed oil samples. Out of this profile, 17 volatile compounds with low odor threshold values were selected as target compounds for the assessment of lipid oxidation in rapeseed and high-oleic rapeseed oils. Additionally, other lipid oxidation parameters such as fatty acid composition, peroxide value, anisidine value, and induction time (Rancimat analysis) were determined. Multivariate statistical methods (principal component analysis in combination with agglomerative hierarchical cluster analysis) were applied to identify sensitive volatile lipid oxidation indicators enabling the differentiation of rapeseed oil samples of different varieties (high-oleic vs. conventional). Moreover, these statistical methods were capable of differentiating rapeseed oils of different oxidative properties. Octanal and 3-octanone showed the highest ability to differentiate between samples of different rapeseed varieties, whereas propanal, *E,E*-2,4-hexadienal, and *E*-2-heptenal were most suitable in differentiating rapeseed oil samples with different oxidative properties from each other. Clustering of rapeseed oil samples according to their volatile compound composition was comparable with results of sensory duo-trio and paired comparison tests, but the analytical approach of the volatile compound analysis in combination with chemometric methods detected changes sooner in relation to the flavor composition of rapeseed oils and high-oleic rapeseed oil samples.

Influence of gut microbiota and manipulation by probiotics and prebiotics on host tissue fat: potential clinical implications

Wall, R., *et al.*, *Lipid Technol. 24*:227–229, 2012.

The gut microbiota is considered as one of the most important environmental factors impacting host metabolism, contributing to variations in body weight, fat distribution, insulin sensitivity, and lipid metabolism. Modification of the gut microbiota by dietary interventions such as probiotics and prebiotics may favorably affect host lipid metabolism. We have shown that microbial metabolism in the gut, and its manipulation by administered microbes, can influence fatty acid composition of a number of organs in the host. Furthermore, a prebiotic approach was shown to alter polyunsaturated fatty acids in white adipose tissue. Although a deeper knowledge of the interactions between members of the gut microbiota and fatty acids is needed, nutritional modulation of this complex community may represent a realistic target for modification of host fatty acid composition.

Influence of different cultivation methods on carbohydrate and lipid compositions and digestibility of energy of fruits and vegetables

Jørgensen, H., *et al.*, *J. Sci. Food Agric. 92*:2876–2882, 2012.

Environmental as well as cultivation factors may greatly influence the chemical composition of plants. The main factors affecting the chemical composition of foodstuff are level and type of fertilizer (conventional and organic cultivation systems), location or soil type, and year of harvest. Organic foods are defined as products that are produced under controlled cultivation conditions characterized by the absence of synthetic fertilizers and very restricted use of pesticides. Very limited information is available regarding the impact of organic cultivation systems on the composition of carbohydrates and fatty acids of fruits and vegetables. The objective was to investigate the influence of organic and conventional cultivation systems on the carbohydrate and fatty acid composition and digestibility of the energy of apple, carrot, kale, pea, potato, and rapeseed oil. Carbohydrate and lignin values ranged from 584 g kg^{-1} dry matter (DM) in kale to 910 g kg^{-1} DM in potato, but with significant differences in the proportion of sugars, starch, non-starch polysaccharides, and lignin between the foodstuffs. Triacylglycerol was the major lipid class in pea, with 82% of total fatty acids, as opposed to apple, with only 35% of fatty acids of the ether extract. The most important factor influencing the digestibility of energy, and consequently fecal bulking, was the content of dietary fiber. The cultivation system had minor impact on the carbohydrate and lipid composition in the investigated foodstuffs or on the digestibility of energy when assessed in the rat model. Fecal bulking was related to dietary fiber in a linear fashion. ■

PATENTS

Apparatus and method for properly pre-measuring turkey frying oil

Jantz, E.L., US8256130, September 4, 2012

A way to safely fry turkeys by minimizing the hazard of overfilling oil, the Turkey Frying Oil Gauge (TFOG) comprises a device and method to properly pre-measure the frying oil used to fry whole turkeys. The Turkey Frying Oil Gauge is dual scale selectable for pot diameter and turkey weight. The turkey frying pot rim is measured and the size is selected on the gauge bottom. The mast is then slid out to view the weight of the turkey to be fried. The gauge is then placed in the bottom of the pot and frying oil is placed in the pot to the top of the gauge. The oil gauge is removed, the oil heated and the turkey introduced without overflowing the oil onto the heating flames.

Multi-layer-core golf ball having highly-neutralized polymer outer core layer

Rajagopalan, M., and M.J. Sullivan, Acushnet Co., US8257201, September 4, 2012

A golf ball including an inner core layer formed from a thermoset rubber composition and having a first surface hardness; a thermoplastic outer core layer having a second surface hardness, an inner surface hardness, and being formed from a copolymer of ethylene and an α,β-unsaturated carboxylic acid, an organic acid or salt thereof, and sufficient cation source to fully neutralize the acid groups of the copolymer; an inner cover layer; and an outer cover layer; wherein the first surface hardness is less than the second surface hardness by at least 5 Shore C and less than the inner surface hardness by at least 5 Shore C.

Etchant for etching metal wiring layers and method for forming thin film transistor by using the same

Chae, G.S., *et al.*, LG Display Co. Ltd., US 8257609, September 4, 2012

The present invention discloses an etchant for etching at least two different metal layers, the etchant comprising hydrogen peroxide (H_2O_2) and one of carboxylic acid, carboxylate salt, and acetyl group ($CH_3CO–$). The present invention also discloses a method of fabricating a metal wiring on a substrate, the method comprising forming a first metal layer on a substrate, forming a second metal layer on the first metal layer, and simultaneously etching the first metal layer and the second metal layer with an etchant comprising hydrogen peroxide (H_2O_2) and one of carboxylic acid, carboxylate salt, and acetyl group ($CH_3CO–$).

Microemulsion paint thinner

Hawes, C.L., *et al.*, W.M. Barr & Co., US8257484, September 4, 2012

A microemulsion paint thinner includes a hydrocarbon solvent, a glycol ether, a carboxylic acid, a base, and water, wherein the carboxylic acid is partially neutralized by the base. A process for thinning oil-based paint includes mixing uncured oil-based paint and the above composition.

Electrical cable for high voltage direct current transmission, and insulating composition

Perego, G., and E. Albizzati, Prysmian Cavi e Sistemi Energia S.R.L., US8257782, September 4, 2012

Cable for high-voltage direct current transmission having at least one conductor and at least one extruded insulating layer consisting of a polymeric composition of a polyethylene and at least one unsaturated fatty acid. Insulating composition having a polyethylene and at least one unsaturated fatty acid.

Composition for vulcanized rubber and vulcanization product

Otaka, T., *et al.*, Daiso Co., Ltd., US8258222, September 4, 2012

A composition for epihalohydrin vulcanized rubber excellent in heat resistance while keeping good vulcanization rate and store stability, comprising (a) an epihalohydrin robber, (b) a metal soap, (c) an acid acceptor, and (d) a vulcanizing agent, the composition further preferably containing (e) a fatty acid for suppressing vulcanization, or preferably containing (f) an alcohol for accelerating vulcanization.

Rubber composition for tire, and tire

Minagawa, Y., Sumitomo Rubber Industries, Ltd., US8258224, September 4, 2012

The present invention provides a rubber composition for a tire containing an epoxidized natural rubber, sulfur, and a fatty acid metal salt, in which the metal of the fatty acid metal salt is a metal belonging to Group 12, 13, or 14 of the periodic table. Here, the fatty acid metal salt is preferably at least one kind selected from the group consisting of zinc stearate, aluminum stearate, and tin stearate. Also, the present invention provides a tire manufactured by using the foregoing rubber composition for a tire.

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.

Supporting standards (cont. from page 15)

has a liaison relationship with SC 2, SC 4, SC 11, SC 16, and SC 17, providing further outlets for AOCS members' comments.

The ISO standards development process is beyond the scope of this article. For more on it, see the AOCS ISO/TC 34 Food Products Manual available at http://tinyurl.com/AOCS-Methods. This page has many other standards- and methods-related resources, such as discussions on the determination of precision of analytical methods.

World Trade Organization (WTO). The WTO deals with the rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably, and freely as possible. ISO, along with IEC (International Electrotechnical Commission) and ITU (International Telecommunication Union), has a "strategic partnership" with WTO. Organizations such as AOCS, which also produce methods in an open, consensus-drive manner, likewise provide standards for use by WTO.

Codex Alimentarius Commission (CAC). CAC, which was founded in 1963, is a joint project of two agencies of the United Nations: the Food and Agricultural Organization and the World Health Organization. In CAC's own words, the organization "develops harmonized international food standards, guidelines, and codes of practice to protect the health of the consumers and ensure fair trade practices in the food trade. The Commission also promotes coordination of all food standards work undertaken by international governmental and nongovernmental organizations."

AOCS participates as an international nongovernmental and standard-developing organization in the Codex Committee on Fats and Oils (CCFO), which meets biannually. Critical to AOCS' constituents are discussions on Named Vegetable Oils, Fish Oils and Olive Oil. AOCS also participates in the Codex Committee on Methods of Analysis and Sampling (CCMAS).

The Inter-Agency Meeting (IAM). AOCS serves as secretariat for IAM. This group organizes regular summits of international organizations working in the field of methods of analysis and sampling of food products and associated quality assurance measures prior to CCMAS meetings. There, they discuss mutual concerns and take positions on the CCMAS agenda. The group reports in the plenary sessions of CCMAS. Among the participants are AOAC International, AACC International, the European Committee for Standardization, ISO/TC 34, ISO Central Secretariat, and the International Dairy Federation. IAM also organizes an annual workshop prior to the CCMAS meeting, in tandem with the MoniQA Association. (MoniQA stands for Monitoring and Quality Assurance in the Total Food Supply Chain. MoniQA is hosted by the International Association for Cereal Science and Technology.)

Other work. AOCS also works on the standards harmonization efforts undertaken by several other organizations. These include ASTM International's Technical Committee D02 (Petroleum Products and Lubricants) and D12 (Soaps and Other Detergents).

Richard Cantrill, AOCS chief science officer and technical director, is a member of the Food Chemicals Codex of the US Pharmacopeial Convention and the Joint FAO/WHO Expert Committee on Food Additives of the Codex Alimentarius Commission.

ADVANTAGES OF INTERNATIONAL STANDARDS

ISO has studied the economic and social benefits of standards, and they are many. For example, in Canada, growth in the number of standards accounted for 17% of the labor productivity growth rate and about 9% of the growth rate in economic output (real gross domestic product, or GDP) over the 1981 to 2004 period. "If there had been no growth in standards in this period," noted Roger Frost in the *ISO Focus* magazine, "real GDP would have been CDN 62 billion lower."

Ray Shillito, manager, Technical Coordination, Seeds and Traits/Regulatory Science at BASF knows the advantages of participating in standard setting firsthand. Shillito currently serves as chairperson for ISO SC16. He says: "Having the right ISO standards in place is important for business as it encourages harmonized and practical policy outcomes. For example, standards for analytical methods are being developed by a broad range of experts. Involving experts from different organizations ensures that ISO standards are pragmatic and support the smooth operation of international trade in food, feed, and fiber."

"When you think about it," notes AOCS' Richard Cantrill, "our members have the opportunity to directly influence the quality and safety of goods that are bought and sold around the world."

For more information about participating in AOCS' standards-development efforts, contact Kimmy Farris, administrative manager for AOCS Technical Services, at kimmy.farris@aocs.org.

Catherine Watkins is associate editor of *Inform* and can be reached at cwatkins@aocs.org.

Governing Board Candidates for 2013–2014

Ballots for the election of the American Oil Chemists' Society Governing Board members are being sent to eligible members by mail or email in December. Completed ballots must be received (either electronically or via mail) at AOCS Headquarters (P.O. Box 17190, Urbana, IL 61803-7190 USA) by February 15, 2013. The new officers will be installed during the 104th AOCS Annual Meeting & Expo in Montréal, Québec, Canada, on Monday, April 29, 2013.

PRESIDENT CANDIDATE

Timothy G. Kemper (1988): Global Technology Director, Solvent Extraction, Desmet Ballestra Group.

Education: M.B.A., 2001, Indiana Wesleyan University; B.S., 1986, Mechanical Engineering, University of Cincinnati.

Previous Employment: President and CEO, Desmet Ballestra North America, 1999–2011; director of engineering, The French Oil Mill Machinery Company, 1993–1999; product manager, solvent extraction, The French Oil Mill Machinery Company, 1988–1992; project engineer, The French Oil Mill Machinery Company, 1986–1987; engineering co-op, The French Oil Mill Machinery Company, 1982–1985.

AOCS Activities: Vice President, AOCS Governing Board, 2012–present; treasurer, AOCS Governing Board, 2008–2012; member, CEO Search Committee, 2011; member, CEO Contract Committee, 2011; member, Audit Committee, 2008–present; member-at-large, AOCS Governing Board, 2006–2007; second vice chairperson, Technical Steering Committee (TSC), 2007; second vice chairperson, Financial Steering Committee (FSC), 2006–2007; AOCS Annual Meeting & Expo exhibitor, 1988–present; member, Processing Division, 1994–present; member, Processing Division Board, 1996–2002; session chairperson, AOCS Annual Meeting & Expo, 1996, 1998, 2000; presenter, AOCS Annual Meeting & Expo and short courses, 1988–2010; winner, Outstanding Paper Presentation, 1994, 2000; presenter, World Conference and Exhibition on Oilseed and Vegetable Oil Utilization, Istanbul, Turkey, 2002; presenter, SODEOPEC, Fort Lauderdale, Florida, 2005; presenter, Latin American Section of AOCS (LA-AOCS) Short Course, Rosario, Argentina, 2005; presenter, AOCS Biodiesel Short Course, Vienna, Austria, 2007; presenter, Biodiesel Conference, Munich, Germany, 2009.

Other: Member, Vistage CEO Organization, 2005–present; registered professional engineer, Ohio, 1993–present; inventor on seven US patents; presenter, Texas A&M Short Courses, 1987–present; presenter, IOMSA annual meetings, 2000, 2003, 2004, 2006, 2009, 2011; author, Oil Extraction chapter, *Bailey's Industrial Oil & Fat Products*, Sixth Edition, 2005.

Research Interests: New technologies to advance current best practice in oilseed preparation, oilseed solvent extraction, and oils refining.

VICE PRESIDENT CANDIDATE

Steven Hill (1987): Senior Director, Research and Nutrition, Kraft Foods, Northfield, Illinois.

Education: B.S., 1987, Food Science, Iowa State University; M.S., 1989 and Ph.D., 1992, Food Science, University of Illinois.

Previous Employment: Director, Cheese R&D, 2007–2012, director, Health and Wellness Policy, 2005–2007, associate director, R&D Sauces and Dressings, Kraft Foods, 2003–2005; section manager, R&D Strategic Research, Kraft Foods, 1999–2003; group leader, R&D Ingredient Technology, Kraft Foods, 1997–1999; senior scientist, R&D Oil Technology, Kraft Foods,

CONTINUED ON NEXT PAGE

1995–1997; scientist, R&D Product Development Oil Products, Kraft Foods, 1992–1995.

AOCS Activities: Secretary, AOCS Governing Board, 2007–2009, treasurer, AOCS Governing Board, 2003–2007; member-at-large, AOCS Governing Board, 1999–2003; associate editor, *Inform*, 1992–2001; chairperson, *JAOCS* Editor-in-Chief Search Committee, 2000; chairperson, AOCS Governance Committee, 2001–2002; member, Publications Steering Committee (PSC), 2002–2003; member, Financial Steering Committee (FSC), 2001–2002; member, Technical Steering Committee (TSC), 1999–2000; member, Information Technology Management Committee, 1999–2002; member, Campaign AOCS Committee, 1999–2001; local Committee member, 1995 and 1996 Annual Meetings; vice technical chairperson, 1998 Annual Meeting; member, *Inform* Editor-in-Chief Search Committee, 1997; member, Edible Application Technology and Lipid Oxidation & Quality Divisions, 1997–present; president, North Central Section, 1998; vice president, North Central Section, 1997; board member-at-large, North Central Section, 1992–1996; chairperson and member, A.E. Bailey Award Selection Committee, 1998–2001.

Other: Fellow, AOCS, 2012; member, University of Illinois Food Science Human Nutrition External Advisory Board; adjunct assistant professor, University of Illinois, department of Food Science and Human Nutrition, 1993–2000; member, Iowa State University Food Science and Human Nutrition Advisory Board, 2002–present; AOCS Honored Student Award, 1991; AOCS Ralph Potts Fellowship Award, 1990; passionate advocate for enhanced AOCS membership services.

Research Interests: Lipid oxidation in food systems; oilseed processing; nutritional lipids related to foods and health.

CANDIDATE'S STATEMENT

Nearly 25 years ago, I chose to join AOCS and become an active contributor to the organization through committees, program development, Section leadership, and Governing Board membership. Having been involved in various aspects of AOCS leadership over the years, most recently as your Secretary and Treasurer, I am especially pleased and honored to be nominated as a candidate for Vice President.

My career in fats and oils began in the United States at the University of Illinois where I studied soybean oil chemistry and processing. I was introduced at that time to not only the field of fats, oils and related materials, but also to the AOCS organization, staff and programs. My major professor, Dr. Ed Perkins, had just completed his term as AOCS President. Thus, in addition to my graduate research, I was also getting an advanced education in how to be a contributing volunteer and leader for AOCS.

My service to AOCS has never been more rewarding than the past 10 years. During that time, the AOCS Board and staff have addressed an agenda of organizational change based upon an assessment of member programs and benefits. This assessment was developed from an in-depth evaluation of the overall AOCS business model under the guidance of AOCS financial committees in which I was involved. This effort was, at times, challenging as many difficult Society issues were addressed. However, the overall experience has been rewarding to me professionally and personally, as the outcomes of the work are now being successfully implemented to better the Society.

Over the past 104 years, AOCS has developed a global reputation built on technical excellence. From its origins as a small group of chemists who had a common interest in cottonseed research, AOCS has grown into a global network of scientists who have developed and sustained the Society's stellar reputation. The future looks bright as the Society has positioned itself to provide new programs, products, and opportunities for members to publish, present, and form critical alliances. The Society is able to focus on these opportunities because of a combination of a solid financial base, a skilled and experienced staff, and a group of motivated volunteers from around the world.

During the past several years, I have been very involved with, and concerned about, Society finances. Securing a firm financial foundation has been critical for a successful AOCS. I believe we are well on our way to building a stronger financial base from which we can draw to support a renewed focus on membership value.

AOCS "value" is defined in many ways. I believe value can be delivered to members through new and enhanced products. This is one of the reasons why the Governing Board decided to form a strategic publishing partnership. This very important decision positions the Society to grow its journals' prestige and circulation by leveraging the global reach of the world's second largest science, technical and medical publisher. It will also provide a number of new value-added features for the subscriber, such as greater accessibility through searchable back issue databases, and enhanced aspects for those interested in publishing, such as online peer review and increased speed from submission to publication. I am a strong supporter of selectively identifying and choosing opportunities which are aligned with AOCS strategies, and will enhance member benefits.

Similarly, I believe in the many Society initiatives that have been increasingly adding more value to AOCS programs. One example is the integration of Division programming and planning with the Annual Meeting, which has contributed to highly successful and technically relevant annual meetings. It is interesting the term "Divisions" indicates separating, yet the approach used for developing the Annual Meeting actually unites people together. I am convinced that Divisions are an important force which allows AOCS to be a global forum for the exchange of ideas, information, and experience among those with a professional interest in the science and technology of fats, oils, surfactants, and related materials.

I have always understood AOCS to be the place to meet people who are involved with the sciences and technologies that are shaping the fields all of us are involved in. This is what first attracted me to the Society, and is what has kept me active in it. I am excited about the future of AOCS, and the opportunities that exist for members. As Vice President, I plan to work closely with Tim Kemper, a colleague I deeply respect for his wisdom and passionate advocacy for AOCS. I will work with other Society leaders and staff to improve and advance AOCS strategies, strengthen its programs and products, and promote the global reputation of our Society. It will be a true honor for me to serve AOCS.

TREASURER CANDIDATE

W. Blake Hendrix (1981): Consultant, Dynamic Engineering Inc., The Woodlands, Texas.

Education: B.S., 1975, chemical engineering, Pennsylvania State University.

Previous Employment: Consultant, Agribusiness and Water Technology, Inc./Hendrix Consulting, LLC, Omaha, Nebraska, 2008–2011; vice president of operations, Everton Energy, LLC, 2006–2008; vice president of operations processing and refining, Ag Processing Inc., Omaha, Nebraska, 2001–2006; business manager, fats and oils, Alfa Laval Inc., 1996–2001; engineering manager, Tetra Laval Food Fats & Oils, 1992–1996; process engineer and vice president of engineering, Johnson-Loft Engineers, Inc., 1984–1992; process engineer, Sullivan Systems Inc. (subsidiary of Alfa Laval), 1978–1984; production supervisor, Hunt-Wesson Foods, 1975–1978.

AOCS Activities: Treasurer, AOCS Governing Board, 2012–present; member, Executive Committee, 2012–present; member, Business Development Committee (formerly Financial Steering Committee), 2002–2005 and 2009–present; member-at-large, AOCS Governing Board, 2002–2005; member, Membership Steering Committee, 2005–2006; member, Technical Steering Committee, 2003–2004; chairperson, Budget Committee, 2004–2005; member, Budget Committee, 1998–2004; vice president, Northern California Section, 1997–1998; member, Sections Committee, 1990–1991.

Other: Registered professional engineer, chemical engineering, California, 1985.

MEMBER-AT-LARGE CANDIDATES

Douglas M. Bibus (1994): Community Faculty, Center for Spirituality and Healing, University of Minnesota; president, Lipid Technologies, LLC; director, Holman Center for Lipid Research.

Education: B.S., 1991, Chemistry, Mankato State University, Mankato, Minnesota; M.S., 1995, nutrition, University of Minnesota, Minneapolis, Minnesota; Ph.D., 1998, nutritional biochemistry, University of Minnesota, Minneapolis, Minnesota.

Previous Employment: Assistant Scientist, Scientist, and Fellow, Hormel Institute at the University of Minnesota, 1986–2002; research assistant, Department of Surgery, University of Minnesota, 1990–1997; scientist, Surgical Research, St. Paul-Ramsey Medical Center, 1989–1997.

AOCS Activities: Member-at-Large, AOCS Governing Board, 2011–present; chairperson, AOCS Awards Administration Committee, 2003–2009; director, AOCS Foundation, 2003–2009; member, Membership Steering Committee (MSC), 2003–2012; chairperson, Health and Nutrition Division, 2006–2008; vice chairperson, Health and Nutrition Division, 2004–2006; Division representative to Membership Development Committee, 2002–2004; treasurer, Health and Nutrition Division, 2000–2003.

Other: AOCS Honored Student Award, 1994; member, American Chemical Society; member, International Society for the Study of Fatty Acids and Lipids; awardee, American Chemical Society Award in Analytical Chemistry, 1990 and 1991; scientific advisor, Essential Nutrient Research Corporation (ENRECO); scientific advisor, Coromega, Inc.

Research Interests: The role of essential fatty acids in human and companion animal nutrition; role of omega-3 fatty acids in the down-regulation of the inflammatory response; role of polyunsaturated fatty acids in disease and the role of omega-3 fatty acids in mood disorders; oxidative adaptation of living systems and its implications in atherogenesis; role of polyunsaturated fatty acids in tumor incidence and promotion; neuro-psychiatric implications of nutrients in aggression models; analytical techniques for determining lipid and fatty acid content in tissues and food products.

Carol J. Lammi-Keefe (1997): Alma Beth Clark Professor and Head, Human Nutrition and Food, School of Human Ecology and Adjunct Professor, Pennington Biomedical Research Center, Louisiana State University, Baton Rouge, Louisiana.

Education: B.S., 1969, Biochemistry, University of Maine, Orono; M.S., Biochemistry, University of Illinois Graduate School at the Medical Center, Chicago; Ph.D., 1971; Food Science and Nutrition, University of Minnesota, St. Paul; Postdoctoral Fellowship, 1980–1981, Hematology, Department of Medicine, University School of Medicine, Minneapolis.

Previous Employment: Assistant Professor, 1981–1988, associate professor, 1988–1995, professor, 1995–2006, acting department head, 1997–1998, department head,

CONTINUED ON NEXT PAGE

INSIDE AOCS

1998–2002, Department of Nutritional Sciences, University of Connecticut, Storrs.

AOCS Activities: Chairperson, Health & Nutrition Division, 2010–2012; member, Division Council, 2009–2012; vice chairperson, Health & Nutrition Division, 2009–2010; chairperson, Awards Administration Subcommittees for Health & Nutrition Division Posters, the Holman Lifetime Achievement Award, and the Health & Nutrition Division Student Excellence award, 2010–2012; Division representative, Annual Meeting Program Committee, 2008–2009; secretary, Health & Nutrition Division, 2008–2009; chairperson and co-chairperson for scientific sessions.

Other: Rainmaker, Louisiana State University, 2009–2010; co-editor, *Handbook of Nutrition and Pregnancy*; member, Provost's Commission on Status of Women, University of Connecticut, 2004–2005; member-at-large, USDA Northeast Regional Research Technical Committee, 2004–2006; University of Connecticut Chancellor's Research Excellence Award, 2003; member, President's Research Administration Committee, University of Connecticut, 2003–2005; American Dietetic Association Foundation Award for Excellence in Research, 2002; Ross Award in Women's Health, The American Dietetic Association Foundation, 2001; member, Task Force on Building a Science Roadmap, National Association of State Universities and Land-Grant Colleges and Experiment Station Committee on Organization and Policy, 2001; member, Chancellor's Task Force on Research Policy, University of Connecticut, 2001–2002; president, Association of Nutrition Department Programs (ANDP), 2001–2002; member, Executive Committee, International Society for Research on Human Milk and Lactation (ISRHML), 1993–1994; chairperson, Northeast Regional Technical Research Committee, 1993–1994; Vice-Chairperson, Northeast Regional Technical Research Committee, 1991–1991; visiting scientist, NCI, NIH, Bethesda, MD, 1989; Consultant, NASA Advisory Council, 1980.

Research Interests: Lipids in human health with focus on maternal-fetal health and wellness; emphasis on the long-chain polyunsaturated fatty acids and impact on adiposity, inflammatory response, endocannabinoids, infant neurodevelopment, maternal postpartum depression.

Michael A. Snow (2003): Industrial Director, Bunge North America, St. Louis, Missouri.

Education: B.S., 1980, Agricultural Engineering, Texas A&M University.

Previous Employment: Manager, Oilseed Processing Division, Bunge, 2004–2006; operations support manager, Oilseed Processing Division, Bunge, 2003–2004; facility manager, Council Bluffs, Iowa, Bunge, 1999–2003; facility manager, Cairo, Illinois, Bunge, 1989–1999; plant engineering and department manager, Cairo, Illinois, Bunge, 1986–1989; plant engineer and assistant plant manager, Destrehan, Louisiana, Bunge, 1980–1982.

AOCS Activities: Member-at-Large, AOCS Governing Board, 2011–present; member, Processing Division; chairperson, Processing Division, 2008–2010; vice chairperson, Processing Division, 2006–2008; member, Proven Practices Ad Hoc Committee, 2009; Processing Division presenter and regular technical session co-chairperson.

Other: Member, National Oilseed Processors Association Technical Safety and Environmental Committee (TESH), 2003–2007; Chairman, TESH Technical and Research Subcommittee, 2004–2007; Member, Bunge Global Productivity, Quality, Safety and Environmental Steering Committee, 2008–present, Member, Texas A&M University Biological and Agricultural Engineering Department External Advisory Council, 2012–2014.

Manfred Trautmann: Vice President and General Manager BU Emulsions, Detergents & Intermediates, Clariant International, Muttenz, Switzerland.

Education: B.Sc., 1976, Chemical Engineering, University of Darmstadt, Germany.

Previous Employment: Global Head of Marketing & Sales, RBU Detergents & Intermediates, 2007–2009; head of new business development, Business Unit Detergents, 2000–2007; global marketing & sales manager, Detergents, Personal Care and Plant Protection Additives Business of the Surfactants/FUN Division during the transition of Hoechst to Clariant, 1996–2000; product manager, national accounts manager, and marketing manager, Detergents and Personal Care Business of American Hoechst/Hoechst Celanese, North America, Charlotte, North Carolina, 1986–1996; application manager, Detergents and Personal Care in R&D, Hoechst AG, 1979–1986; project engineer in the Hoechst Engineering Department, 1976–1979.

AOCS Activities: Member-at-Large, AOCS Governing Board, 2011–present; presenter, speaker, and/or co-author, various AOCS Annual Meeting & Expos; member, Executive Committee, 7th World Conference on Detergents (Montreux Conference), 2010; member, Organizing Committee, 5th and 6th World Conference on Detergents (Montreux Conference), 2002, 2006.

Other: Member, Organizing Committee, CESIO 2004, Berlin, Germany.

Research Interests: Green chemistry, including chemicals and/or intermediates derived from bioethanol, biodiesel, and glycerol. ■

Biotechnology News (cont. from page 30)

products in 2004 and in food in 2005.) The researchers announced that the rats (i) had a higher incidence of cancers, (ii) had larger cancerous tumors, and (iii) died earlier than controls. The authors summarized their results, saying, "These results can be explained by the nonlinear endocrine-disrupting effects of Roundup [glyphosate], but also by the expression of the transgene in the GMO and its metabolic consequences."

The dire health effects reported by Séralini and co-workers do not correspond with those from about a dozen other long-term studies of different GM crops (Snell, C., *et al.*, *Food Chem. Toxicol. 50*:1134–1148, 2012).

The experiments of Séralini and co-workers involved feeding Sprague-Dawley rats for two years (i) with isogenic non-transgenic (control) corn, (ii) with NK603 corn—at three different levels–that either had or had not been treated during the growing season with glyphosate, and (iii) with isogenic non-transgenic corn and with glyphosate in their drinking water. According to the authors, this is the first study to look at long-term effects of NK603 consumption in rats, whose lifespans are about two years. Earlier, Monsanto had sponsored a 90-day feeding trial of NK603 in rats, the current regulatory norm.

Responses to the release of this paper were swift. For example, Russia halted all imports of US corn, which has GM constituents. The European Food Safety Agency (EFSA; Parma, Italy) reviewed the paper and concluded it was "of insufficient scientific quality to be considered as valid for risk assessment (http://tinyurl.com/EFSA-review)." Furthermore, the EFSA review found "that the design, reporting and analysis of the study . . . are inadequate."

In its review, EFSA identified issues with the strain of rat used (Sprague-Dawley rats are prone to developing tumors during their life expectancy, no matter what they are fed, particularly if their food intake is not restricted), inadequate controls, noncompliance with standard protocols (such as those developed by the Organisation for Economic Cooperation and Development), insufficient number of experimental animals, inadequate statement of objectives of the experiments, absence of data on the composition of the food given to the rats or on the analysis for the presence of harmful substances in the food, absence of data on volume of food and water consumed, and questionable statistical analysis. EFSA reported sending two letters to Séralini, one dated October 4 and another on October 18, requesting further data to use in its evaluation on any safety issues involved with NK303. On October 22, EFSA said it had not yet received a response (www.efsa.europa.eu/en/press/news/121022.htm).

Séralini responded in the press by saying he and his co-workers would not release their data until EFSA released the data it had used to authorize the approval of NK603 in Europe. According to FoodNavigator.com on October 22, EFSA complied with this request.

Many other scientists questioned the study's methodology and findings. More than 700 scientists and academics signed a petition urging Séralini and co-workers to release the study data (www.ipetitions.com/petition/dr-seralini-please-release-data/signatures). If the data were not forthcoming, the petitioners urged that the paper be retracted from *Food and Chemical Toxicology.*

Elsevier responded on November 7 by publishing 16 letters critiquing the study online alongside the original paper by Séralini and co-workers (http://tinyurl.com/16responses). On November 9, Elsevier published the authors' responses to these critiques (http://tinyurl.com/ResponseSeralini). There, the authors tabulated their rebuttals to their critics and promised further publications on the subject.

In an EFSA statement issued on November 28, Per Bergman, director of scientific evaluation for regulated products directorate at EFSA, said: "EFSA's analysis has shown that deficiencies in the Séralini *et al.* paper mean it is of insufficient scientific quality for risk assessment. In addition, several national organisations were independently mandated by Member States to assess this study. These reviews have demonstrated a consensus among a significant part of the EU risk assessment community that the conclusions of Séralini *et al.* are not supported by the data in the published paper. We believe the completion of this evaluation process has brought clarity to the issue."

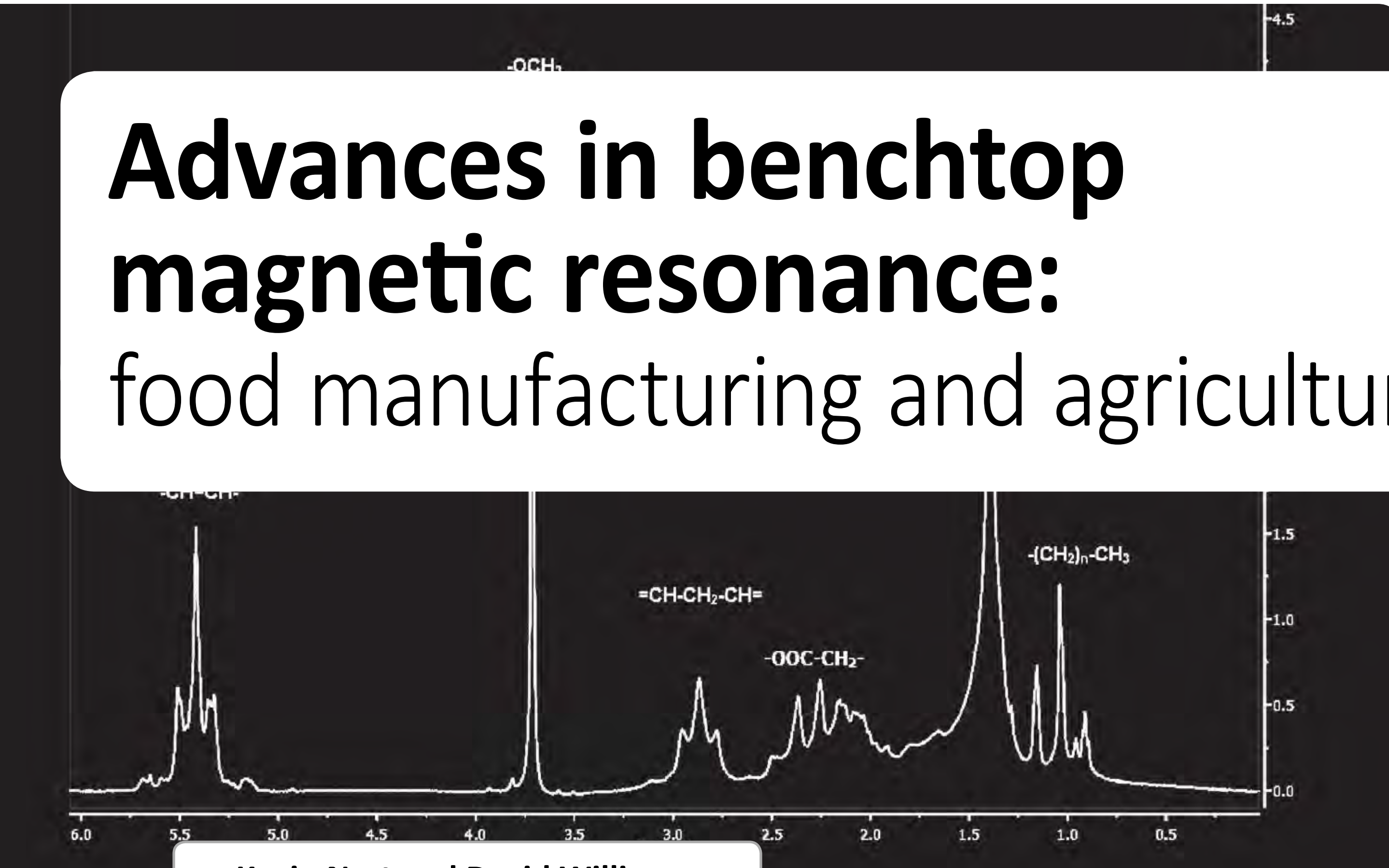
Another aspect of this report that struck a sour note was the orchestrated manner in which Séralini released it at a press conference on September 19. The paper had been embargoed until that conference, and the journal *Nature* reported that science writers given pre-embargo access were required to sign a confidentiality agreement that prevented them from seeking outside comments from scientific experts in advance of the study's release, an unusual requirement (*Nature 490*:158, 2012). On September 26, Séralini's book *Tous Cobayes?* [translation: *All of Us Guinea-Pigs Now?*] was released. It describes his efforts to show in the laboratory the long-term toxic effects of genetically modified (GM) food and pesticides. There is also an accompanying film by the same name and a television documentary.

Séralini is a molecular biologist with the University of Caen, France, and heads the scientific board of the Paris-based Committee for Research Independent Information on Genetic Engineering (CRIIGEN). Séralini carried out the research in collaboration with CRIIGEN, which says in Article 3 of its Articles of Association that its objective is "To carry out research and provide information on genetic engineering and its impact in the fields of biology, the environment, agriculture, food, medicine and public health."

Lively accounts of the issues involved as they developed appear at http://tinyurl.com/Science2-0-Seralini and at http://tinyurl.com/Forbes-scientists. ■

CLASSIFIED

Advances in benchtop magnetic resonance: food manufacturing and agriculture



Kevin Nott and David Williamson

There has been and always will be a need for rapid measurement techniques, especially ones that drive innovation, quality, and efficiency in food and agricultural production. Magnetic resonance techniques have been at the forefront of food research and quality control for decades largely due to the introduction of pulsed nuclear magnetic resonance (NMR) instrumentation, which provides qualitative advantages of increased sensitivity and flexibility (as compared to continuous wave NMR). However, NMR offers another advantage: It can make data analysis simple and transparent, leading to more reliable quantitative measurements.

- **Measuring oil content by solvent/Soxhlet extraction is time consuming and can be costly in terms of labor, solvent purchase, and solvent disposal. The results also tend to be variable, as they are operator dependent.**
- **Benchtop NMR relaxometry is nondestructive, rapid, repeatable, and solvent-free. It can also easily distinguish between solid and liquid fat.**
- **Benchtop NMR is becoming more accessible due to new fats- and oils-related applications and a recent trend toward more cost-effective instrumentation.**

SIMPLE AND ACCURATE OIL CONTENT MEASUREMENT

While routinely accepted as the "gold standard," measurement of oil content by solvent/Soxhlet extraction is time consuming and often costly in terms of labor, solvent purchase, and solvent disposal. The results tend to be variable, as they are operator dependent, and it is not possible to extract all of the oil needed to provide a complete representation of the oil content without adding an additional acid hydrolysis procedure to break down the matrix. This additional step significantly lengthens and complicates the analysis.

Benchtop NMR relaxometry is a well-established technique that has been successfully adopted and used to measure oil content in food and agricultural products over many decades. Benchtop NMR relaxometry instrumentation uses permanent magnets and is therefore cryogen-free. Additionally, NMR relaxometry measurements have many advantages over traditional methods including being nondestructive, rapid, repeatable, and solvent-free. As with near infrared (NIR) spectroscopy, NMR is often calibrated to "'match" the results generated by solvent extraction. However, unlike NIR, NMR makes it possible to set up a primary calibration using the oil of interest, as the signal is directly and linearly related to hydrogen content.

A comparison of the results generated from Soxhlet extraction and an NMR oil calibration is given in Figure 1.

Note that the NMR results are typically higher than those from Soxhlet; this is because NMR measures all the oil, whereas Soxhlet does not measure the unextracted oil. The latter is not constant and accounts for scatter in the data. This scatter cannot be corrected using a calibration bias. Subsequently, the unextracted oil content in the Soxhlet residue was measured using NMR and a correction was applied to the individual Soxhlet results (Fig. 2).

The most noticeable feature is that the scatter is reduced, as indicated by the improved correlation (R^2). Secondly, there is now a direct correspondence between the NMR and corrected Soxhlet results; that is, the line goes through the origin. This demonstrates that not only can NMR accurately measure oil content in the residue, for optimization of the crushing/extraction process, but also it can measure "total" oil content from a sample of the oil-producing crop. This is typically measured by solvent extraction after an acid hydrolysis step. It is also possible to simultaneously measure moisture content by NMR provided it is less than a nominal value of 10% for which there are AOCS/ISO methods for a variety of oilseeds and their residues (1–4).

TRADITIONAL SOLID FAT CONTENT MEASUREMENTS VS. ISOTHERMAL CRYSTALLIZATION

Solid fat content (SFC), for which there are AOCS/ISO methods (5,6), is another measurement at which benchtop NMR excels because it can easily distinguish between solid and liquid fat. Samples are fully melted to remove their thermal history, then frozen before measuring the melting profile equilibrated at different temperatures (3,4). Whereas each NMR measurement is rapid (usually no more than eight seconds), it takes at least three to four hours to obtain a melting profile owing to the necessity for thermal equilibration times.

An alternative method, isothermal crystallization, requires the sample to be heated, usually to 75°C, then placed in the NMR probe thermally stabilized at 25°C. SFC is measured continuously as the oil crystallizes during cooling. Typical results for a palm oil sample are shown in Figure 3. Isothermal crystallization gives complementary information that is often faster to obtain than the traditional AOCS method. In this case, palm oils from different geographical locations give vastly different crystallization profiles.

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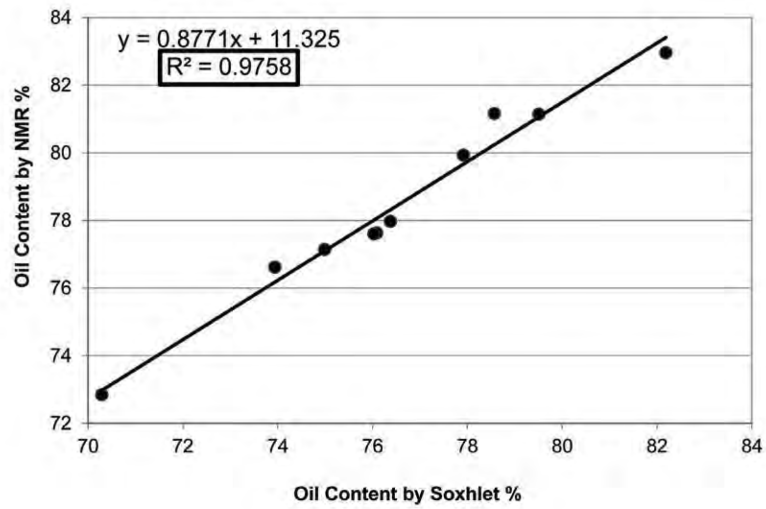

FIG. 1. Comparison of nuclear magnetic resonance (NMR) relaxometry vs. Soxhlet extraction shows offset and scatter due to oil not extracted by Soxhlet.

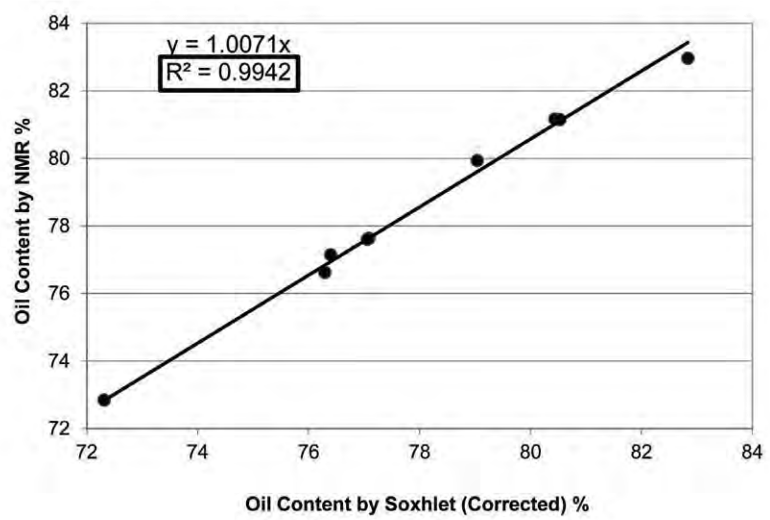

FIG. 2. Results from NMR vs. Soxhlet corrected for unextractable oil show direct 1:1 correlation and reduced scatter. For abbreviation, see Figure 1.

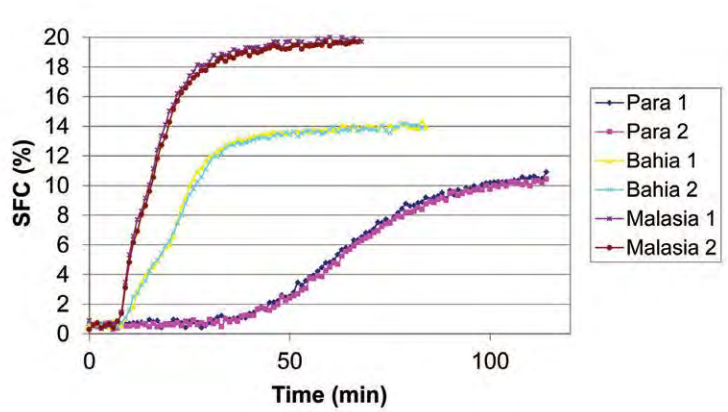

FIG. 3. Profiles of solid fat content (SFC) vs. time for various palm oils from different geographical regions during isothermal crystallization.

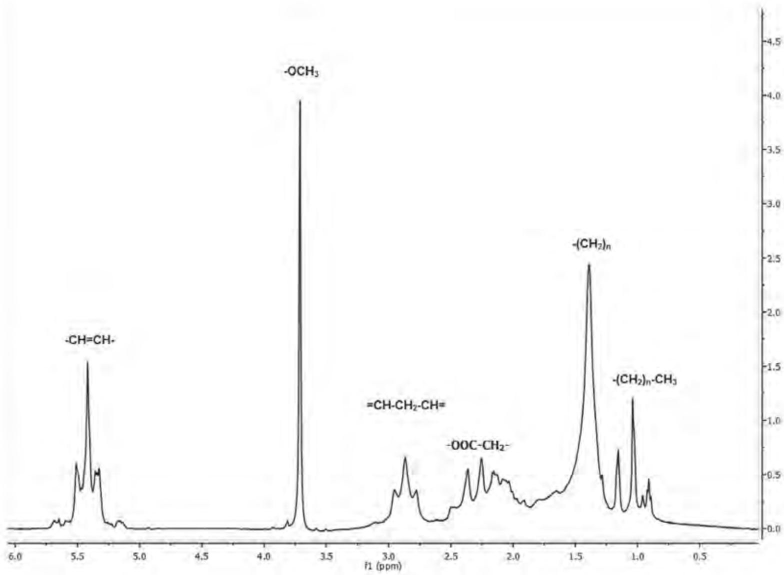

FIG 4. ^{1}H NMR spectrum of methyl linolenate collected at 1.4 T (60 MHz). Despite the smaller frequency dispersion at 60 MHz, quantification of double bond protons (–CH=CH–) and bis-allylic (=CH–CH$_2$– CH=) protons is still possible using the methoxy group (–OCH$_3$) as an internal reference. Further quantitative information could be extracted using a spectral deconvolution approach. For abbreviation, see Figure 1.

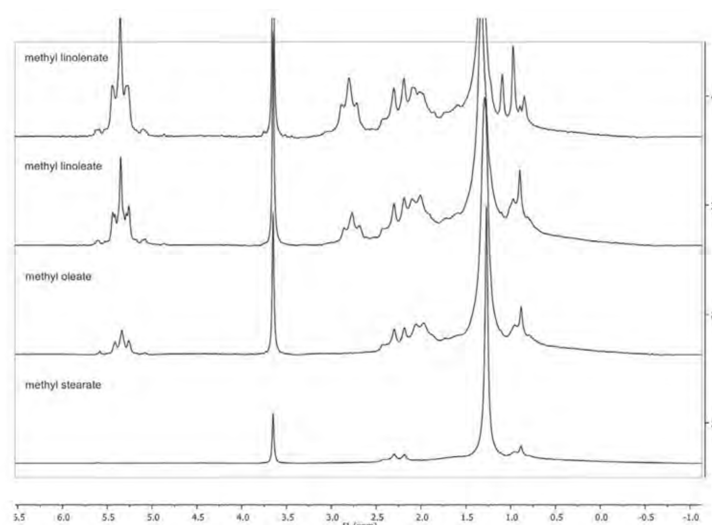

FIG. 5. ^{1}H NMR spectra of methyl stearate, methyl oleate, methyl linoleate, and methyl linolenate collected at 1.4 T (60 MHz). For abbreviation, see Figure 1.

TOWARD ACCESSIBLE MAGNETIC RESONANCE

Other magnetic resonance techniques provide additional information to that described above, but they are traditionally expensive to purchase and maintain. Also, their size and complexity usually prevent them from being used in quality control laboratories. More recently there has been a growing "back-to-basics" movement addressing the need for high-performance, low-cost, and, where possible, mobile magnetic resonance instrumentation.

For example, electron magnetic resonance (EMR), also known as electron spin resonance (ESR) or electron paramagnetic resonance (EPR), which is usually confined to advanced research applications and expert users using large electromagnets, is now available as low-cost benchtop instrumentation. EMR directly detects free radicals down to submicromolar concentrations (7). Radicals occurring in oils/fats are the initiators in lipid oxidation reactions and are therefore early indicators.

However, despite the sensitivity of the technique, radicals by their very nature are reactive and can have very short lifetimes. Consequently, a spin trap such as α-phenyl-*tert*-butyl nitrone (PBN) is added. PBN forms a spin adduct, which allows detectable concentrations to accumulate. The oil/fat may also be heated to accelerate the oxidation process. This enables a rapid measurement of the rate of radical formation, which provides an indicator of the oxidative stability of the oil.

Over the last year there has been a surge of interest in NMR spectroscopy at magnetic fields around 1–2 teslas (T) corresponding to ^{1}H frequencies of 45–90 MHz. Spectrometers at these fields, which are usually designed around a permanent magnet, offer several practical advantages over the higher-field spectrometers, which are commonly designed around super-conducting magnets. These advantages relate to simplicity of use and low running costs—particularly with respect to liquid helium, which is becoming scarce and consequently increasingly expensive—but come at the cost of signal sensitivity and spectral dispersion. Despite the loss of peak separation, the ^{1}H spectrum of methyl esters, for example, still contains a significant amount of quantifiable information that can be extracted by peak integration or use of spectral deconvolution methods. The ^{1}H spectrum of methyl linolenate obtained at 1.4 T (60 MHz proton frequency) is shown in Figure 4.

Several of the characteristic resonances are labeled, in particular, the olefinic resonances (–CH=CH–), the methoxy resonance (–OCH$_3$), the bis-allyllic resonance, and the methylene group sandwiched between two double bonds (=CH–CH$_2$–CH=). These resonances are particularly useful for determining the unsaturated character of a biodiesel, which has implications

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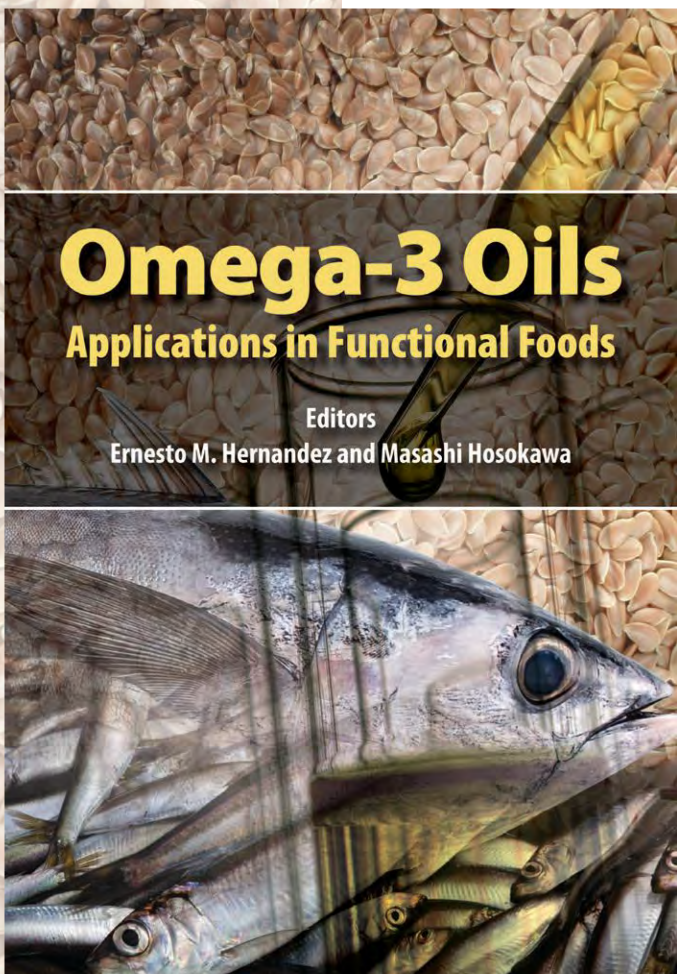
Book of the Month



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Ernesto M. Hernandez & Masashi Hosokawa, Editors
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This book addresses new applications of omega-3 fatty acids from both plant and marine sources in food supplements and pharmaceuticals and covers three basic areas: structure and function, production and processing, and health effects. The authors review the latest clinical evidence on the impact of consumption of omega-3 polyunsaturated fatty acids on prevalent human diseases such as inflammation-related illnesses in general and cardiovascular illnesses in particular. They also examine technologies to purify marine oils and protect them against oxidation as well as novel techniques for their incorporation into foods.

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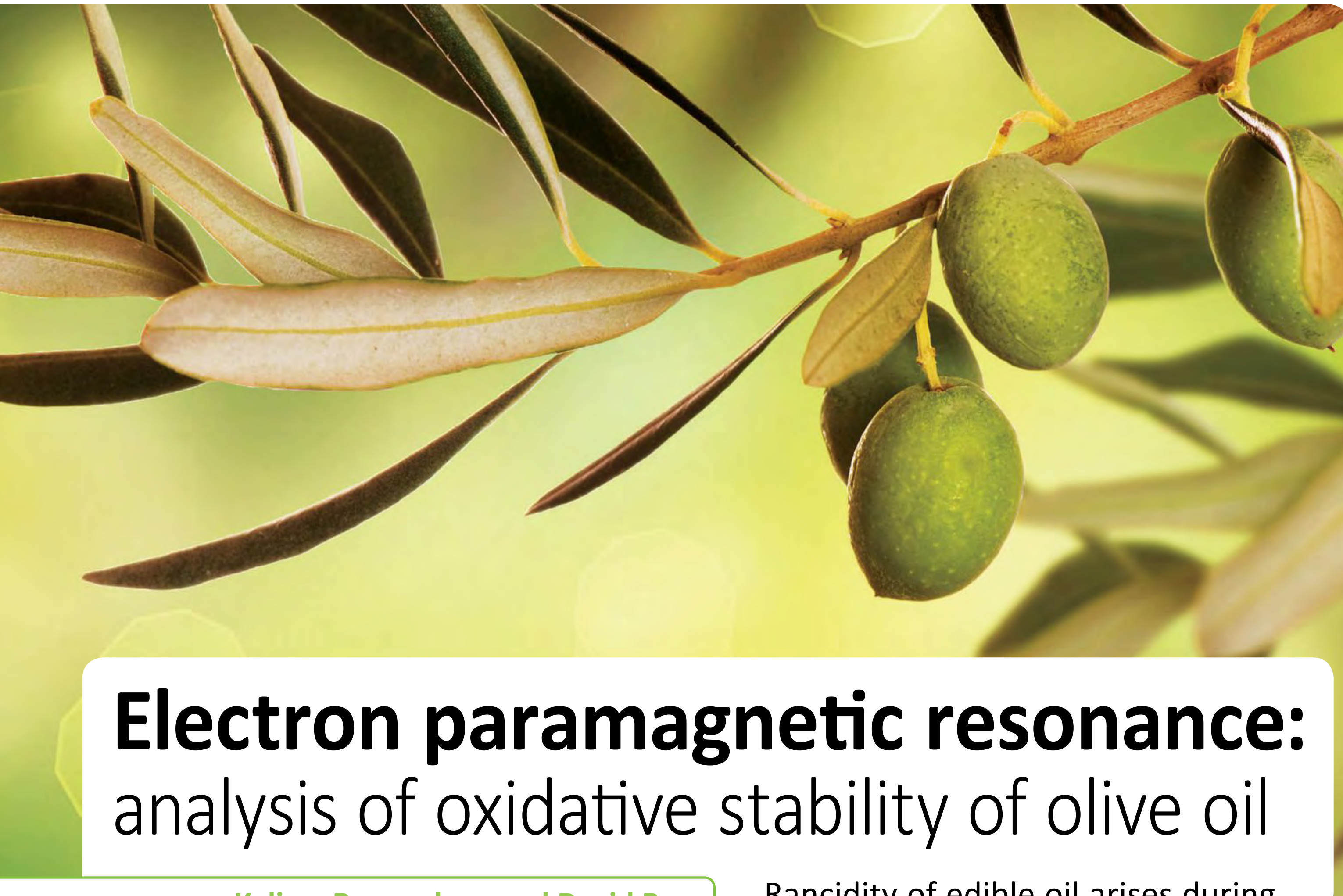

Electron paramagnetic resonance: analysis of oxidative stability of olive oil

Kalina Ranguelova and David Barr

- Stability testing of edible oils at storage conditions is often too slow for practical use in quality control, so such tests are often performed at elevated temperatures and other conditions that in themselves cause oxidation.

- Stability or rancidity is usually assessed by measuring the lipid peroxides and hydroperoxides that form during the initial stages of oxidation; however, variability when peroxide levels are low makes it difficult to reliably determine an oil's shelf life.

- Studies using olive oil showed that electron paramagnetic resonance (EPR) analysis is more sensitive than peroxide value (PV) analysis, because it measures free radicals before hydroperoxide formation and after hydroperoxide decomposition.

Rancidity of edible oil arises during storage or transport and is due to the free radical-mediated oxidation of unsaturated fatty acids. It occurs in three well-documented phases: (i) initiation, (ii) propagation, and (iii) termination. The oxidized compounds that result at the end of the process give the oil an undesirable odor and taste. This free radical lipid oxidation process affects quality and determines, in many cases, the shelf life of the oil.

Hydroperoxides form during the initiation phase and are commonly measured to monitor the oxidative status of an oil sample. It is assumed that hydroperoxide groups attach to the carbon atoms of unsaturated fatty acids and that, subsequently, the breakdown of hydroperoxides propagates the chain reaction. Currently, the AOCS Olive Oil Expert Panel is looking for new rapid and reliable methods to measure oxidative stability and predict shelf life, and to evaluate the efficacy of protective methods (such as antioxidant addition). Oxidative stability is affected by a number of factors, such as oxygen, temperature, presence of metals, and light. Transition metals, especially iron and copper, are known contaminants of olive oil and act as pro-oxidants by catalyzing both the generation of free radicals and the decomposition of hydroperoxides.

During the propagation phase, hydroperoxides combine with other fats to form additional reactive products. Hydrocarbons, aldehydes, and ketones are the typical end products that form during the termination phase and are the primary compounds detected as "rancidity." These compounds are volatile, easily detected by the human nose, but are relatively unreactive.

Recently, the overall quality of extra virgin olive oil (EVOO) has become of particular interest due to the complexity of its distribution channels around the world and the fact that it is an individually packaged product (its final quality reflects either positively or negatively on the producer). The resistance of EVOO to oxidation is related to the high levels of monounsaturated triacylglycerols and the presence of natural phenolic antioxidants.

Figure 1 provides an example of a free radical chain reaction that leads to rancidity. It starts with the oxidation of fatty acids to various fatty acid free radicals.

These free radicals are usually carbon centered and react rapidly with oxygen to form alkylperoxyl radicals. Alkylperoxyl radicals propagate further free radical formation by abstracting hydrogen atoms from other fatty acids. The alkylperoxyl radicals are converted to hydroperoxides that either undergo thermolysis or react with metals to form alkoxyl, alkylperoxyl, and carbon-centered free radicals. This free radical chain reaction proceeds until it is terminated by an antioxidant. Antioxidants "intercept" a propagating free radical by donating an electron. A "good" antioxidant is oxidized to a stable nonreactive form. If the free radical process is not terminated in its early stages, rancid flavor products (i.e., aldehydes, ketones, and alcohols) will form.

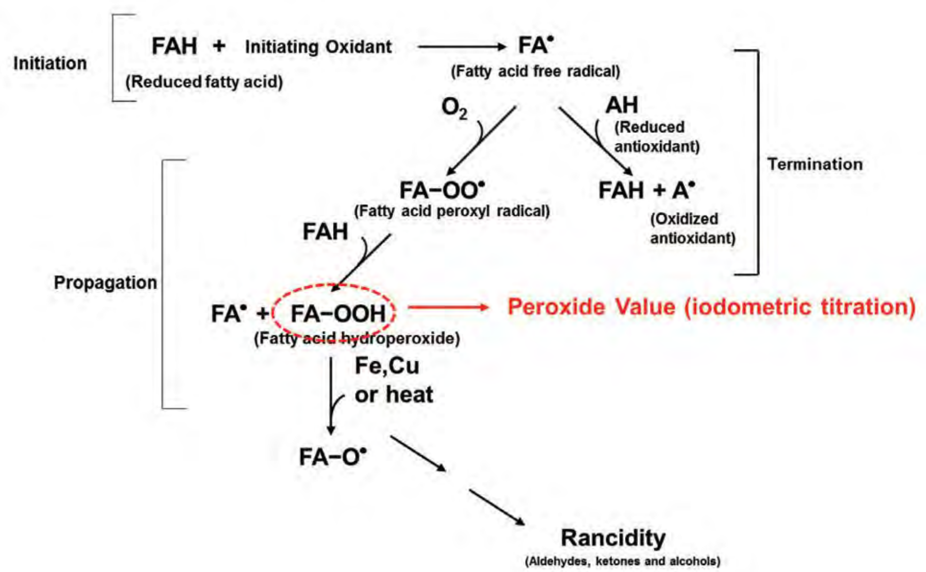

FIG. 1. Simplified scheme for the free radical degradation of a fatty acid.

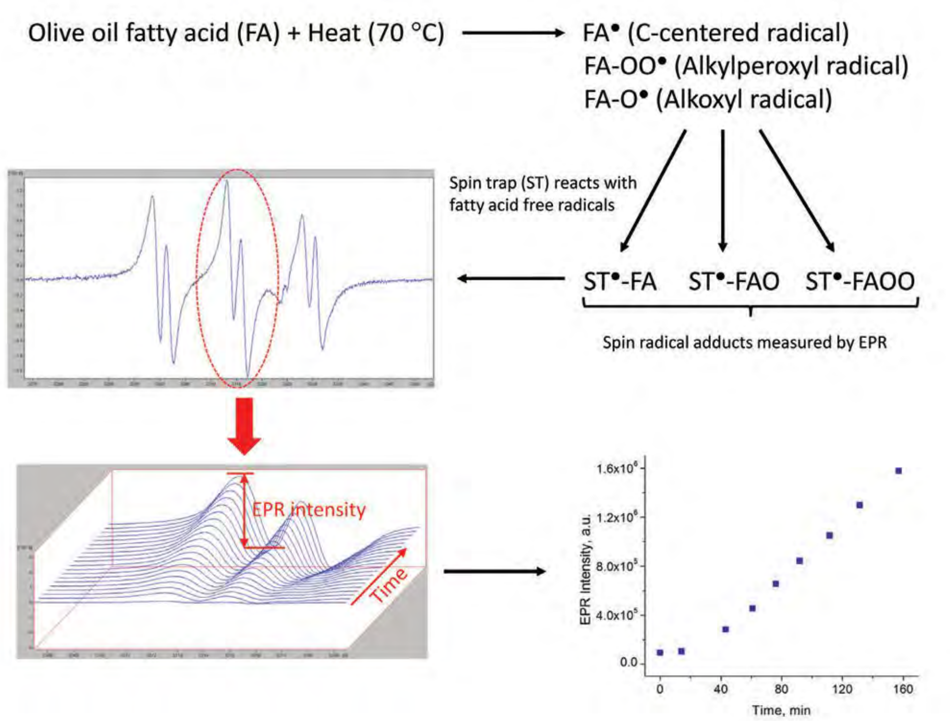

FIG. 2. Spin trapping in vegetable oil.

Stability testing at storage conditions is often too slow for practical use in quality control, and as a result such tests are often performed under "forced" conditions (e.g., using elevated temperature). The peroxide value (PV) is one of the most commonly used indicators of primary fat oxidation. It is used by food-related industries to assess the stability or rancidity of fats, by measuring lipid peroxides and hydroperoxides formed during the initial stages of oxidation. It should be noted that difficulties in the titration end point are common for PV levels below 5 meq/kg, which may account for a portion of the high variability generally associated with the method. For these reasons, these industries are looking for new and better methods for shelf life testing.

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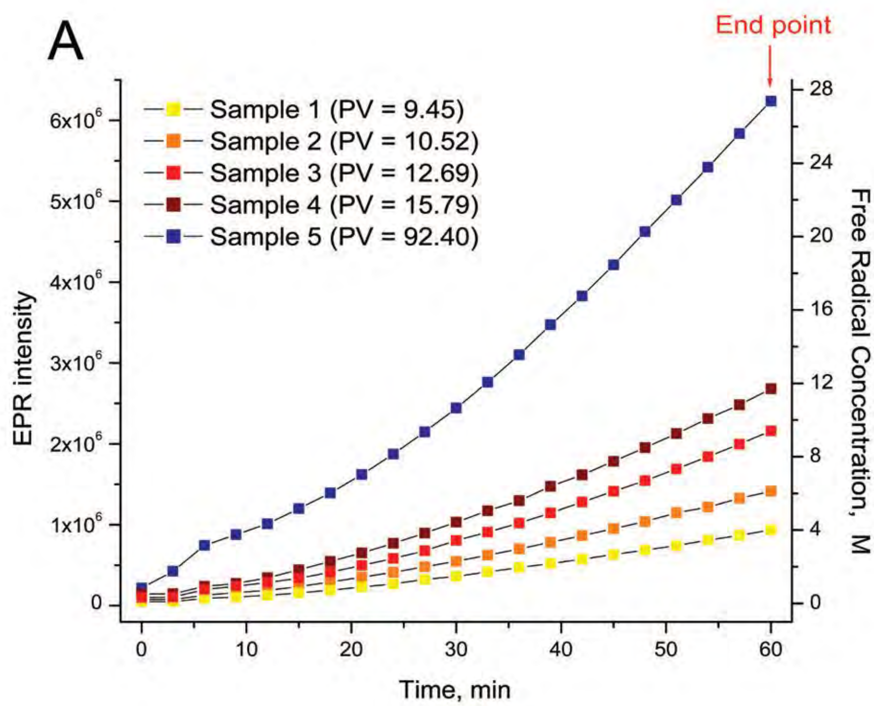

FIG. 3A. Electron paramagnetic resonance (EPR) radical adduct formation and peroxide values (PV) for the five AOCS samples.

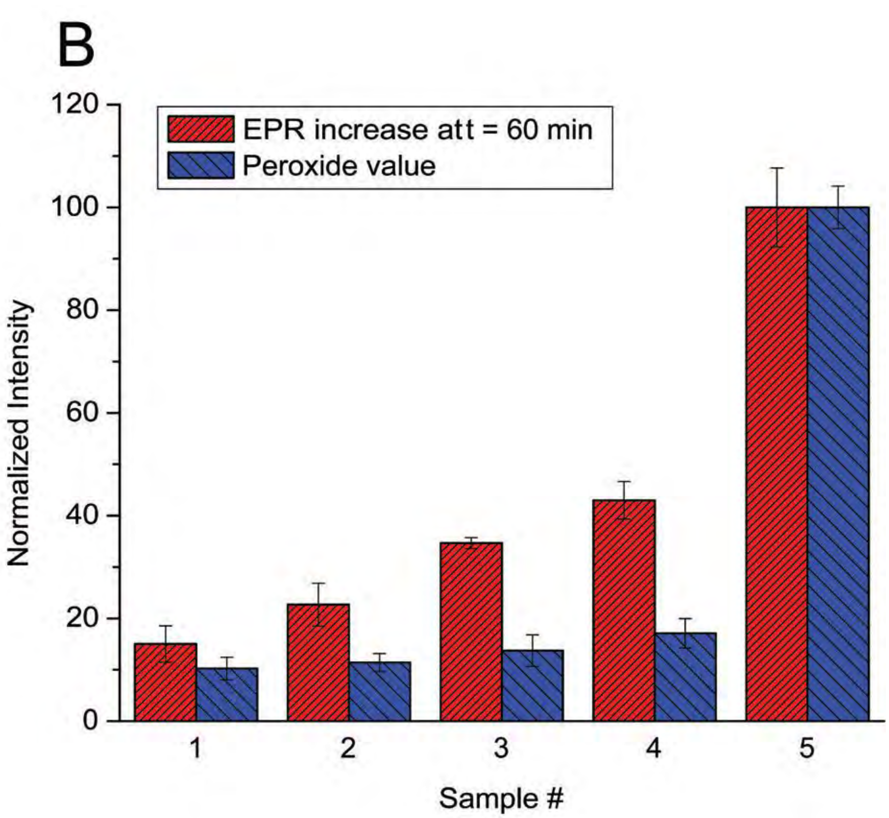

FIG. 3B. Comparison of EPR data with PV data.

EPR (electron paramagnetic resonance, a.k.a. ESR, electron spin resonance) is a spectroscopic technique that specifically and directly measures samples containing free radicals. At the same time the technique is completely "blind" to samples without free radicals (or unpaired electrons) and so is very specific. Free radicals are "short-lived," so to increase our ability to detect them, we add a compound known as a spin trap.

The spin trap reacts with the free radical to form a "radical adduct." Radical adducts are also free radicals, but they are much more stable than the original (half-lives as long as days compared to milliseconds). Most of the spin traps used have a nitrone-type group that forms a nitroxide (radical adduct) upon trapping the free radical. PBN (α-phenyl-*N*-*tert*-butylnitrone) is one of the nitrones commonly used to measure free radical formation during the forced oxidation of a variety of commercial products. Trapping of free radicals during this forced oxidation test yields a six-line EPR spectrum. The intensity of the lines is proportional to the concentration of free radicals that formed during the forced oxidation test. The general procedure for the EPR spin trapping assay is depicted in Figure 2.

EPR provides an excellent technique to monitor free radical formation from lipid oxidation in oils. Figure 3 highlights the ability of EPR to differentiate and screen for five olive oil samples from the AOCS Laboratory Proficiency Program.

These samples had known PV. The assay involves adding PBN spin trap to the oil sample of interest. The sample is mixed using a vortex and transferred immediately to a capillary tube. Samples are then heated at 70°C (to provide the forced oxidation). EPR measurements are then made over a user-specified period. The EPR intensity is measured from the peak-to-trough intensity of the middle lines of the EPR spectrum (Fig. 2).

EPR intensity values are converted to a free radical concentration (Fig. 3A). Free radical concentration is plotted vs. measurement time to show the respective level of oxidation that occurs in each olive oil sample. Figure 3B shows that the EPR signal increase correlates reasonably well with the PV data for the respective oil samples. In this example the EPR data were compared with the PV data by normalizing to the sample with the highest value (i.e., AOCS sample with PV = 92.40). From Figure 3B, we can see that EPR seems to be much more discriminating for samples that have PV values that are relatively similar (consider that samples 1–4 had PV that were at most 5 units apart).

The scheme in Figure 1 shows that peroxidized fatty acids (FA-OOH) convert to free radicals when they are exposed to pro-oxidant conditions (e.g., metal ions, heat, or light). An example would be the Fenton-type free radical-generating reaction here:

$$\text{FA-OOH} + Fe^{2+} \rightarrow Fe^{3+} + RO\bullet + OH^{-}$$

$$\text{FA-OOH} + Fe^{3+} \rightarrow ROO\bullet + H^{+} + Fe^{2+}$$

We believe this explains why EPR detection is more discerning even when samples have similar PV. In these cases it is likely that some of the oils originally had higher PV but by the time the PV test was performed the peroxides were not detected because they had decomposed to other end products (due to pro-oxidant conditions). [From the literature, it is known that PV decrease with time due to hydroperoxide decomposition.] This may be why consistent PV data are often difficult to attain. To explore this further we compared the EPR response vs. PV response after addition of 100 mM Fe^{3+} as a pro-oxidant. The EPR intensity and total extent of the free radical formation increased dramatically and immediately even at room temperature (Fig. 4).

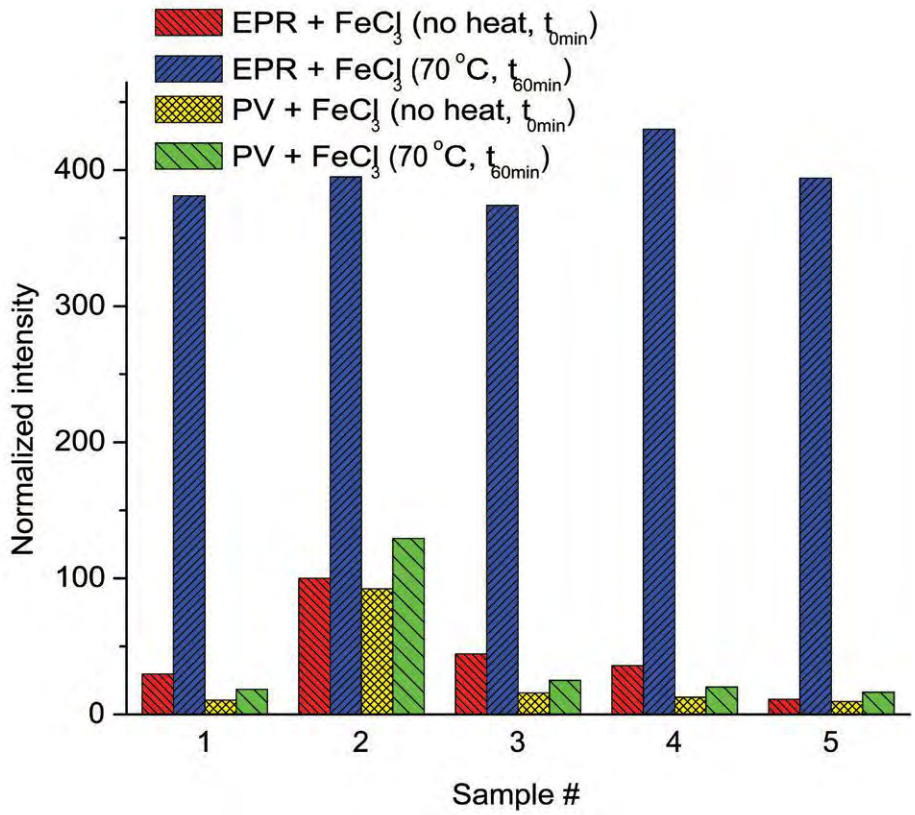

FIG. 4. Normalized data (EPR vs. PV) after pro-oxidant (100 µM Fe^{3+}) treatment.

Free radical formation was more than five times that of the control sample without iron. However, the PV only increased by 20% compared to the control sample. The EPR forced oxidation test provides a very simple and useful analytical tool for measuring the propensity of an oil to become rancid (and its ability to resist rancidity). The sample handling is minimal, and a bench-top EPR spectrometer makes operation facile and reliable. The method provides the industry a new tool for quality control that has advantages over other techniques that are more labor intensive and prone to uncontrollable variation. There is a reasonable correlation (for example, Figs. 3A, 3B) between the EPR and PV obtained from olive oil oxidation; thus, the $EPR_{t=60min}$ end point can be successfully used to detect early stages of the oxidation process. EPR also gives an overall picture of how well the oil will resist oxidation, which includes later stages of oxidation. In fact, our studies here show that EPR is more sensitive than the PV test because we measure free radicals before hydroperoxide formation and after hydroperoxide decomposition. These findings justify the further development of an EPR method for measuring and improving the resistance of edible oils to rancidity. At Bruker we are currently developing sample handling techniques and assay conditions that will make EPR a reliable and rapid assay for evaluating freshness in all forms of edible oil.

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trans Fatty acid content of foods in China

Yuanrong Jiang

Growing evidence that dietary consumption of *trans* fatty acid (TFA) increases the risk of cardiovascular disease (Pietinen *et al*., 1997; Oh *et al*., 2005; Ascherio *et al*., 1999) has made TFA a hot topic among people, food industries, and government officials in China.

The number of published papers in Chinese related to TFA increased nearly threefold from 2009 (47 papers) to 2011 (136 papers). Also, the Chinese government has increased its efforts to restrict TFA. On January 1, 2013, it became mandatory for manufacturers to indicate on the nutrition label of foods the content of hydrogenated and and partially hydrogenated fats. A new series of standards that include TFA labeing rules for rapeseed oil, maize oil, olive oil, and olive-pomace oil are under discussion as well. Meanwhile, the food industries in China have been introducing more healthful food through innovation.

In 2012, researchers at Wilmar Biotechnology R&D Center in Shanghai, China, conducted a nationwide survey of bottled cooking oil, food service oil, and oil-bearing processed food, to reveal the current trend of TFA content in foods within the Chinese market. The results of this survey were then compared with the outcomes of previous research to learn whether any improvements had occurred (Jiang *et al*., 2010; Fu *et al*., 2008; Fu *et al*., 2010; Niu, 2011; Hou *et al*., 2012).

BOTTLED COOKING OIL

To get a better understanding of TFA in China, it is necessary to appreciate how fats and oils are consumed

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- In 2012, the *trans* fatty acid (TFA) contents of 573 samples of bottled cooking oil, 74 samples of food service oil, and 257 samples of oil-bearing processed food in China were analyzed.
- The results were compared with previous analyses of the TFA contents of similar foods in studies that have been conducted since 2008.
- The comparison revealed that the TFA content of oil-bearing foods in China has been reduced measurably during the past four years.

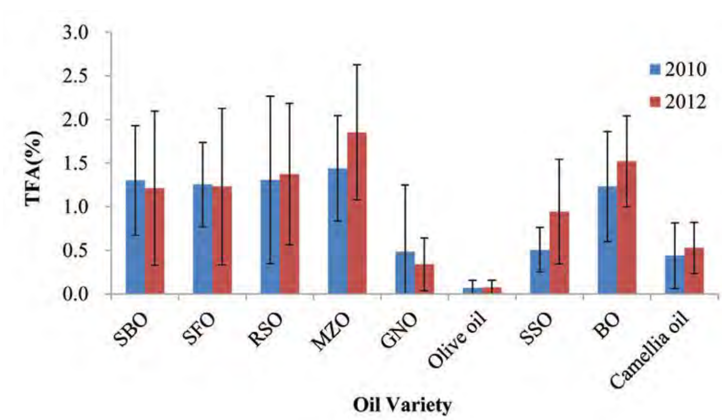

FIG. 1. Comparison of *trans* fatty acid (TFA) contents in 2010 and 2012. Abbreviations: SBO, soybean oil; RSO, rapeseed oil; SFO, sunflower oil; BO, blended oil; MZO, maize oil; GNO, groundnut oil; SSO, sesameseed oil. Error bars represent mean ± standard deviation.

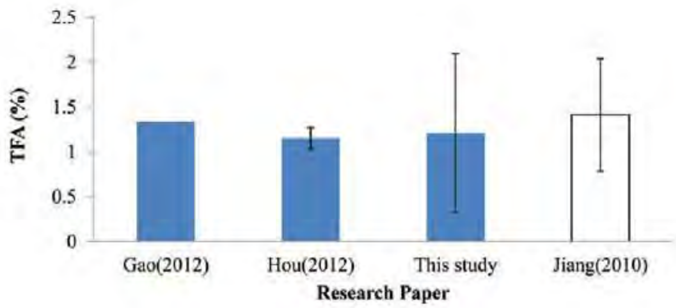

FIG. 2. TFA contents of soybean oil in different studies. Error bars represent mean ± standard deviation. For abbreviation see Figure 1.

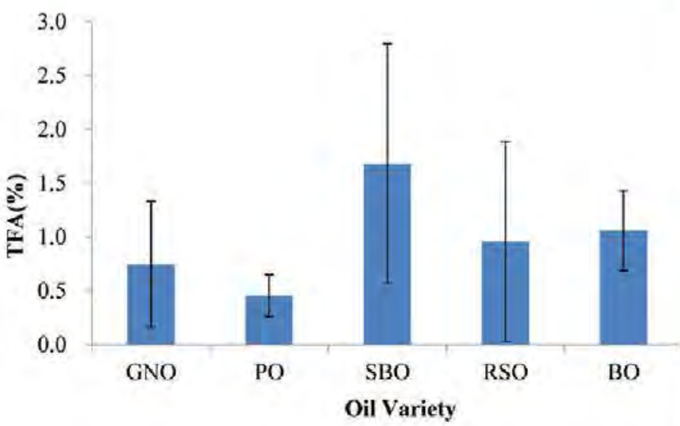

FIG. 3. TFA contents of different varieties of food service oil. Error bars represent mean ± standard deviation. For abbreviations see Figure 1.

TABLE 1. *trans* Fatty acid (TFA) content, categorized by range, of samples of oil-bearing foods (oil base)

Food category	Sample size (*n*)	Percentage of samples grouped according to content of TFA		
		TFA < 2%	2% < TFA < 5%	TFA ≥ 5%
Cake, bread, and pie	52	60	40	0
Cookies	69	88	9	3
Fried chips	8	100	0	0
Ice cream	29	100	0	0
Chocolate	28	96	4	0
Popcorn	3	100	0	0
Instant noodles	51	98	2	0
Nondairy creamer	12	100	0	0
Whipping cream	5	100	0	0
TOTAL	257	88	11	1

there. The Chinese consume more vegetable oils both at home and in restaurants than most Westerners. Bottled cooking oil (no more than 5 liters) and food service oil (containers holding18–22 liters) are the most common vegetable oils used in household cooking and food service businesses, respectively. Bottled cooking oil and catering oil provide a large portion of total oil intake.

For the study, 573 samples from 126 brands and 14 oil varieties were collected from eight different cities and analyzed using the national standard method (GB/T 22110-2008 [Recommended Chinese National Standard]). Of these samples, 87.52% had TFA levels less than 2%. There was a significant difference between refined and unrefined oils. The TFA contents were lowest in camellia oil, groundnut oil, and olive oil. All three are made by expelling the oil without further refinement. Compared to the outcomes of an earlier survey (Jiang *et al.*, 2010), the results were quite similar (Fig. 1, page 59).

Both found that 90% of the samples contained TFA below 0.2%. Only two oil varieties had an obvious increase in TFA average contents: maize oil and sesameseed oil. The much larger sample size and the diverse qualities included in this survey could explain the increase. The intentional adding of blended oil to sesame oil and the possible inclusion of fraudulent oils could also explain such increases.

Several other studies related to TFA contents within Chinese food appeared in 2012 (Gao *et al.*, 2012; Ning *et al.*, 2012). Soybean oil constitutes the largest portion of vegetable oil consumption in China. Thus, it was chosen in these three papers as the basis for comparing the similarities of our results with those of other studies. Figure 2 shows that all of the surveys yielded similar outcomes, that is, a slight decrease of TFA content in soybean oil between 2010 and 2012.

In general, TFA content within bottled cooking oils remained at roughly the same level as in 2010 (Jiang *et al.*, 2010). Nearly 90% of samples contained less than 2% TFA. In addition, unrefined oils contained lower concentrations compared to refined oils.

FOOD SERVICE OIL

This is the first research to date that has included food service oil. Seventy-four samples were collected from different areas in China, and five different varieties were measured. All five oil varieties contained quite low TFA concentrations (Fig. 3). Palm oil possessed the lowest TFA, which might be caused by its higher saturated fatty acid content. TFA concentrations in food service oils were much lower than those in corresponding bottled cooking oil varieties. Note that restaurants and hotels in China care less about the color and appearance of the oil than consumers do, which leads to milder refining of food service oils. Reduced refining is believed to have a positive effect on TFA concentrations. In short, TFA concentrations in food service oils were much lower than those in corresponding bottled cooking oil categories, and they were lowest in palm oil.

OIL-BEARING FOODS

Although Chinese consumed much less fried and baked food with higher oil content compared to westerners, the intake of such food has increased year by year. Consequently, oil-bearing

CONTINUED ON PAGE 63

foods are possibly the most important source of hydrogenated vegetable oil intake for Chinese and play an important role in the study of TFA intake. Two hundred fifty-seven samples from nine categories (cake, bread and pie; cookies; chips; ice cream; chocolate; popcorn; instant noodles; non-dairy creamer; and whipped topping) were collected from supermarkets and bakery houses.

All samples contained less than 5% TFA (oil base), with the exception of two samples in the cookie category (Fig. 4), and only some samples in the cake, bread and pie, cookie, chocolate, and instant noodle category had TFA contents in the range of 2% to 5% (Table 1, page 60). TFA levels in popcorn, ice cream, nondairy creamer, fried chips, and whipping cream were less than 2% (oil base).

Almost all of the research published in the past four years on TFA in China confirms that cake, bread, and pie are the categories of food with the highest TFA concentrations (Fig. 5). Partially hydrogenated oil, which is the most popular component of coatings and fillings, could be the source of the higher TFA in these categories.

Figure 5 shows a reduction in TFA concentrations occurred in three of four categories from 2008 to 2012, although TFA concentrations varied depending on the food category. Table 2 compares the analytical results of five categories included by our survey and by that of Fu *et al.* (2008). The percentage of samples containing more than 2% TFA decreased by more than 50% from 2010 to 2012.

The outcomes of this survey, which were presented in August 2012 at the ICC/CCOA Cereal and Bread Congress entitled "Science and Technology Innovation for Healthy Cereals & Oils" held in Beijing, China, revealed that the TFA content within bottled cooking oils remained at the same level as those reported by Jiang *et al.* in 2010 (almost 90% had a TFA content less than 0.2%).

Meanwhile, there was a significant reduction in the TFA concentration in oil-bearing processed foods, and the TFA amounts in food service oils were generally lower than bottled cooking oils. The results demonstrated that significant improvements were made in food and oils in China thanks to industrial efforts.

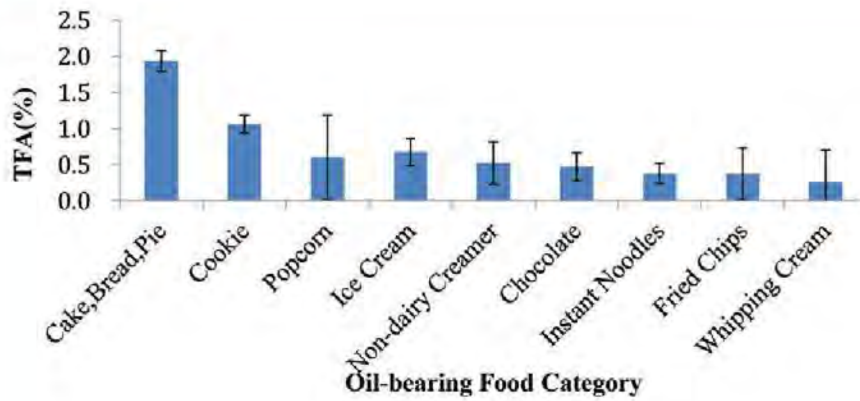

FIG. 4. TFA contents of different categories of oil-bearing food. Error bars represent mean ± standard deviation. For abbreviation see Figure 1.

TABLE 2. Comparison of percentage of oil-bearing food in different TFA range between 2010[a] and 2012 surveys (oil base)

Food category	Relevance ratio (%)				Sample size (*n*)	
	2% < TFA < 5%		TFA ≥ 5%			
	2010	2012	2010	2012	2010	2012
Cake, bread, and pie	81	40	30	0	21	52
Cookies	35	9	15	3	34	69
Fried chips	28	0	0	0	21	8
Ice cream	60	0	0	0	10	29
Chocolate	35	4	0	0	14	28

[a]Fu *et al.* (2008). For abbreviation, see Table 1.

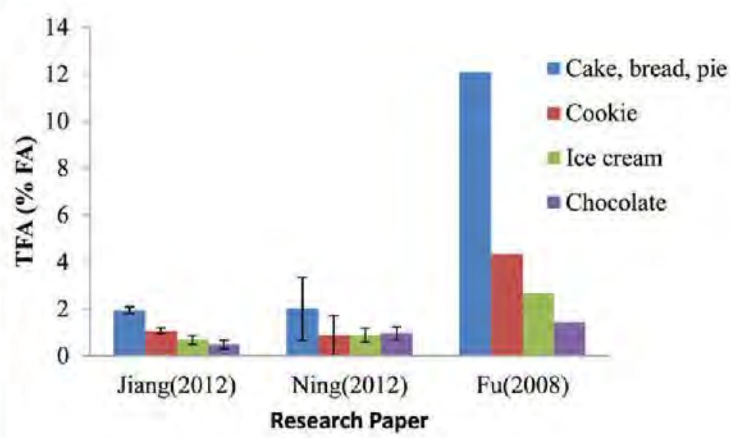

FIG. 5. Research results comparison. Error bars represent mean ± standard deviation For abbreviation see Figure 1.

A list of complete references can be found in the digital edition. Log in to read the January 2013 issue at aocs.org/login.

Yuanrong Jiang, Ph.D., has worked as R&D director in Wilmar International Ltd. since 2006. Her research interests involve nutrition and health of fatty acids, oxidative stability and antioxidants of fats and oils and their processing and flavor. The Chinese government has given her numerous scientific achievement awards. She has over 40 publications and has applied for 20 patents. She may be contacted at jiangyuanrong@wilmar-intl.com. *The author thanks Xuebing Xu, Peng Hu, Yuquan Zhang, Shuhua Xia, and Jingyi Zhang for their assistance in collecting and organizing the data and preparing this paper.*

Benchtop magnetic resonance (cont. from page 50)

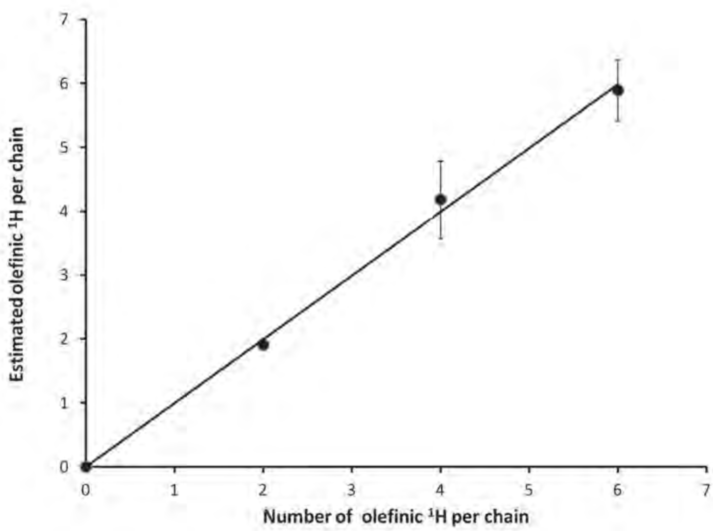

FIG. 6. Estimate of the number of ^{1}H per chain using the ratio of the integrals of the olefinic (–CH=CH–) region and methoxy (–OCH_3) region of the ^{1}H spectrum of four methyl esters. Error bars were calculated by integrating five spectra per data point.

toward oxidative stability and engine deposits. The ^{1}H NMR spectrum of the methyl ester family derived from the 18-carbon-chain fatty acids, stearic, oleic, linoleic, and linolenic are shown in Figure 5.

This clearly illustrates how the ^{1}H NMR spectrum of each methyl ester changes as the unsaturated character of the derivative fatty acid chain changes. Integrating the olefinic resonance (–CH=CH–) in each of these spectra relative to the methoxy resonance (–OCH_3) gives an estimate of the number of olefinic protons per chain. The results of this quantification are shown in Figure 6.

Quantitative profiling of the fatty acid chains is also useful for monitoring the transesterification of oils/fats, from which the end product is used to make biodiesel.

FUTURE TRENDS

With increasingly tight budgets, it is often hard to justify the purchase of expensive NMR and EMR instrumentation based on superconducting- and electromagnets. Additionally, most users prefer the convenience of a benchtop instrument that may be sited as a resource in a standard laboratory environment. Benchtop NMR has a proven track record over many decades in oil, moisture, and SFC measurements. Magnetic resonance instruments based on rare earth magnets—which are smaller, lighter, and have much better performance than traditional AlNiCo magnets—are currently being developed and will open up a variety of new applications in the fields of NMR and EMR spectroscopy.

Kevin Nott obtained his Ph.D. at the University of Cambridge in the field of NMR imaging (MRI) and relaxometry applied to food. He continued this work as a postdoctoral researcher before joining Oxford Instruments in 2005. Since then he has been primarily working on benchtop NMR for a variety of quality control and research applications. He can be contacted at Kevin.NOTT@oxinst.com.

After obtaining his Ph.D. in computational chemistry from the University of Sheffield, David Williamson worked in the area of liquid state physics at Universidad Autónoma Metropolitana in Mexico City and the Institute of Physics at the Guanajuato State University, Mexico. On returning to the United Kingdom, his research focus moved from computational chemistry to nuclear magnetic resonance spectroscopy via the field of magnetic resonance imaging thanks to funding from the UK Medical Research Counci. In 2011, he joined Oxford Instruments from the Department of Chemistry at the University of York, where he had been senior experimental officer in the Centre for Magnetic Resonance. He can be contacted at David.Williamson@oxinst.com.

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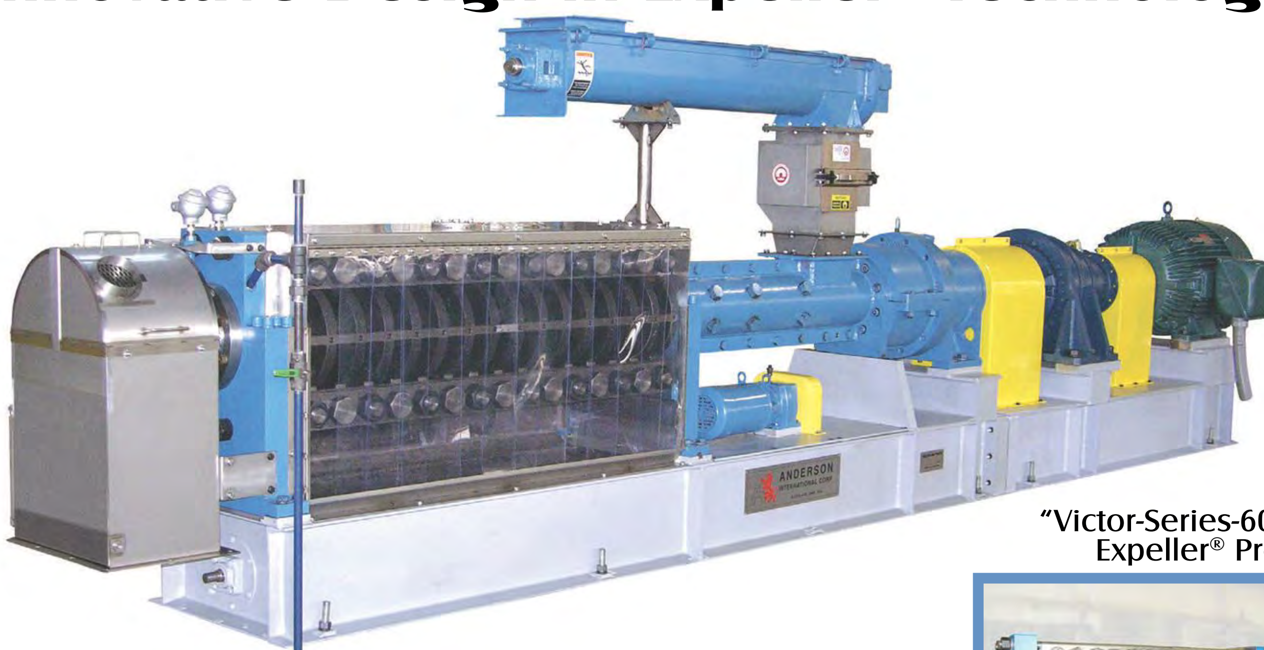

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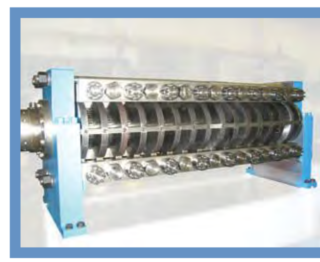

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trans Fatty acid content of foods in China

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