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International News on Fats, Oils, and Related Materials

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Special report on  
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US Marine Corps Capt. Ernesto Howard takes notes during a patrol in Charibaya in Afghanistan's Helmand province, Aug. 8, 2013. Howard is the assistant officer in charge of the Supporting Arms Liaison Team, 2nd Air Naval Gunfire Liaison Company. US Marine Corps photo by Sgt. Tammy K. Hineline

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As consumer preference for all-natural labels continues to grow, natural antioxidants offer an alternative to synthetic antioxidants in the stabilization of vegetable oils and prepared foods. Here is a look at some of the latest research in this area.

### **490** Sesamol: a natural antioxidant for frying oil

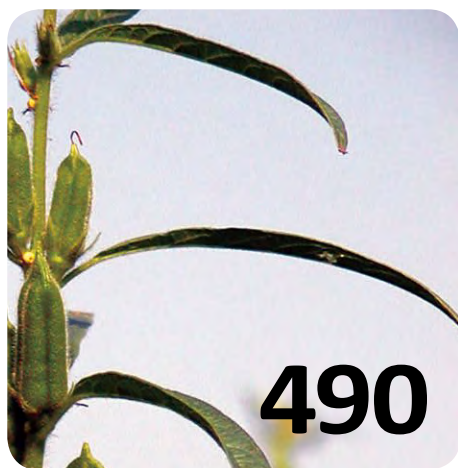
This phenolic compound, found in sesame seeds and sesame oil, is relatively inexpensive compared to other natural antioxidants. Its strong antioxidant activity and health benefits are well documented. What are the current barriers, and how might they be addressed?

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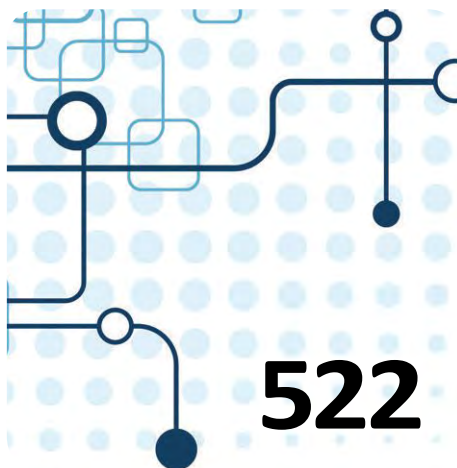
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Long-chain polyunsaturated fatty acids (LC-PUFA) are highly susceptible to oxidation, yet the natural antioxidants that are traditionally applied to prevent common food oil oxidation are inefficient at inhibiting LC-PUFA oxidation. Recent research suggests that antioxidant regeneration could improve stability using currently available natural antioxidants.

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# Vitamin D status and military populations: implications for bone health

**James P. McClung**

Vitamin D, an essential nutrient for human health, is unlike any other nutrient in that it can be obtained through both dietary sources and production in the skin. Roles for vitamin D have been identified in the function of the cardiovascular, immune, and musculoskeletal systems. The Institute of Medicine (IOM) of the National Academies (Washington, DC, USA) provided updated recommendations for vitamin D intake in December 2010. This report set the recommended dietary allowance (RDA) at 600 international units (IU) for children and adults, and 800 IU for adults over 70 years of age (IOM, 2011). Although many of the potential roles for vitamin D in the body were considered in the development of the recommendations, optimization of bone health and the prevention of bone diseases were cited as the primary justification for the IOM's recommendation.

- Stress fractures may affect up to 5% of males and 20% of females during US basic combat training. Such injuries result in substantial healthcare costs and significant attrition.
- Recent studies have considered whether optimizing vitamin D status can prevent stress fractures in military personnel.
- The following article reviews those studies and describes how scientists at the US Army Research Institute of Environmental Medicine have since launched a multicenter randomized, double-blind, placebo-controlled intervention trial providing supplemental vitamin D and calcium to military personnel during training.

Estimates of the prevalence of vitamin D deficiency vary greatly depending on the biochemical parameters used to define deficiency. Population data collected from the third National Health and Nutrition Examination Survey (NHANES III) were used to identify the prevalence of mild to moderate vitamin D deficiency (defined as serum vitamin D levels of 25–75 nmol/L) at 40 and 50% for American men and women, respectively (Zadshir *et al.*, 2005). Studies investigating vitamin D status in military personnel are extremely limited, although recent work from the US Army Research Institute of Environmental Medicine (USARIEM), in Natick, Massachusetts, indicates that over 50% of soldiers may begin basic combat training (BCT: the initial 8–10 week training of recruits when they join the Army) with serum vitamin D levels below 75 nmol/L, and that vitamin D status may decline even further during training (Andersen *et al.*, 2010).

Vitamin D maintains calcium homeostasis through its effect on the efficiency of intestinal calcium absorption and by its promotion of the synthesis of calcium transport proteins, such as calbindin. Conversely, poor vitamin D status results in the secretion of parathyroid hormone, which increases bone resorption through the mobilization of calcium from bone. As





Crawling through mud, Pvt. Charles Shidler, Company A, Special Troops Battalion, 37th Infantry Brigade Combat Team, Ohio National Guard, searches for the next covered fighting position during individual movement techniques training at the Camp Ravenna Joint Maneuver Training Center, Ravenna, Ohio. The IMT is just one of more than 200 common training tasks that Shidler, as well as about 3,600 other Soldiers of the 37th brigade, completed before they deployed to Afghanistan in fall 2011 in support of Operation Enduring Freedom. Photo by Sgt. Sean Mathis.

such, vitamin D status is associated with bone mineral content and bone mineral density in children and adults.

Optimizing bone health of military personnel is essential, especially during BCT and other military training activities. Stress fractures, which are partial or complete fractures that occur due to an inability to withstand unaccustomed, repeated stress (such as marching with body armor), may affect up to 5% of males and 20% of females during BCT. These injuries are costly to warfighters themselves and to the military, as a significant portion of individuals who suffer from stress fractures are lost by attrition from military service. Furthermore, stress fractures result in substantial health care costs associated with treatment and rehabilitation.

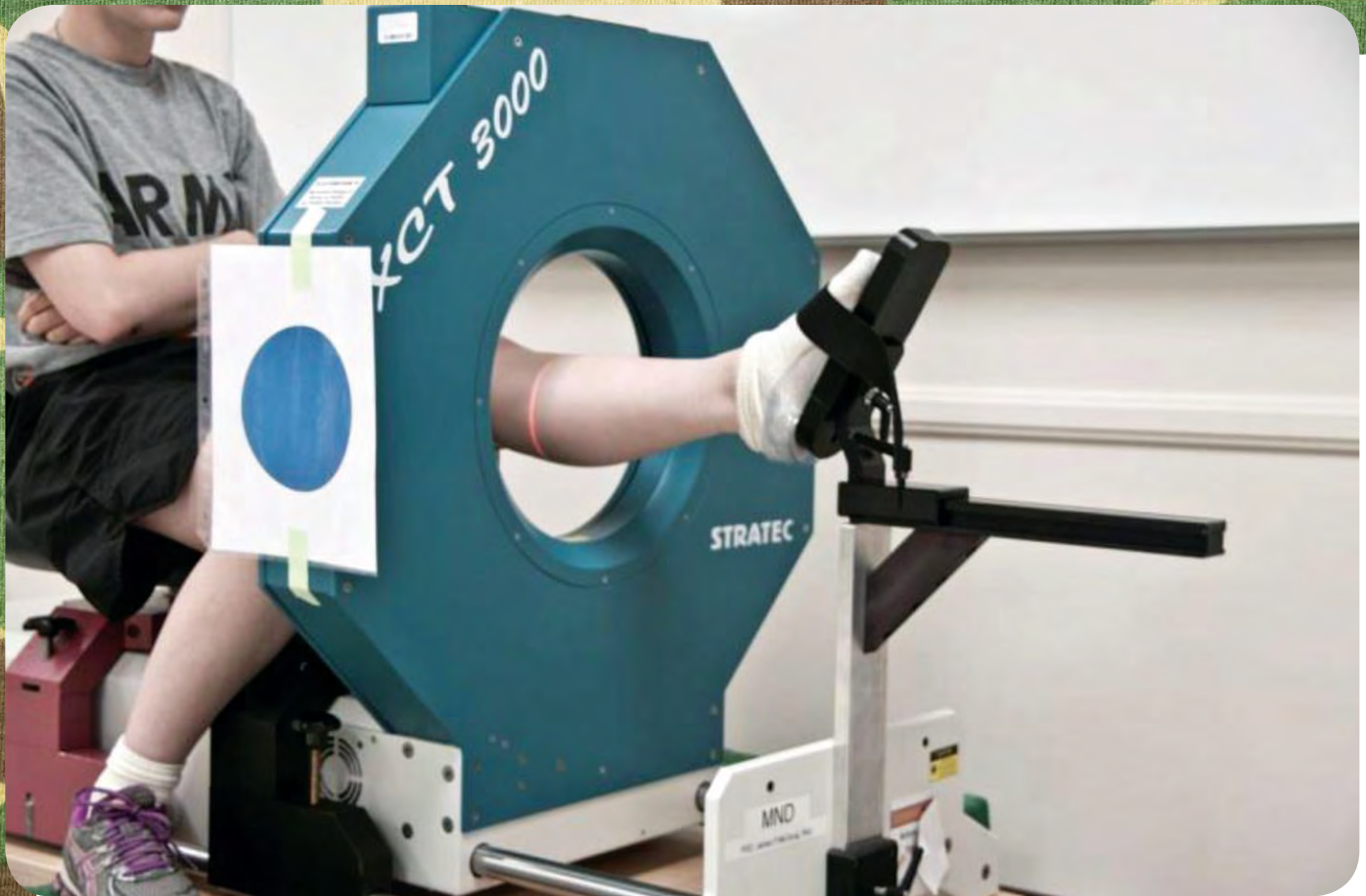
A study of Finnish military recruits established a relationship between diminished vitamin D status and risk of stress fracture: The mean serum vitamin D concentration of recruits who suffered from stress fracture was lower than those that did not (Ruohola *et al.*, 2006). Similarly, a study with male Israeli military recruits determined that stress fracture may be associated with diminished dietary vitamin D and calcium

intake, as recruits who suffered from stress fractures during basic training had consumed less vitamin D and calcium prior to beginning military training than those that did not suffer fractures (Moran *et al.*, 2012).

A recent randomized, double-blind, placebo-controlled intervention trial (RCT) uncovered a possible role for supplemental vitamin D (800 IU/day) and calcium (2000 mg/day) in the prevention of stress fracture during military training (Lappe *et al.*, 2008). In this study, over 5000 female recruits were randomized to consume either the vitamin D and calcium-containing supplement or a placebo over the 8 weeks of Navy boot camp (the Navy version of BCT). During the course of the study, 226 stress fractures were observed in the group receiving the vitamin D and calcium supplement, whereas 270 stress fractures were observed in the placebo group. Advanced statistical analysis indicated that vitamin D and calcium supplementation may have reduced the risk of stress fracture by up to 20%, although measures characterizing the effects of the supplement on biochemical indicators

CONTINUED ON NEXT PAGE





The tibia of a volunteer is scanned using peripheral quantitative computed tomography during basic combat training.

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of nutritional health or functional indicators of bone health were not collected.

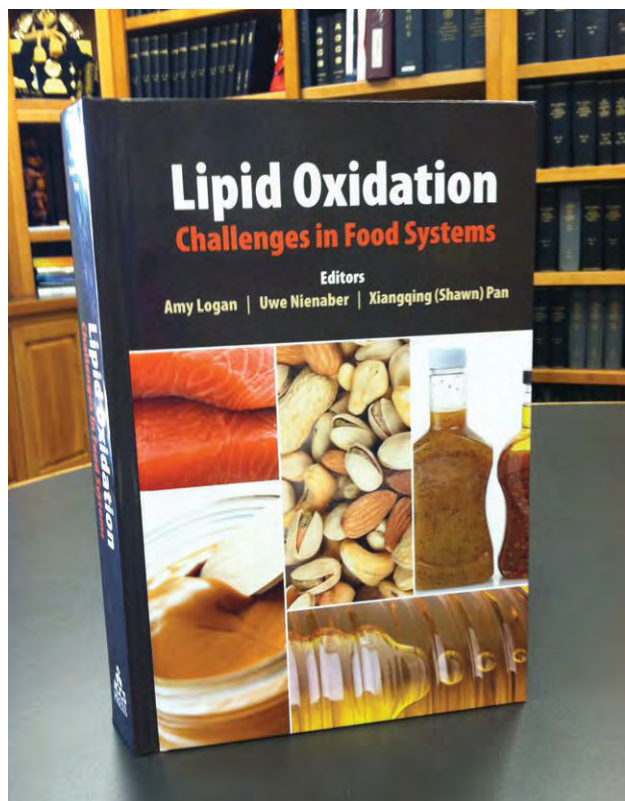
In an effort to expand upon the findings of Lappe and co-workers (2008), scientists at USARIEM have designed a multicenter RCT providing supplemental vitamin D and calcium to military personnel during training. Similar to the earlier study, vitamin D and calcium will be provided at 800 IU and 2000 mg/day, respectively, although the nutrients will be provided in a fortified food product, as opposed to a supplement in capsule form. The food product has been specially formulated in partnership with scientists from the Combat Feeding Directorate at the Natick Soldier Research, Development, and Engineering Center and is of relevance to military personnel in that the product, a snack bar, meets operational standards for military rations.

Biochemical indicators of nutritional status and functional measures of bone health will be collected using peripheral quantitative computed tomography, an advanced bone-scanning technique for assessing bone quality and strength. Up to 1400 volunteers total, both male and female, will participate; to date approximately 500 soldiers have completed the study at Fort Sill, Oklahoma. Upon completion of the study, scientists from USARIEM will share the data with senior leaders from the Department of Defense's medical and training

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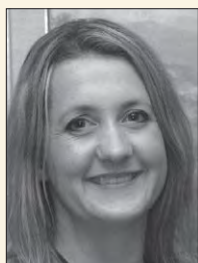


## ***Lipid Oxidation*** ***Challenges in Food Systems***

Editors: Amy Logan, Uwe Nienaber, and Xiangqing (Shawn) Pan, Editors  
Hardbound. 2013. 548 pages. ISBN:978-0-9830791-6-3.  
Product code 269

Lipid oxidation in food systems is one of the most important factors that affect food quality, nutrition, safety, color and consumers' acceptance. The control of lipid oxidation remains an ongoing challenge as most foods constitute very complex matrices. Lipids are mostly incorporated as emulsions, and chemical reactions occur at various interfaces throughout the food matrix. Recently, incorporation of healthy lipids into food systems to deliver the desired nutrients is becoming more popular in the food industry. Many food ingredients contain a vast array of components, many of them unknown or constituting diverse or undefined molecular structures making the need in the food industry to develop effective approaches to mitigate lipid oxidation in food systems. This book provides recent perspectives aimed at a better understanding of lipid oxidation mechanisms and strategies to improve the oxidative stability of food system.

## MEET THE EDITORS



**Amy Logan (nee Richards)** has over 10 years of experience as a lipid chemist, and is currently working as a research scientist within CSIRO Animal, Food and Health Sciences in Werribee,

Australia. With a Ph.D. from the University of Melbourne (School of Agriculture and Food Systems), Amy has worked alongside the Australian Canola Industry studying the effect of genotype and environment on chemical composition and the influence of oxidative stability within Brassica oils. She is an active member of the AOCS including roles within both the Australasian Section and the Lipid Oxidation and Quality (LOQ) Division.



**Uwe Nienaber** is an Associate Principal Scientist in the Analytical Sciences Department at Kraft Foods in Glenview, Illinois, where he is currently leading the Physical Sciences

group. His main interests are in the areas of analytical testing, lipid oxidation, water relations in foods and shelf life. He has been a member of the American Oil Chemists' Society since 2008. He is also a professional member of IFT since 1997 and has served the Chicago Section as treasurer and chair.



**Xiangqing (Shawn) Pan** is a research scientist at DuPont Nutrition and Health (formerly Solae, LLC), and his research interests are in the areas of analytical sciences, lipid oxidation

and antioxidants, phospholipids, protein and carbohydrate chemistry. Shawn earned his Ph.D. in the area of Food Chemistry from Tokyo University of Marine Science and Technology at Japan. As an active AOCS member, Shawn has been an LOQ Division Executive Steering committee member since 2008, and the Technical Program Chair since 2010. He has also served as LOQ Frankel Best Paper Award Committee Chair, Best Student Poster Award Committee Chair, AOCS Honored Student Award Committee Chair, and AOCS Young Scientist Award Committee member.





# Special report on natural antioxidants

- As consumer preference for all-natural labels continues to grow, Vitamin E, sesamol, and extracts from common herbs and spices offer a natural alternative to synthetic antioxidants in the stabilization of vegetable oils and prepared foods.
- Meanwhile, the increasing use of long-chain polyunsaturated fatty acids (PUFAs) in the fortification of foods and beverages requires new approaches, as the conventional antioxidants that prevent oxidation in most food oils are inefficient at inhibiting oxidation in PUFAs, which are exceptionally vulnerable to oxidation.
- The 2013 AOCS Annual Meeting & Expo in Montréal, Canada, April 28-May 1, featured some of the latest research on novel antioxidants and approaches to inhibiting oxidation in a variety of edible oils. The following articles are just a sampling of what was presented.

Sesame pods. Image courtesy of Jason Tzen.

## Sesamol: a natural antioxidant for frying oil

**Hong-Sik Hwang and Jill Winkler-Moser**

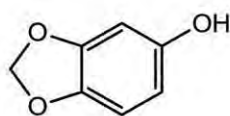
Sesamol is a phenolic compound found in sesame seeds and sesame oil and is regarded as a major antioxidant component in the oil. While raw sesame seeds contain only a trace amount of sesamol, sesamol is produced from decomposition of sesamolin during the roasting process of sesame seeds (Wanasundara *et al.*, 1998).

Sesamol has many important biological activities and health-promoting benefits such as inducing growth arrest and apoptosis in cancer and cardiovascular cells and enhancing vascular fibrinolytic capacity (Jacklin, *et al.*, 2003). For an order quantity of 100 kg, synthesized sesamol can be purchased for \$60/kg and natural sesamol for about \$100/kg. Although sesamol is relatively inexpensive compared to other natural antioxidants and is well documented to have strong antioxidant activity and health benefits, it is not being used in frying oils yet. The rest of this article considers current barriers to the use of sesame oil in frying.

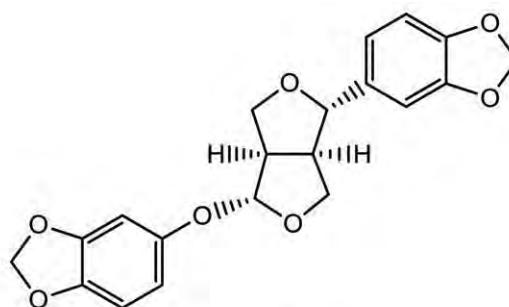
### HOW EFFECTIVE IS SESAMOL IN FRYING?

The antioxidant activity of sesamol in frying oil was evaluated during the following situations: frying with (i) soybean oil





sesamol



sesamolin

(SBO) containing sesame oil, (ii) sesamol in heated methyl linoleate, (iii) lignans found in sesame seed, and (iv) sesamol in a lard model system. Among 10 lignans and model compounds that we tested, sesamol was the strongest radical scavenger and the best antioxidant for heated SBO (Hwang *et al.*, 2012). Sesamol showed about 60% higher radical scavenging ability than TBHQ (*tert*-butylhydroquinone), a synthetic antioxidant, toward ABTS [2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid)] radical. However, the antioxidant activity of sesamol observed in frying experiments was not as good as that demonstrated in heating studies and radical scavenging ability tests. To exhibit higher activity than 200 ppm of TBHQ, a higher concentration of sesamol was required. This prompted our research group to investigate causes of the unexpectedly inferior antioxidant activity under frying conditions.

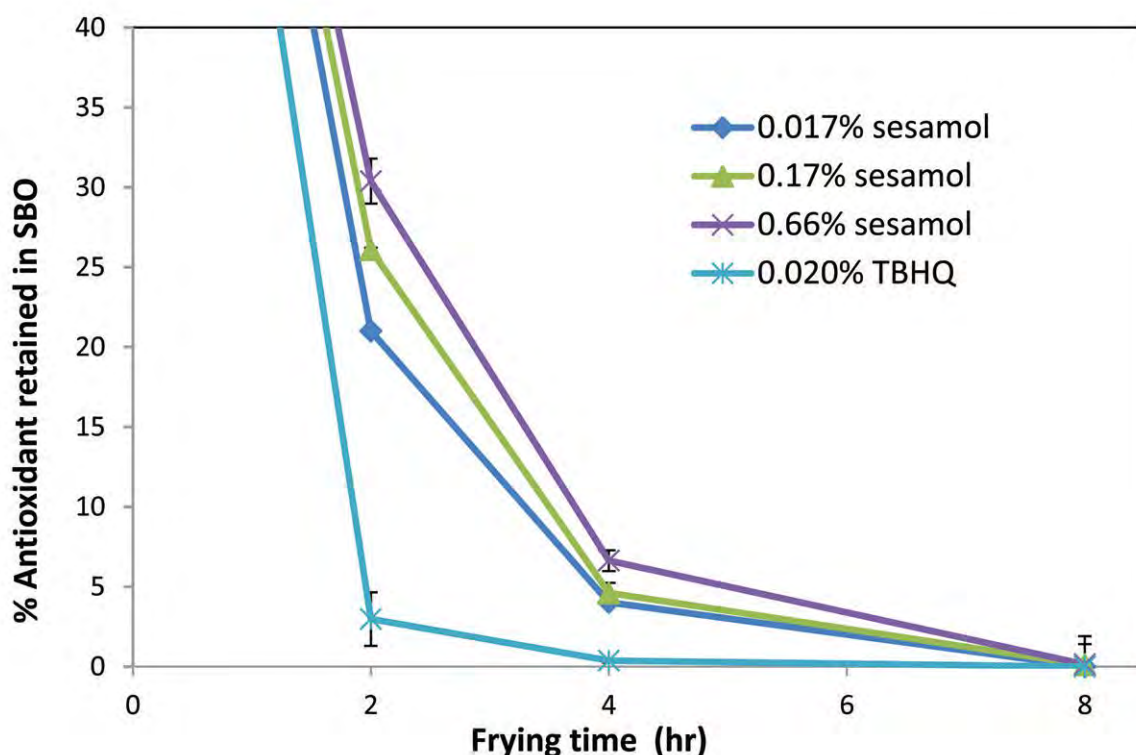
A high-pressure liquid chromatography (HPLC) protocol was performed for quantitative analysis of sesamol concentration in frying oil. The percentage of sesamol retained during frying for three different initial concentrations of sesamol is

shown in Figure 1. While sesamol was retained slightly better at higher concentrations, the concentration decreased sharply for all concentrations of sesamol and became close to zero after frying for eight hours. In a comparison between the same molar concentrations of sesamol and TBHQ (0.017% and 0.020%, respectively), the concentration of TBHQ fell even faster than sesamol.

Possible reasons for the sharp concentration decrease include: (i) reaction with radicals for antioxidant activity, (ii) reaction with oil at an inactive part of the antioxidant, (iii) decomposition, and (iv) evaporation. While the first two reactions affect antioxidant activity positively, the last two lower the effectiveness of the antioxidant. This means that if a method is developed to prevent/reduce decomposition and evaporation of the antioxidant, the activity will increase.

Evaporation, one possible reason for concentration decreases during frying, was examined with thermogravimetric

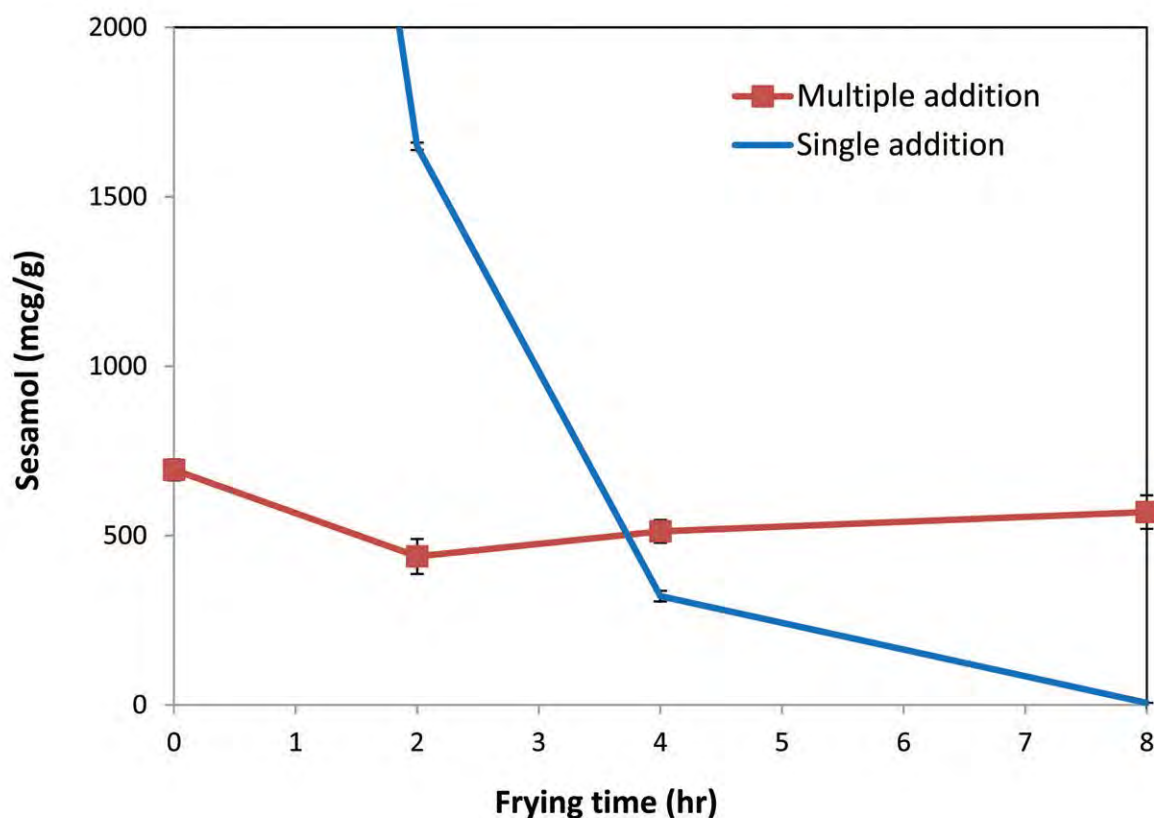
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◀ **FIG. 1.** Sesamol and *tert*-butylhydroquinone (TBHQ) levels retained in soybean oil during frying of potato cubes at 180°C. Error bars show the standard deviation of three replicates.

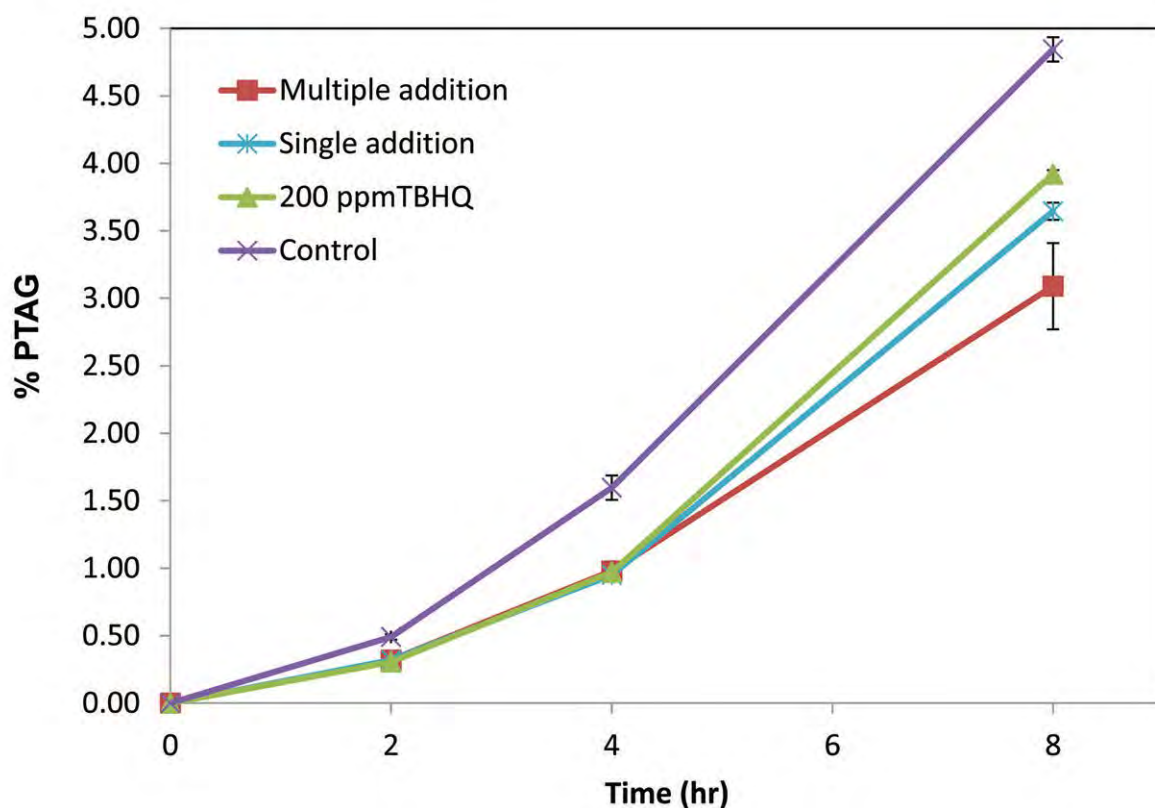
**FIG. 2. ►**

Concentration changes of sesamol in soybean oil during frying at 180°C by single addition and multiple addition methods. Error bars show the standard deviation of three replicates.



**FIG. 3. ►**

Percentage of polymerized triacylglycerols (PTAG) by single addition and multiple addition of sesamol to soybean oil compared to 0.020% (w/w) TBHQ and control (no antioxidant) during frying at 180°C. Error bars show the standard deviation of three replicates. For abbreviation see Figure 1.





analysis (TGA). The experiment was conducted under nitrogen to minimize oxidation/decomposition. TGA of sesamol and TBHQ at the heating rate of 10°C/min showed these antioxidants evaporated rapidly. For example, 100% of the sesamol evaporated before the temperature had reached a typical frying temperature (180°C). Evaporation of TBHQ was slightly slower than sesamol presumably due to its higher molecular weight (166 g/mol vs. 138 g/mol). TGA of 5% antioxidants in SBO also showed rapid evaporation of these antioxidants.

## HOW COULD THE ANTIOXIDANT ACTIVITY BE IMPROVED?

If evaporation is one of the important factors inhibiting sesamol effectiveness, finding a method to reduce volatility would be critical to using this natural antioxidant for frying oil. As one possible solution, we tested a multiple addition approach, in which the same amount of sesamol was added portion by portion throughout the frying process to keep the sesamol concentration at a certain level. The frying experiment was carried out with SBO and small cubes of potato at 180°C. Eight times every hour, 0.083% of sesamol was added was tested, and results were compared with the single addition method in which 0.66% sesamol was added at the beginning of frying.

Sesamol concentration was determined by HPLC during frying by the multiple addition method and by the single addition method (Fig. 2). In the multiple addition method the sesamol concentration fell to 438 µg/g (2 hr) and then slightly increased to 569 µg/g (8 hr). As a result, the sesamol concentration between 4 hr and 8 hr frying time for multiple additions was higher than for the single addition method, when the sesamol concentration dropped to 6 µg/g at 8 hr.

Oxidation products, determined as polymerized triacylglycerols after 2, 4, and 8 hr frying time, are shown in Figure 3. The same amount of sesamol added using the multiple addition method showed better antioxidation activities than the single addition method, despite the fact that overall concentration in the soybean oil was initially much lower. It is evident that the level of sesamol throughout the frying process is more important than the initial concentration of sesamol and that keeping the sesamol at a certain level is important for good antioxidant activity.

Our research group has invented another method to reduce volatility of sesamol for which we have made patent application. We intend also to study preventing and reducing decomposition of sesamol under frying conditions. By using several combined technologies, sesamol may be used in the frying industry as a natural antioxidant.

## TOXICITY AND REGULATORY STATUS

People have consumed sesamol for thousands of years as a natural component in sesame seeds and sesame oil. In the

CONTINUED ON NEXT PAGE



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## RECOMMENDED READING

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latter, the sesamol concentration is up to 900 ppm. Sesamol was found to be non-mutagenic by the Ames assay, but showed a positive test for mouse lymphoma cell cultures. Sesamol was positively associated with the occurrence of several types of tumors when fed to rats and mice at a level of 2% of the diet for 96–104 weeks. However, several other natural and common antioxidants such as caffeic acid and catechol were also found to be positive for tumors in these studies, and usage at such a high level of the diet is very unlikely.

The National Cancer Institute nominated sesamol for further carcinogenicity testing by the National Toxicology Program (NTP) in 1989, based on the positive test result for mouse lymphoma. However, after reviewing the available data, the NTP did not recommend any further testing. Neither

sesamol nor sesame extracts containing sesamol are listed in the US Food and Drug Administration's (FDA's) inventory of Generally Recognized as Safe (GRAS) substances or in the GRAS Notice Inventory. Companies that want to use sesamol or sesame extracts containing sesamol as a food ingredient would need to evaluate all of the available data and file a notice to the FDA of GRAS determination under the specific conditions of use as a food ingredient.

*Hong-Sik Hwang is a research chemist at NCAUR (National Center for Agricultural Research), Agricultural Research Service (ARS), US Department of Agriculture (USDA; Peoria, Illinois). He has been with NCAUR since 2010. Prior to joining NCAUR, he worked for Indium Corporation for nine years. He received his Ph.D. in organic chemistry from Texas Tech University, Lubbock, Texas, USA, in 1996.*

*Jill Winkler-Moser received a Ph.D. in Food Science and Human Nutrition from the University of Illinois, Urbana-Champaign, USA. She has been a research chemist at the NCAUR, ARS, USDA since 2005, and is lead scientist of the project team that focuses on improving the stability, functionality, and healthfulness of oils. She can be reached at jill.moser@ars.usda.gov.*

# Stabilizing edible oils with supercritical extracts from herbs

**Ignacio Vieitez, Isabel Mailhe, Mathias Braun, and Ivan Jachmanián**

Extracts from a number of common herbs and spices are rich in natural antioxidants. Such extracts not only provide efficient protection from the harmful effects of free radicals but also offer the food industry a natural alternative to synthetic antioxidants that are often used to stabilize refined vegetable oils and other food products.

Supercritical fluid extraction with carbon dioxide offers several advantages when compared with conventional organic

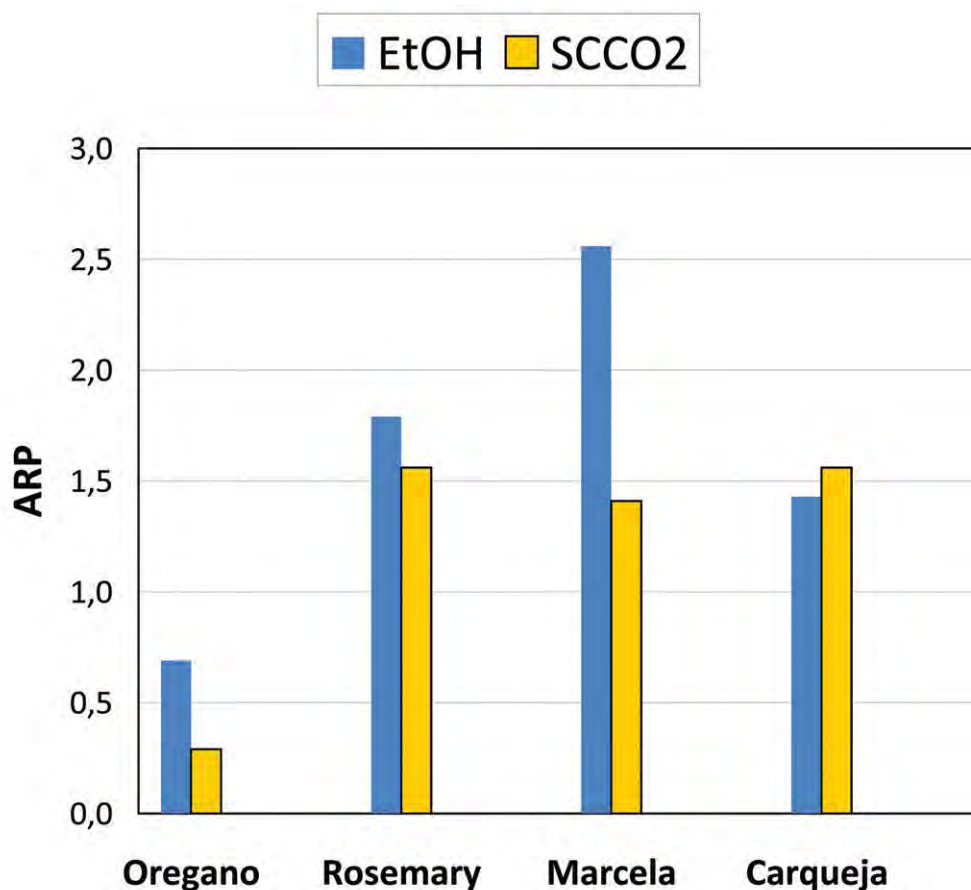
solvents: Supercritical CO<sub>2</sub> is safe, nontoxic, noncarcinogenic, and nonflammable. It also has moderate critical points (31.1°C, 7.38 MPa). Additionally, the selectivity of supercritical CO<sub>2</sub> used as extraction solvent can be conveniently adjusted by varying temperature and pressure, and supercritical CO<sub>2</sub> can be efficiently separated from the final extract by simple decompression.

Our research team recently investigated the efficiency of supercritical CO<sub>2</sub> extracts from four herbs—rosemary (*Rosmarinus officinalis*), oregano (*Origanum vulgare*), marcela (*Achyrocline satureioides*), and carqueja (*Baccharis trimera*)—in the stabilization of sunflower oil (SFO) when they were added to the oil at two different concentrations.

The supercritical extractions were performed at 40°C and 300 bar (30 MPa). Extracts from the same herbs were also obtained by a prolonged maceration (48 h) in ethanol at room temperature to compare the efficiency of the two methods.

Figure 1 shows that all the extracts exhibited some antiradical power (ARP; obtained by the diphenylpicrylhydrazyl radical,





◀ **FIG. 1.** Antiradical power (ARP) of the extracts obtained from four herbs using ethanol (EtOH) or supercritical carbon dioxide (SCCO<sub>2</sub>) as solvent. Each ARP value represents the average of two determinations. Error bar represent one standard deviation. Abbreviation: DPPH, diphenylpicrylhydrazyl radical.

or DPPH, method). Of the extracts obtained by maceration, the one obtained from marcela had the highest ARP, followed by rosemary, carqueja, and oregano. In most cases, the ARP values from ethanol extracts were higher than those from the supercritical CO<sub>2</sub> extracts. The latter showed no significant differences in the ARP between rosemary, marcela, and carqueja.

That the ARP values differed for extracts from each individual herb—obtained by maceration with ethanol and by supercritical CO<sub>2</sub>—was not unexpected since the extracts are a complex mixture of compounds whose proportions depend on their solubility in both solvents.

The effect of natural extracts on a vegetable oil's oxidative stability was studied. A sample of refined commercial SFO that had previously been purified by passage through a column of activated alumina to strip off all the natural and synthetic antioxidants was used. The oxidative stability of the purified oil, before and after the addition of the different extracts at 500 or 1000 ppm, was determined using Rancimat equipment at 100°C.

The induction period of the purified SFO (IP<sub>100°C</sub> = 1.4 h) was increased to different extents by the addition of ethanol extracts (Fig. 2, left, page 496) or supercritical CO<sub>2</sub> extracts (Fig. 2, right, page 496) at 500 or 1000 ppm.

Regardless of the extraction method used, the addition of rosemary extract at 500 or 1000 ppm increased the IP<sub>100°C</sub> of SFO by 9- or 15-fold, respectively, and was the most efficient of the four herbs in providing oxidative stability to SFO.

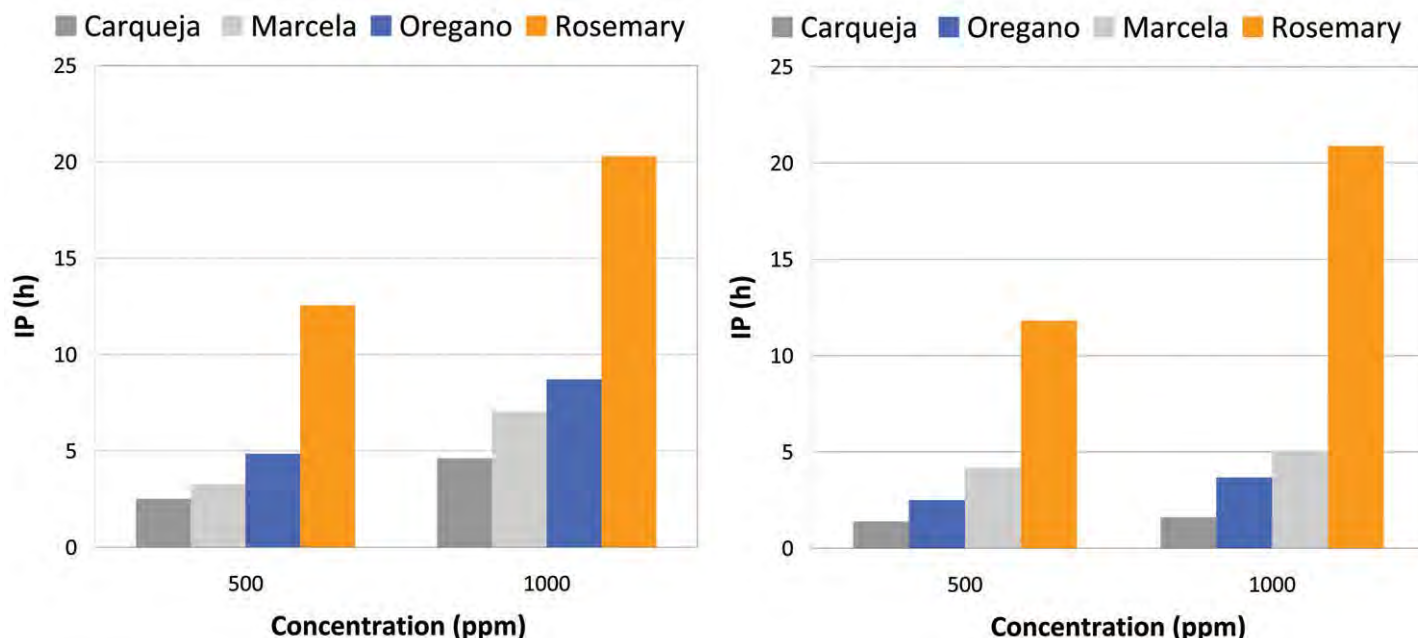
The effect on the IP<sub>100°C</sub> of the addition of the marcela or oregano extracts to SFO was lower and depended on the extraction method. While the ethanolic extract from marcela was somewhat less potent than that from oregano, the situation was reversed for the supercritical CO<sub>2</sub> extracts. This observation suggests there were differences in composition between extracts from the same herb obtained by the different solvents.

The extracts from carqueja showed the lowest protective power, doubling or tripling the IP<sub>100°C</sub> in the case of the ethanol extract added at 500 or 1000 ppm, respectively, and with almost no effect in the case of the supercritical CO<sub>2</sub> extract.

The efficiency displayed by each extract (determined by the Rancimat method) in stabilizing SFO was not related to the ARP (by DPPH method). Although both extracts from carqueja were useless for stabilizing SFO, they showed similar ARP values to those obtained from rosemary extracts, which were highly active in increasing the IP<sub>100°C</sub> of SFO. This confirms that the antioxidant actions of these two analytical methods involve different mechanisms, so that one cannot make direct extrapolation of results from one method to the other.

Table 1 (page 496) shows the effect on the IP<sub>100°C</sub> of the SFO resulting from the addition of 500 ppm of three different synthetic antioxidants commonly used in the food industry: BHT, butylated hydroxytoluene; BHA, butylated

CONTINUED ON NEXT PAGE



**FIG. 2.** Induction period at 100°C (IP<sub>100°C</sub>) corresponding to the purified sunflower oil supplemented with 500 or 1000 ppm of (left) ethanolic extract or (right) supercritical CO<sub>2</sub> extract.

hydroxyanisole; and TBHQ, *tert*-butylhydroquinone. The most effective was TBHQ, followed by BHA and BHT. Interestingly, adding rosemary extract at 500 ppm (Fig. 2) also caused an increase in the IP<sub>100°C</sub> higher than that produced by BHA and BHT, and very similar to that produced by TBHQ. In summary, addition of supercritical CO<sub>2</sub> extracts of rosemary, marcela, and oregano in a concentration of 500 ppm to purified SFO produced an increase in its oxidative stability of 8.7-, 3.1-, and 1.8-fold, respectively, whereas the extract from carqueja produced no significant effect. Addition to the oil of synthetic antioxidants TBHQ, BHA, and BHT at 500 ppm increased the oxidative stability 9.6-, 7.8-, and 6.4-fold, respectively. This indicates that, despite being an unpurified “crude” extract, this extract may provide high stability to SFO and appears as a very attractive alternative to synthetic antioxidants in the stabilization of edible oils.

Stabilizing oils with these supercritical CO<sub>2</sub> herbal extracts would increase the desirability of the product because there

would be no synthetic additives. It would also be necessary to study the flavor of the oil preserved with these herbal extracts to determine what impact this may have on consumer preferences. Economic efficiency of using these alternative antioxidants will also need to be considered.

*Each of the authors is affiliated with the Universidad de la República, Montevideo, Uruguay. Ignacio Vieitez can be contacted at [ivieitez@fq.edu.uy](mailto:ivieitez@fq.edu.uy).*

**SPECIAL REPORT ON  
NATURAL ANTIOXIDANTS  
CONTINUES ON PAGE 532.**

**TABLE 1.** Induction period at 100°C (IP<sub>100°C</sub>) of the purified sunflower oil (SFO) before and after the addition of 500 ppm of three synthetic antioxidants (BHT, BHA, and TBHQ)

Sample	IP <sub>100°C</sub> (h)
SFO	1,4
SFO + BHT (500 ppm)	8,6
SFO + BHA (500 ppm)	10,6
SFO + TBHQ (500 ppm)	12,9



## BRIEFS

AOCS has received accreditation from the A2LA Accreditation Program for Reference Material Producers, effective June 5, 2013.

A2LA, or the American Association for Laboratory Accreditation, is a non-profit, nongovernmental membership society based in Frederick, Maryland, USA. The organization offers accreditation programs based on internationally accepted criteria for competence.

Formal accreditation by A2LA ensures that certified reference materials (CRM) offered by AOCS have been produced and handled in accordance with the criteria outlined in the International Organization for Standardization (ISO) Guide 34:2009. The AOCS CRM program provides control materials for third-party qualitative testing of transformation events in agricultural commodities derived through biotechnology.

"We are pleased to have successfully undergone the rigorous audit conducted by A2LA," said Richard Cantrill, AOCS chief science officer and director of AOCS Technical Services. "And we look forward to undergoing an additional audit based on ISO/IEC 17043:2010 in order to achieve A2LA accreditation of our laboratory proficiency program."

For more information about the AOCS CRM program, visit <http://tinyurl.com/AOCS-CRM>.

■ ■ ■

AOCS member Albert J. Dijkstra points out that there are no internationally agreed-upon rules telling people where to divide a chemical name at the end of a line. The American Chemical Society has some rules about hyphenating words, but using these rules often makes it unnecessarily difficult to read or recognize the names. Dijkstra has now developed a set of rules for dividing names at the end of a line. He is soliciting comment so that he can amend his rules before submitting them for review by one or more chemical societies. You can read about his novel system in the digital edition of *Inform* via the new *Inform* app or by logging in to read the September 2013 issue at [www.aocs.org/login](http://www.aocs.org/login). Email him with comments at [albert@dijkstra-tucker.be](mailto:albert@dijkstra-tucker.be). ■

## NEWS & NOTEWORTHY



### FSMA update

"Foodborne illness is not just a stomach ache," cautioned Daniel G. McChesney during his presentation at the 119th Annual Summer Convention of the International Oil Mill Superintendents Association (IOMSA; [www.iomsa.org](http://www.iomsa.org)) held in Denver, Colorado, USA, in June 2013. "It can cause life-long chronic disease."

McChesney is uniquely positioned to give an insider's view of food safety as director of the US Food and Drug Administration's (FDA) Office of Surveillance and Compliance in FDA's Center for Veterinary Medicine in Rockville, Maryland. Although his presentation came six weeks before the release on July 26 of the next two proposed regulations under FSMA, it still provides insight into how FDA plans to proceed with implementation.

Today's food safety system must meet the demands of a food supply system vastly different from 100 years ago—or even 10 years ago, he noted. "Our food supply is truly global," he said, adding that food imports are at an all-time high. Fully 75% of seafood, 20%

of vegetables, and 50% of fruit are imported, according to FDA data.

The Food Safety Modernization Act (FSMA), which was enacted by the US Congress in 2010, was signed into law by President Barack Obama in January 2011. It mandates a change in how FDA does its work. The current system is reactive to problems but is "not so good at prevention," McChesney said. "We can't keep reacting to everything with around 100,000 domestic human food manufacturers and 12,000–15,000 manufacturers of animal feed. We need a better approach."

The new food safety system will require more on the part of manufacturers, he said. To meet the vision, industry must employ risk-based preventive measures at all appropriate points and manage its supply chains to ensure appropriate measures are being implemented as routine practice. FDA is committed to developing guidance for industry on "how to do it on a day-to-day basis," he stressed. "But in the end, it is industry that must primarily be responsible for food safety."

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According to McChesney, vegetable oil processing is a relatively low-risk industry in terms of food safety. "I had a hard time coming up with problems in this industry," he said, with the exception of past issues with distillates and dioxins from bleaching clay.

McChesney also addressed the timing of the regulations. Because the proposed FSMA rules are being published in a piecemeal fashion, the scheduling of final implementation is problematic. For example, the proposed regulations concerning produce safety and preventive controls for human foods were published in January 2013; the comment period for preventive controls has been extended until October 2013. The proposed regulations on preventive controls for animal foods, foreign supplier verification program, and third-party certification remain under review at the Office of Management and Budget (OMB).

The proposed regulation on preventive controls for animal feed establishes current good manufacturing practices (CGMP)—which has not yet been released—does not include allergens as a hazard, McChesney said. The elements of CGMP include: personnel, plant and grounds, sanitary operations, sanitary facilities and controls, equipment and utensils, processes and controls, and warehousing and distribution. He noted that the CGMP concerning equipment and utensils does not apply to suppliers.

"Is your equipment easily cleaned out? That might be a selling point," he advised the equipment suppliers in the audience.

Once hazards are identified, manufacturers must have a written plan about how to control them. In the oilseed crushing industry, "hazards are more likely to be found on the by-product/co-product side," he noted.

The exemptions and modified requirements for the preventive controls for animal feed "probably do not apply" to the vegetable oil processing industry, McChesney said. It is possible, however, that facilities that sell castoffs into the animal feed industry could qualify on the feed side of their businesses for exemptions and modified requirements.

One of the definitions of facilities that qualify for exemptions are those in which the total annual food sales average less than \$500,000 per year during the last three years and in which sales to qualified end users exceed sales to others.

FDA estimates that about 4,500 pet and animal feed firms qualify as small businesses and produce roughly 87% of manufactured pet food and animal feed based on sales. Very small businesses have less than \$1 million in annual sales. "If you run a mixed business with very little on the animal feed side, you might qualify," McChesney said.

The safety of imported foods under FSMA will require importer accountability for knowing where the foreign food is coming from and that it meets the standards set by the United States. "If products can't be inspected, they will be blocked," he cautioned.

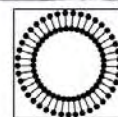
"We want your input," McChesney stressed. "Come visit or talk by phone." General questions can be emailed to [FSMA@fda.hhs.gov](mailto:FSMA@fda.hhs.gov) and more information about the regulations is available at [www.fda.gov/fsma](http://www.fda.gov/fsma).

Questions from the floor raised specific issues regarding FSMA. One questioner had problems registering his facility on the FDA website. "I don't know if I succeeded or not," he complained.

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McChesney suggested anyone with similar concerns contact him directly at [Daniel.McChesney@fda.hhs.gov](mailto:Daniel.McChesney@fda.hhs.gov).

After a question regarding the staggered comment periods for the various pieces of FSMA, McChesney said: "We will have to sync up the comment periods. The vision now is that we will leave the comment periods open until everything is synchronized. If the preventive controls for animal feed regulations are not released [during the third quarter of 2013], it is likely that the comment period for the preventive controls for human food will stay open. We have told OMB that this is a package and that we can't do them sequentially."

McChesney also advised supervisors of facilities that are currently following preventive controls for human food to use those controls for everything, including co-products going into animal feed. The alternative, he said, would be to separate out the animal feed product "if there's a split in the processing."

## LAWSUIT DETERMINATION AND FARM BILL COMPLICATIONS

About 10 days after the IOMSA Annual Summer Convention, Judge Phyllis Hamilton of the US District Court of Northern California issued a ruling regarding the lawsuit brought against FDA by two watchdog groups (the Center for Food Safety and the Center for Environmental Health) for the agency's failure to meet FSMA implementation deadlines. Hamilton rejected FDA's proposed timelines for completion of the regulations, which suggested "target timelines" of 2015–2016 for publication of all final rules.

According to Hamilton's ruling, FDA must publish all of the regulations required under FSMA by June 30, 2015. While finding the deadlines submitted by FDA to be "too fluid," Hamilton also recognized the complexity of FDA's task.

Further complicating implementation of FSMA was a provision added to the farm bill that passed the US House of Representatives in June 2013 requiring FDA to conduct a "scientific and economic analysis" of FSMA rules before they can advance. Industry observers suggested that the US Senate likely would strip the measure from the bill when the House and Senate versions are reconciled in conference.

## IMPORTED FOOD SAFETY REGS RELEASED

McChesney's remarks about FDA's desire to synchronize comment periods were substantiated when the agency released the next two proposed regulations under FSMA on July 26.

The two rules concern Foreign Supplier Verification Programs and Accreditation of Third-Party Auditors. In brief, importers must verify that their suppliers meet US safety standards for domestic producers. Comments on the two new rules are due on November 26; the comment periods for the produce safety and preventive controls in human foods regulations have been extended until November 15.

As for the missing piece of the FSMA puzzle, FDA told *Inform* in an email that "it is FDA's intention to publish the proposed rule for Preventive Controls for Food for Animals prior to November 30, 2013." ■

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# Welcome New Members



## AOCS is proud to welcome our newest members\*.

\*New and reinstated members joined from April 1, 2013 through June 30, 2013.

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## BRIEFS

The US National Biodiesel Board (NBB) opened its membership in the second quarter of 2013 to include qualified renewable diesel producers. In the announcement, Joe Jobe, CEO of NBB said, "While produced with different technologies, biodiesel and renewable diesel are close cousins with a lot of shared interests, particularly in policy areas such as the RFS [Renewable Fuel Standard] and the blender's tax incentive. Joining forces puts us in a much stronger position as a coalition to . . . spread the word that these policies are working and that advanced biofuels are here today."

■ ■ ■

SGB, Inc. (SG Biofuels) announced in June that it has identified, through its global network of field trials, fungal rust (*Phakopsora arthuriana*)-resistant hybrids of *Jatropha curcas*. Rust-related diseases can be destructive not only to *jatropha* but also to mainstream crops. Discovery of the trait indicates the plant has a critical defense that will help ensure plant health and yield preservation. The UN Food and Agriculture Organization estimates that 29 countries in Africa, Asia, and Southeast Asia, accounting for 37% of global wheat production, are currently affected by or at risk from wheat stem rust. Asian soybean rust (*P. pachyrhizi*) increased 84% in Brazil this past crop season compared with the previous year, according to the Embrapa Consortium of Anti-rust. SGB now has 13 locations in Brazil, India, and Central American where it is testing *jatropha* hybrids for commercial deployment.

■ ■ ■

A research group headed by Michael Adams of the University of Georgia (Athens, USA) found that at 78°C the anaerobic bacterium *Caldicellulosiruptor bescii* was able to solubilize the majority (85%) of insoluble switchgrass biomass that had not been previously chemically treated. The organism was able to solubilize lignin as well as carbohydrates. The authors suggested that simultaneous microbial lignin and carbohydrate solubilization would be useful in industrial

## BIOFUELS+



## Using ultrasound in making biofuels, chemicals

*Soybean oil and biomass.* Engineers with Iowa State University (ISU; Ames, USA) reported at the 21st International Congress on Acoustics in June 2013 that pretreating a wide variety of feedstocks (including switchgrass, corn stover, and soft wood) with ultrasound consistently enhanced the reactions necessary to convert the biomass into fuels and chemicals.

David Grewell, associate professor of agricultural and biosystems engineering, and his colleagues at ISU showed that ultrasound can accelerate transesterification of soybean oil into biodiesel. Using ultrasound, they found the reaction took place in less than a minute, rather than the more usual 45 minutes. Additionally, yeast grown on by-product glycerin from the production of biodiesel could be extracted and simultaneously converted to biodiesel with ultrasonics in less than a minute (<http://tinyurl.com/ISU-glycerin>).

In another example, lignin could be removed much more efficiently from plant cell walls if the biomass was pretreated with ultrasound. The researchers found that sugar dissolution from the cellulose and hemicellulose

fractions also present in the cell walls occurred in minutes rather than the hours needed with traditional mixing systems (<http://tinyurl.com/ISU-ultrasound>).

Grewell and his team also showed that the hydrolysis of corn starch, derived from ground corn, could be greatly accelerated using ultrasonics. The sound fractured the corn into tiny particles, creating more surface area for enzymes to react, releasing glucose from the corn for fermentation into ethanol.

Ultrasonics potentially offers cost savings in making biofuels, said Grewell. "Economic models have shown that once implemented, this technology could have a payback period of less than one year."

*Algae.* Scientists with the National Physical Laboratory, located in Middlesex, England, are working with partners from Spain, Netherlands, and Turkey to develop an ultrasound-based flow processor that will harness low-power sound to increase the concentration of algae prior to harvesting them for uses as disparate as fuel and pharmaceuticals. The device they are working with is called an Algae-max Flowcell; it is designed to create acoustic standing waves in the algal liquid, which will generate local forces on particles, causing the algae to clump together. This will effectively

CONTINUED ON NEXT PAGE

situations involving biomass requiring limited or no chemical pretreatment. For further information see I. Kataeva, *et al.*, *Energy Environ. Sci.*, 2013. doi: 10.1039/c3ee40932e.

■ ■ ■

The US government has spent much time and treasure to increase the transportation use of biofuels in the country. At present, most gasoline sold is required by law to be E10 (i.e., 10% ethanol and 90% petroleum-based gasoline), and E15 is now approved for use in cars and light trucks manufactured since 2001. The push to increase ethanol usage has been contentious. In June, Rick Scott, the governor of the state of Florida, signed a bill repealing the law requiring that gasoline sold in the state be E10. In response, Paul Woods, the CEO of Algenol Biofuels, a Florida-based biotechnology company making ethanol from algae, announced he was scrapping plans to build a nearly \$500-million ethanol production plant in Florida. The facility had already been started and was already employing 120 people. Woods said construction of the full plant would have provided 2,000 more jobs. He added that he would look at sites in other states, including Texas, New Mexico, and Arizona. ■

concentrate the algae from their original 0.5% to 5%. At this higher concentration they can be separated out using ordinary commercial technologies. One of the technical challenges is to ensure that the algae are not destroyed by high acoustic pressures through the process of cavitation, that is, the formation of bubbles. Project leaders predict microalgae harvesting costs can be reduced 65% with the Algaemax process (<http://tinyurl.com/AlgaeMax>).

## Feedstock for German biodiesel

Berlin-based UFOP (Union zur Förderung von Oel- und Proteinpflanzen e.V.) reported in July that rapeseed oil remains the most important raw material source for the production of biodiesel in Germany, at 53%. Palm oil is second, at 25%, and coconut and soybean oil are both 11%. These data are based on samples collected at 60 filling stations throughout the country, weighted according to market shares of the mineral oil companies that own the stations.

In this report UFOP pointed out that in 2010 and 2011 virtually the only certified (as defined by the European Union's Renewable Energies Directive, or RED) rapeseed oil available in Germany for domestic production of biodiesel came from Germany itself, thus greatly benefitting the country's farmers during those years.

Certification of feedstock came about through national implementation of the Renewable Energies Directive (RED). Appearing initially in 2009, with revisions since, RED is a directive of the European Union (EU) that mandates levels of renewable energy use within the EU.

The UFOP report shows that the raw materials being used for biodiesel in Germany today reflect the fact that certification systems have now been introduced in countries outside the EU that supply feedstocks to the EU, including Argentina, Brazil, Indonesia, and Malaysia. In other words, "the supply of sustainably certified raw materials for biofuel production has . . . become globalized" (<http://tinyurl.com/UFOP-cert-fuel>).

## Algae oil to be feedstock for renewable diesel

Finland's renewable biodiesel company Neste Oil has signed a contingent commercial off-take agreement with Cellana (formerly HR BioPetroleum), an algae biomass developer based in the US states of Hawaii and California. Under the agreement Neste Oil will purchase Cellana's ReNew Fuel crude algal oil as a feedstock for production of renewable fuel. The agreement is contingent on Cellana's future production capacity and on compliance with future biofuel legislation in the European Union and the United States.

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Cellana has almost a decade of experience in growing oil-rich marine microalgae. Its ALDUO technology, which couples closed-culture photobioreactors with open ponds in a two-stage process, has yielded over 20 metric tons of algae biomass at the company's six-acre demonstration plant in Kona, Hawaii. Cellana expects to be able to produce algae oil on a commercial scale from late 2015 onward.

Neste Oil's Senior Vice President, Technology, Lars Peter Lindfors said, "The off-take agreement . . . fits very well with our strategy aimed at extending the range of feedstocks we use for [Neste's] NExBTL renewable fuel" (<http://tinyurl.com/Cellana-Neste>). Cellana's present business model looks to harvest three kinds of products from algae: high-priced nutritional supplements, such as omega-3 fatty acids, animal feeds, and biofuels. If Cellana is able to scale up production, the company might wind up with a total capacity of at least 100,000 metric tons of algae biomass per year (<http://tinyurl.com/potential-Cellana>).

## Cold-tolerant lipid-producing alga

A new yellow-green alga has been isolated from snow fields in the Rocky Mountains near Breckenridge, Colorado, USA. The organism, tentatively named *Heterococcus* sp. DN1 was selected for study because of its high degree of lipid accumulation.

The organism was reported by David R Nelson and co-workers from the University of Minnesota (St. Paul, USA). When grown at 4°C, the alga accumulated large amounts of lipids in abundant

Einstein, Newton, and Pascal were getting ready to play hide and seek. Einstein agreed to be "It" and covered his eyes.

Pascal scampered away, but Newton carefully drew a box one meter on a side on the ground and stepped inside it.

Einstein reached the count of 10, uncovered his eyes, and saw Newton standing there. He said, "I found you, Newton, now you're it."

Newton replied, "You see one Newton per square meter—you've found Pascal!"

[for the uninitiated, a pascal is a unit of pressure equal to one newton per square meter, or about 0.000145 PSI]

spherical intracellular droplets of varying sizes, starting at about one week from the initiation of growth. The organism had considerable tolerance to drying, and cultures would grow readily after six months of desiccation.

On average, a mature culture (>1 month) of *H. sp.* DN1 contained 55% ( $\pm 3\%$ ) lipids by dry weight. Analysis by gas chromatography followed by mass spectroscopy showed that the dominant lipid species at 4°C were palmitoleic acid (16:1, or PA; 20% of total lipids) and eicosapentaenoic acid (20:5, or EPA; 25% of total lipids).

The researchers suggested that, if the organism were to be developed for commercial purposes, the high content of PA would be useful for those interested in biofuels and EPA for use in nutritional supplements.

For further information, see D.R. Nelson *et al.*, New lipid-producing, cold-tolerant yellow-green alga isolated from the Rocky Mountains of Colorado, *Biotechnol. Progr.*, 2013. doi:10.1021/btpr.1755. ■

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**Alejandro Marangoni** is a professor and Tier I Canada Research Chair in Food, Health and Aging at the University of Guelph. His work concentrates on the physical properties of foods, particularly fat crystallization and structure. He has published over 200 refereed research articles, nine books, and 14 patents. He is the recipient of many awards, including a 1999 Premier's Research Excellence Award, the first Young Scientist Award (2000), and the Stephen S. Chang Award (2013) from the American Oil Chemists' Society, a Tier II Canada Research Chair in Food and Soft Materials Science (2001–2011), two Distinguished Researcher Awards from the Ontario Innovation Trust (2002), a Career Award from the Canadian Foundation for Innovation (2002), an E.W.R. Steacie Memorial Fellowship (2002)—given to the top 6

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In an item completely unrelated to fats and oils but that gives hope for aging brains, scientists led by Kirsty L. Spalding of Stockholm's Karolinska Institute reveal that up to 1,400 new neurons are created daily in the adult human brain. The team "carbon dated" neurons by measuring  $^{14}\text{C}$  concentration in DNA from hippocampal neurons of deceased humans. The strategy took advantage of the elevated atmospheric levels of  $^{14}\text{C}$  stemming from above-ground nuclear bomb testing more than 50 years ago in the United States and the former Soviet Union. The work appeared in *Cell* (doi:10.1016/j.cell.2013.05.002, 2013).

■■■

The World Health Organization has developed FOSCOLLAB—a new platform for food safety professionals available at [www.who.int/foodsafety/foscollab](http://www.who.int/foodsafety/foscollab). FOSCOLLAB integrates food safety data and information using four elements: food, hazards, country, and date/year. Information has been pulled from the Codex Alimentarius Commission, the Joint Expert Committee on Food Additives, the WHO Collaborating Centres Database, and the WHO/Global Environmental Monitoring System database.

■■■

Blood levels of free fatty acids are associated with insulin resistance during young adulthood and cardiovascular risk factors in later adulthood, according to a study published online May 13 in *Diabetes* (doi:10.2337/db12-1122, 2013). Researchers led by Brigitte I. Frohnert of the University of Minnesota in Minneapolis (USA) examined the relationship of serum total free fatty acids to adiposity, insulin resistance, and cardiovascular risk factors in 207 individuals at 15 and 22 years of age, as well as their parents. The researchers found that while there was no significant association between free fatty acids and insulin resistance at 15 years of age, the association became significant at 22 years of age, and free fatty acids at 15 years of age estimated insulin resistance at 22 years of age. In the parents, there was a significant association between free fatty acids and body mass index (BMI), percent body fat, systolic blood pressure, low-density lipoprotein cholesterol, and insulin resistance, although adjusting for BMI attenuated all associations except insulin resistance. ■

## HEALTH & NUTRITION



### Composition of diacylglycerols determines signaling patterns

Previous work has shown that disruptions of lipid signal transmission appear to be involved in diseases such as atherosclerosis (the deposition of fatty deposits on artery walls) and diabetes, as well as inflammation and pain. Now, researchers from Heidelberg report on lipids that can be activated by light and used to manipulate signaling processes in cells with both spatial and temporal control.

To communicate with each other and react to external stimuli, cells need signal-transmission mechanisms. The signal cascades involved are complex and vary greatly from one cell type to the next. For example, one type of cascade involves the activation of phospholipase C, which then splits a membrane building block into inositol trisphosphate and diacylglycerol (DAG). These compounds, in turn, serve as secondary messengers within the cell.

DAG anchors the enzyme protein kinase C (PKC) to the cell membrane and activates it. In addition, DAG can open certain calcium channels in the cell membrane, allowing

calcium ions to flow into the cell. This stimulates further steps, eventually triggering physiological responses such as changes in gene expression.

Lipids as secondary messengers have received relatively little attention from researchers. And the work that has been done has not looked at how different hydrocarbon chains can affect signaling.

To help address this lack, Carsten Schultz and a team from the European Molecular Biology Laboratory (EMBL) in Heidelberg synthesized DAG with a variety of chains and locked their glycerol heads into "cages"—molecules attached so as to block and deactivate the head group. The cages are designed with a built-in "break away" point that breaks open upon irradiation with light, thereby releasing the DAG. These types of molecules that are activated by light make it possible to deliver biologically active signal molecules at a specific time and place with subcellular resolution.

The researchers were able to demonstrate that the activation of PKC is locally limited by DAG, whereas the elevation of internal calcium ion concentration through activation of calcium channels affects the entire cell. Surprisingly, these effects seem to be dependent on the fatty acid composition of the lipid. One

CONTINUED ON NEXT PAGE

of the DAG variants induced fewer, shorter, and weaker elevations of the calcium level; another caused stronger, long-lasting calcium signals. A third had no significant influence on the intracellular calcium concentration.

"If this variability concerning the fatty acid composition should influence the control of cellular processes in most lipids, a completely new level of complexity has to be considered in cell biology," says Schultz. "Furthermore, our results demonstrate that cells can respond to a given spatially confined signal with both a local and a global response pattern. Local signaling is particularly important in polarized and migrating cells, where different signals are needed at opposite ends of the cell."

The study appeared in *Angewandte Chemie* (doi:dx.doi.org/10.1002/anie.201301716, 2013).

## Unintended consequences

US scientists report the surprising finding that two proteins involved in taste detection also play a crucial role in sperm development in mice.

"This paper highlights a connection between the taste system and male reproduction," said lead author Bedrich Mosinger, a molecular biologist at the Monell Chemical Senses Center in Philadelphia, Pennsylvania, USA. "It is one more demonstration that components of the taste system also play important roles in other organ systems."

While breeding mice for taste-related studies, the researchers discovered the mice were unable to produce offspring that were simultaneously missing two taste-signaling proteins.

As reported in the *Proceedings of the National Academies of Sciences* (doi:10.1073/pnas.1302827110, 2013), the critical proteins were TAS1R3, a component of both the sweet and umami (amino acid) taste receptors, and GNAT3, a molecule needed to convert the oral taste receptor signal into a nerve cell response.

Breeding experiments determined that fertility was affected only in males. Both taste proteins had previously been found in testes and sperm, but until now, their function there was unknown.

To explore the reproductive function of the two proteins, the research team engineered mice that were missing genes for the mouse versions of TAS1R3 and GNAT3 but expressed the human form of the TAS1R3 receptor. These mice were fertile.

However, when the human TAS1R3 receptor was blocked in the engineered mice by adding the drug clofibrate to the rodents' diet, thus leaving the mice without any functional TAS1R3 or GNAT3 proteins, the males became sterile owing to malformed and fewer sperm. The sterility was quickly reversed after clofibrate was removed from the diet.

Clofibrate belongs to a class of drugs called fibrates that frequently are prescribed to treat lipid disorders such as high blood cholesterol or triglycerides. Previous studies from the Monell team had revealed that clofibrate is a potent inhibitor of the human, but not mouse, TAS1R3 receptor.

Noting the common use of fibrates in modern medicine and the widespread use in modern agriculture of the structurally related phenoxy herbicides, which also block the human TAS1R3 receptor, Mosinger speculates that these compounds could be negatively affecting human fertility, an increasing problem worldwide.

He in turn notes positive implications related to the research. "If our pharmacological findings are indeed related to the global

increase in the incidence of male infertility, we now have knowledge to help us devise treatments to reduce or reverse the effects of fibrates and phenoxy compounds on sperm production and quality. This knowledge could further be used to design a male nonhormonal contraceptive."

Earlier studies from Monell and other groups have shown that some taste genes can be found in other parts of the body, including stomach, intestines, pancreas, lungs, and brain, where they are increasingly thought to have important physiological functions.

## Omega-3 fatty acids may reduce breast cancer risk

A review published in *BMJ* of prospective cohort studies suggests that intake of long-chain polyunsaturated (LC-PUFA) omega-3 fatty acids from oily, coldwater marine fish such as salmon, tuna, or sardines may help reduce the risk of breast cancer.

The researchers reviewed 21 different studies that looked at the intake of fish and PUFA among 883,585 women in the United States, Europe, and Asia. Among those women, 20,905 had breast cancer. The follow-up time varied, from four years to 20.

The researchers found that PUFA from marine sources were associated with a 14% reduction of risk of breast cancer, and the relative risk remained similar whether marine omega-3 PUFA were measured as dietary intake or as tissue biomarkers. For every 0.1 gram-per-day increase in the intake of the fatty acids, there was a 5% lower risk of breast cancer, the study found. No significant association was observed for fish intake itself or exposure to  $\alpha$ -linolenic acid.

The researchers concluded: "Higher consumption of dietary marine [omega-3] PUFA is associated with a lower risk of breast cancer. These findings could have public health implications with regard to prevention of breast cancer through dietary and lifestyle interventions."

The review (doi:dx.doi.org/10.1136/bmj.f3706, 2013) was led by Duo Li of the Department of Food Science and Nutrition at Zhejiang University in Hangzhou, China.

## Unraveling the complexity of human breast milk

Scientists are making strides toward unraveling the surprisingly complex chemistry underpinning the beneficial effects of human breast milk, according to a recent article in *Chemical & Engineering News* (91:28–29, 2013).

Author Jyllian Kemsley points out that recent findings reveal many intriguing and sometimes counterintuitive ways in which sugars, proteins, and fat in human breast milk interact with microbes in infants' intestines to nourish babies and protect their health. For instance, scientists have discovered that breast milk contains oligosaccharides, complex sugars that babies cannot even digest. It turns out that these oligosaccharides, rather than providing nutritional value directly to infants, actually confer protection. They feed beneficial intestinal bacteria that seem to crowd out harmful *E. coli* strains that might otherwise thrive. ■



## BRIEFS

In late May 2013, Monsanto (St. Louis, Missouri, USA) announced it would no longer lobby European governments to allow the cultivation of its genetically modified (GM) seeds. Nor would Monsanto make any further efforts to acquire licenses for any new GM plants or to conduct field trials of GM seeds in most of western Europe. BASF, Syngenta, and Bayer CropSciences, which also are heavily involved in producing GM seed, already have withdrawn from the European market.

Monsanto intends to sell its corn event MON810 in Spain, Portugal, and Romania, where objections to GM products are less, and also gain approval to import GM cattle feed.

■■■

Although corn starch is well known as a feedstock for ethanol production for the biofuel industry, corn oil has a number of uses as well, such as an ingredient of animal feed, a feedstock for biodiesel production, and a component of soaps. Novozymes, headquartered in Bagsværd, Denmark, announced in June the introduction of new enzyme technology that it claims can increase corn oil extraction by 13% and ethanol yield by up to 5%. These technologies can also produce 8% savings in energy costs. Two new enzymes, Olexa (which releases bound oil in oleosomes in the germ) and Spirizyme Achieve (a glucoamylase that is able to break down fiber and make starch accessible), are used in combination with the enzyme Avantec (starch hydrolyzer) to achieve these results.

According to a study out of the University of Illinois-Chicago (USA), there was a nearly fivefold increase in corn oil production in the US ethanol industry between 2008 and 2012 (<http://tinyurl.com/CornOil-Enzymes>). Novozymes estimates that about 80% of the operating ethanol capacity in the United States will have incorporated oil extraction into its plants by the end of 2013 (<http://tinyurl.com/CornOilExtraction>).

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# BIOTECHNOLOGY NEWS



## Programming bacteria to make precursors for fuel, biobased chemicals

Research identifying new lines of engineered bacteria that can tailor-make key precursors of high-octane biofuels that could one day replace gasoline was published in late June by scientists at the Wyss Institute for Biologically Inspired Engineering at Harvard University and the Department of Systems Biology at Harvard Medical School (Boston, Massachusetts, USA).

In a statement released by the university, Pamela Silver, senior author of the study, said, "The big contribution is that we were able to program cells to make specific fuel precursors." The same lines can also produce precursors of pharmaceuticals, bioplastics, herbicides, detergents, and more.

Present-day oil refineries produce medium-chain-length compounds from crude oil. But Silver pointed out that "instead of using petroleum products, you can have microbes or other living organisms do it for you."

Silver and coworkers have been using the bacterium *Escherichia coli* to synthesize fatty acids, specifically medium-chain fatty acids ( $C_4$ – $C_{12}$ ). Fatty acids with shorter chains do not contain enough energy to be good fuels,

and fatty acids with longer chains are too "waxy" to make into fuels.

In one set of experiments, the scientists administered a drug that blocks enzymes that extend fatty-acid chains. Medium-chain fatty acids could accumulate (while still leaving the organism competent to reproduce), but the drug was too expensive for routine use.

In a second strategy, the scientists programmed an essential ketoacyl synthase in the organism to degrade in response to a chemical inducer, thus slowing fatty acid chain elongation beyond eight carbon atoms and leading to octanoate accumulation.

The scientists next plan to engineer *E. coli* to convert octanoate and other fatty acids into alcohols, just one chemical step away from octane.

For further information, see J. Torrella, *et al.*, Tailored fatty acid synthesis via dynamic control of fatty acid elongation, *Proceedings of the National Academy of Science*, 2013. doi:10.1073/pnas.1307129110.

## Solazyme, Roquette end microalgae JV

US algal oil company Solazyme, Inc. (South San Francisco, California) and starch derivatives company Roquette Frères, S.A. (Lestrem, France) mutually ended their joint venture (JV) on June 24, 2013. The

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In its annual food and health survey, conducted in April 2013, the International Food Information Council Foundation polled 1,006 Americans, ages 18 to 80, for their thoughts on the question "What other information that is not currently on the food package, if any, would you like to see there?" Only 3% of the respondents indicated they would like to see whether the product in the package contains genetically modified organisms (<http://tinyurl.com/IFICSurvey>).

■ ■ ■



A recent investigation studied the effects on pigs of consuming a diet derived from genetically modified (GM) feed. The pigs were weaned at the same time; and then 64 were fed a mixed GM soy and GM corn diet, and 64 were fed an equivalent non-GM diet in a study that ran for 23 weeks. The researchers, headed by Judy Carman (Institute of Health and Environmental Research, Kensington Park, South Australia), reported no differences between the two groups in feed intake, weight gain, mortality, and routine blood biochemistry measurements. However, female pigs fed the GM diet had uteri that were 25% heavier than non-GM fed pigs ( $P = 0.025$ ), and GM-fed pigs had a higher rate of severe stomach inflammation than non-GM-fed pigs (32% vs. 12%,  $P = 0.004$ ). For further information see Judy A. Carman *et al.*, A long-term toxicology study on pigs fed a combined genetically modified (GM) soy and GM maize diet, *Journal of Organic Systems* 8:38–54 (2013). Commentary on the internet since the paper appeared in June (e.g., <http://tinyurl.com/GMOs-and-pig-diets>) has pointed out issues with statistical analysis of these data. ■

two companies could not agree on how to market and distribute their food ingredients made from microalgae. The companies had formed the joint venture (JV) Solazyme-Roquette Nutritionals in 2010, becoming fully operational in 2011.

Through the work of the JV, Roquette owns a facility in Lestrem, France that can produce 5,000 metric tons (MT) of product per year. Construction on the third phase of the facility, which will increase production to 50,000 MT per year, will begin in 2015.

Solazyme said in a press release it is better positioned to market its own microalgae products without the JV. The company plans to produce 100,000 MT per year of products through its other JVs with Bunge, Archer Daniels Midland, and other companies.

San Diego, California, USA law firm Johnson & Weaver, LLP, stated it is investigating whether certain Solazyme officers and directors violated state or federal laws when communicating to shareholders about the status of the JV. According to the firm, management members aggressively sold their shares in April and May before the announcement, and shareholders may have received false encouragement over the JV's status.

Solazyme and Roquette marketed their microalgae products independently of each other at the 2013 Institute of Food Technology Annual Meeting and Expo held July 14–16, 2013. Both companies plan to have their products ready for commercial production by 2014. Roquette will sell its microalgae flour, an algae powder fortified with fibers and proteins and used as a replacement in cooking applications for fats, such as eggs and butter. Solazyme will have a microalgal flour lipid replacement, as well as an algal protein product for protein fortification. Solazyme is also working on a line of algal oils for its Novel Food Oils portfolio.

## GM yeast produces large quantities of EPA: implications

DuPont (Wilmington, Delaware, USA) scientists created a strain of yeast that produces the highest amount yet of eicosapentaenoic acid (EPA; 20:5n-3). The yeast generates 15% of its dry cell weight in EPA. The new oil source may curb overfishing of

fatty fish such as salmon that are currently the best sources of EPA and help support the fish oil supplement market, which reached \$1 billion in sales in 2010 (<http://tinyurl.com/fishoilbrew>)

In a paper published in *Nature Biotechnology* (doi: 10.1038/nbt.2622) on July 21, 2013, a research team led by DuPont's Quinn Zhu used metabolic engineering of the oleaginous yeast *Yarrowia lipolytica* to create the yeast strain Y4305. The yeast lipid comprises 56.6% EPA and less than 5% saturated fatty acids by weight, the highest and lowest percentages, respectively, among known EPA sources.

The yeast can also be used as food for salmon in aquaculture facilities, which would yield omega-3 fatty acid-enriched fish products. The technology also encourages the production of other lipids with tailored fatty acid compositions. The yeast-borne lipids are currently sold as a vegan alternative to fish-extracted oils.

## South Korea lifts ban on US wheat imports, search for Monsanto GM wheat source continues

With the search ongoing for the source of the genetically modified (GM) wheat discovered in an Oregon, USA field in May 2013, South Korea and Taiwan lifted their bans on importing US wheat from the Pacific Northwest and ended their restrictions on Oregon-based wheat purchases in July 2013. The bans were placed in May shortly after the discovery. South Korea will continue to test the wheat it receives for biological markers indicative of GM strains. As of press time Japan had not lifted its ban, but it was testing wheat shipments. If no GM was found, country officials planned to lift the ban in August 2013.

The USDA has narrowed the search for the strain of herbicide-resistant Roundup Ready wheat from Monsanto (St. Louis, Missouri, USA), MON71800, to the 16 states Monsanto had field tested its crop in (*Nature*; doi: 10.1038/499262a).

Identification of the source of the rogue seeds may help determine how they were planted in the field: If they come

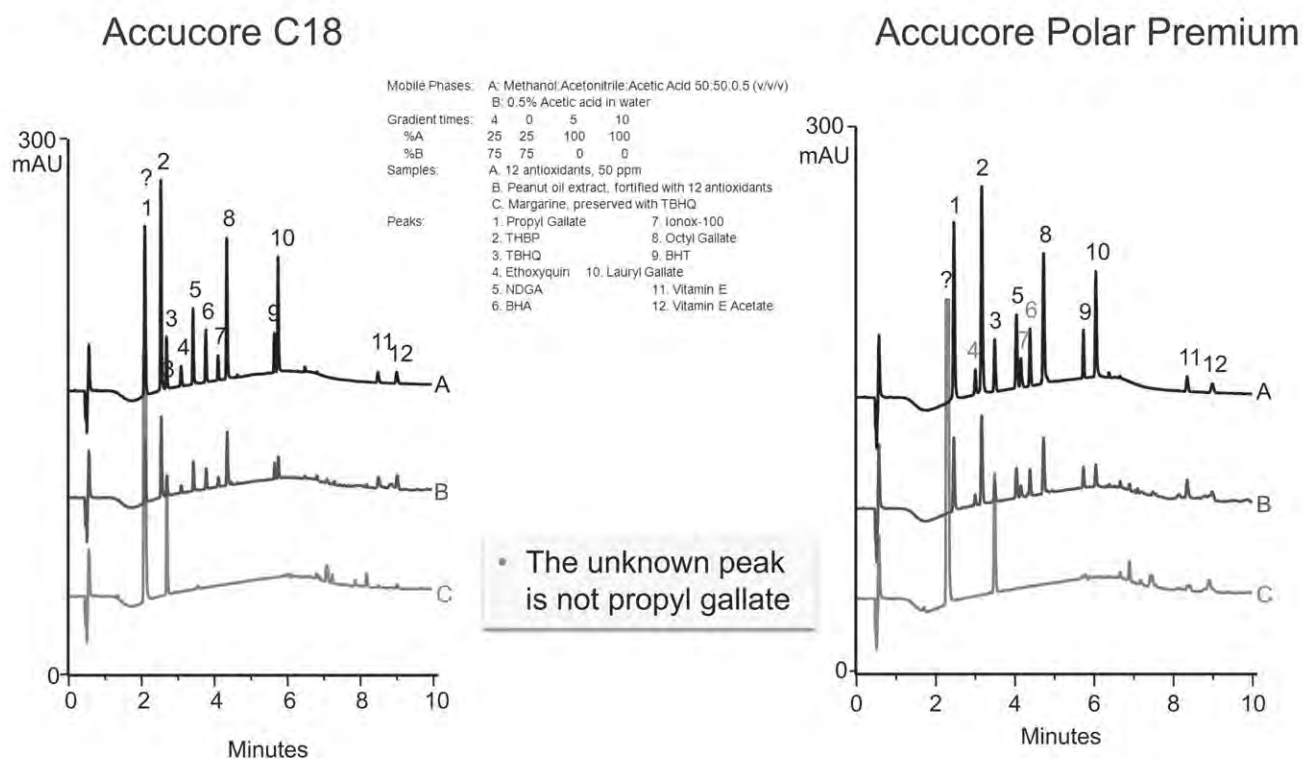


from nearby states such as Washington, Idaho, or Oregon, the contamination may be accidental, whereas seeds from more distant testing sites in Minnesota, Nebraska, or Illinois may imply that seeds were intentionally kept and released after the MON71800 trials ended in 2005. Monsanto representatives

have said the seeds were planted as a form of company sabotage, but this theory has received little scientific support so far (<http://tinyurl.com/Monsanto-sabotage>). According to Monsanto, the seeds, planted on 400 hectares of land during field trials, were accounted for and either secured or destroyed. ■

## [FAST FACT]

### Accucore C18 Polar Premium Comparison



Courtesy of ThermoFisher Scientific

## Mystery in the margarine

The analysis of antioxidants in edible oils is essential in determining whether an oil is fortified against oxidation (which can lead to rancidity) or if there are other components present in the oil.

Researchers at Thermo Scientific in Sunnyvale, California, USA, recently analyzed antioxidants in a household margarine by high-performance liquid chromatography according to the AOAC 983.15 method. Results obtained using a Thermo Scientific™ Accucore C18™ column revealed a peak that elutes at the same time as propyl gallate, but propyl gallate was not listed as an ingredient. The results

(left figure) were compared against a peanut oil fortified with 12 antioxidants.

Was the mystery peak propyl gallate, which the manufacturer neglected to list on the label? Or was it the result of a matrix interference effect from another antioxidant or an unidentified constituent? To find out, researchers Mark Tracy, Paul Voelker, and Xiaodong Liu repeated the analysis with a second column type, an Accucore Polar Premium™. Results (right figure) show that the margarine mystery peak elutes earlier than propyl gallate and that the tert-butyl hydroquinone (TBHQ) in the margarine overlays with the TBHQ in the peanut oil. The conclusion is the mystery peak is an (as yet) unidentified constituent.

Codexis Inc., a developer of engineered enzymes for pharmaceutical, biofuel, and chemical production, and Chemtex, a provider of chemical engineering and renewable processes, announced in June 2013 the successful scale-up in the production of CodeXol® detergent alcohols using cellulosic sugars. The scale-up was achieved at a 1,500 liter (400 gallon) demonstration facility at Chemtex's research and development complex in Tortona, Italy, and is a milestone in the ongoing effort initiated by the two companies to develop a fully integrated biomass-to-detergent-alcohols technology.

■ ■ ■

Denmark's Novozymes has introduced a new enzyme technology (Blaze® Ecity® 16 L) that it says improves the performance of liquid automatic dishwashing formulations on protein-based soils.

"More and more customers are turning to liquids or gel caps when they wash their dishes in a dishwasher," the company said in a news release. "This is particularly [the] trend in Europe and North America where the market for liquid automatic dishwashing solutions has grown by 23% from 2002 to 2012, according to Euromonitor International."

■ ■ ■

Switzerland's Clariant International Ltd. and Singapore's Wilmar International Ltd. received regulatory clearances in July 2013 to establish a 50:50 global amines joint venture (JV). The JV will be based in Singapore, according to the companies, with dedicated production capacities for amines in Germany and China. The new JV will produce and sell fatty amines and selected amine derivatives.

■ ■ ■

In the second quarter of 2013, BASF announced it had strengthened its position in the enzymes market with three transactions including the acquisition of Henkel's detergents enzyme technology and a research and development collaboration with Germany's Direvo Industrial Biotechnology to develop a feed enzyme for animal nutrition. The final deal involves a research and license agreement with Dyadic International, a biotechnology firm based in Jupiter, Florida, USA, for access to a new production host technology. ■

## SURFACTANTS, DETERGENTS, & PERSONAL CARE NEWS



### EU cosmetics rules come into force

The European (EU) cosmetics Regulation EC No 1223/2009 became fully applicable on July 11, 2013.

According to the *Chemical Watch* (CW) news service, the most significant changes introduced by the regulation include:

- An obligation for manufacturers to follow specific requirements when preparing a product safety report prior to placing a product on the market.
- The restriction that only cosmetic products for which a "legal or natural person" is designated within the EU as a "responsible person" may be placed on the market. The responsible person (who must be based in the EU) can be the manufacturer, the importer, the distributor, or a person/company designated as the responsible person (and who has accepted this role in writing).
- The centralized notification of all cosmetic products placed on the EU market via the EU Cosmetic Products Notification Portal (<http://tinyurl.com/CPNP-Portal>). This has been optional for the last 18 months and now becomes mandatory. There are

already around 200,000 notifications in the system, CW noted.

- The introduction of the proactive reporting of serious undesirable effects.
- New rules for the use of nanomaterials in cosmetic products, including their labeling in the ingredients list with the word "nano" in brackets following the name of the substance; and
- A parallel new Regulation EC No 655/2013 adopted on July 10 that sets out common criteria for cosmetic claims.

In related news from the United States, the Food and Drug Administration (FDA) announced in June 2013 that export certificates for US-produced cosmetic products are available now only online.

The FDA Certificate Application Process (CAP) website allows cosmetic exporters to apply online for a cosmetic export certificate using FDA's secure web portal. To create an account in CAP, visit <https://www.access.fda.gov/oaa>, select "Create New Account," then select "Certification Application Process" and fill in the required contact information. Applicants will receive an email notification when the account has been activated, FDA said.

*Chemical Watch* also reports that India has imposed a ban on animal testing of domestic



cosmetics. The move was announced by Drugs Controller General G.N. Singh at a meeting in New Delhi on June 28. The decision to ban tests previously allowed under India's cosmetics safety testing standard IS4011:1997 was made at a meeting of the Bureau of Indian Standards Cosmetics Sectional Committee, CW said.

## Sustainability standard for home laundry appliances

The first voluntary sustainability standard for home laundry appliances has been released by three US-based industry groups. The new standard is the second in a family of product sustainability standards under development by The Association of Home Appliance Manufacturers (AHAM), CSA Group, and UL (Underwriters Laboratories) intended for use by manufacturers, governments, retailers, and others to identify environmentally preferable products. The first sustainability standard developed by the three groups covered home refrigeration appliances.

The standard (AHAM 7003-2013/CSA SPE-7003-13/UL 7003, Sustainability Standard for Household Clothes Washers) is based on a lifecycle approach for identifying the environmental impacts of household clothes washers in six key areas: materials, manufacturing and operations, energy and water consumption during use, end-of-life options, consumables, and innovation.

## Loofah plant seeds absorb organic pollutants

Seeds and oils from the plant that produces the loofah sponge could help purify wastewater and prevent the spread of waterborne diseases in the developing world, according to a researcher who spoke at the 17th Annual Green Chemistry & Engineering Conference held in June 2013 in Bethesda, Maryland, USA. The low-cost, biodegradable seeds and substances made from oils of these seeds are particularly effective at absorbing heavy metals and other potentially harmful organic compounds from polluted water, he said.

Adewale Adewuyi, a lecturer at Redeemer's University in Mowe, Nigeria, noted that rain water, rivers, and streams are the most common direct sources of drinking water in many developing countries. Often, this water is polluted with substances from factories and agricultural runoff, which can harm both people and animals. In 2010, for instance, lead poisoning in Nigeria—which was later linked to industrial wastewater—claimed the lives of more than 500 children in less than seven months, he reported.

Absorbents, such as activated carbon, can help remove these pollutants from water. However, they work slowly, are only effective in a limited pH range, and are expensive. To help overcome this problem, Adewuyi turned to the seeds of the *Luffa cylindrica* plant. This plant, commonly known as sponge gourd, produces sponge-like fruit—loofahs—that are used as bathing brushes by millions of people worldwide. But Adewuyi says the seeds, which are plentiful, are considered environmental waste. As a result, they are underutilized.

In laboratory tests, he isolated oil from *L. cylindrica* seeds and used it to produce surfactants. These surfactants reportedly enhanced the seed's absorption capacity in cleaning wastewater.

He found the new product was cheaper and more effective than existing absorbents. Adewuyi is currently exploring whether other underutilized seeds and oils could have the same effect.

"It's a win-win process," he says. "It's cost effective, green, reproducible and, of course, applicable in developing countries because it is very easy to start up and maintain."

## P&G reorganizes in July 2013

The Procter & Gamble Co. (P&G; Cincinnati, Ohio, USA) reorganized its global business units into four industry-based sectors, effective July 1, 2013.

"This sector organization and leadership team will help us operate more effectively and efficiently to continue momentum behind P&G's growth strategies," said A.G. Lafley, P&G chairman of the board, president, and chief executive officer, who returned to P&G May 2013, replacing Robert S. McDonald.

### NEW SECTOR GROUPS

The businesses in each sector are focused on common consumer benefits, share common technologies, and face common competitors, P&G said in a statement. Each sector will be led by a group president.

Martin Riand has been named group president of global baby, feminine, and family care. Deborah A. Henretta has been elected group president of global beauty. David S. Taylor, currently group president—global home care, has been elected group president of global health and grooming. Giovanni Ciserani has been elected group president of global fabric and home care.

In other company news, P&G announced that beginning in July 2013, the company will work with eight transportation carriers to convert up to 20% of its North America truck shipments to natural gas vehicles within two years. The company said that, as a result, it expects to reduce greenhouse gas emissions (GHG) by nearly 5,000 metric tons (or the equivalent GHG emissions from 1,000 passenger vehicles for a year).

## Study on fatty alcohols receives award

A study that demonstrated the environmental safety of key detergent ingredients was recognized as one of the top research articles published in 2012 in *Environmental Toxicology and Chemistry*.

The research, "Quantifying the anthropogenic fraction of fatty alcohols in a terrestrial environment," tied for third runner-up for the Best Paper Award for 2012 research appearing in the journal.

The paper, which appeared in the June 2012 issue of the journal (doi:10.1002/etc.1808, 2012) was written by Stephen Mudge, Exponent; Scott Dyer, The Procter & Gamble Co.; and Paul DeLeo, senior director of environmental safety for the American Cleaning Institute (ACI). ACI is a trade group based in Washington, DC, USA.

"We have taken what we learned at the single field location reported on in our 2012 paper," DeLeo noted, "and have now applied it to two dozen more sites across the United States. We are anticipating the publication of this more comprehensive study later this year." ■

# PEOPLE NEWS

## Vavpot retires—or not?



Vavpot

After 39 years with Anderson International Corp. (Stow, Ohio, USA), **Vincent J. Vavpot** retired on March 27, 2013. He first took five weeks off to “to get a small flavor of retirement and enjoyed every minute.” He is now back at Anderson, providing mentoring to younger staff members and advice on the development of process and machinery for the oilseed industry—but on a two-days-a-week contract basis.

Vavpot graduated from the University of Dayton (Ohio, USA) in mechanical engineering and worked for three years with National Cash Register and then five years with Dow Chemical before joining Anderson as a process engineer for the dairy equipment product line. There, he initially worked with evaporators and spray dryers to make condensed and powdered milk. After four years, he was promoted to sales engineering manager, where he learned design and specifications for oilseed processing machinery. Following three years in that position, he moved to regional sales manager for East Asia and Oceania. In that post, he sold Anderson products, trained and supervised country representatives, and commissioned Anderson machinery.

Next, he became worldwide troubleshooter for oilseed equipment, followed by stint as director of marketing for all Anderson products and markets. Vavpot finished his full-time employment with Anderson as vice president of vegetable oil and animal feeds business.

Anderson International has exhibited regularly at AOCS Annual Meetings & Expos. Vavpot headed the exhibitors' group for five years on the exhibition floor for five years.

## 2013 World Food Prize announced

During a ceremony at the US State Department on June 19, 2013, Marc Van Montagu, Mary-Dell Chilton, and Robert T. Fraley were named winners of the 2013 World Food Prize, which comes with a cash prize of \$250,000.

Kenneth Quinn, former US Ambassador to Cambodia and head of the World Food Prize Foundation, emphasized the impact and potential of their work. Quinn said, in part, “These three scientists are being recognized for their independent, individual breakthrough achievements in founding, developing, and applying modern agricultural biotechnology. Their research is making it possible for farmers to grow crops with improved yields, resistance to insects and disease, and the ability to tolerate extreme variations in climate.”

Building on the scientific discovery of the double helix structure of DNA in the 1950s, Van Montagu, Chilton, and Fraley each conducted molecular research on how a plant bacterium could be adapted as a tool to insert genes from other organism into plant

cells, which could produce new genetic lines with highly favorable traits. The World Food Prize will formally be awarded on October 17, 2013, in Des Moines, Iowa, USA in conjunction with the Norman Borlaug Dialogue international symposium.

Van Montagu is founder and chairman of the Institute of Plant Biotechnology Outreach at Ghent University (Belgium). Mary-Dell Chilton is founder and distinguished fellow of Syngenta Biotechnology (Research Triangle Park, North Carolina, USA). And Robert Fraley is executive vice president and chief technology officer of Monsanto Corp. (St. Louis, Missouri, USA).

## Litle joins GEA Westfalia Separator

AOCS member **Darren Litle** joined GEA Westfalia Separator on June 3, 2013 as new business development manager for Oils and Fats Processing, North America (OFP-NA). He will work from his home near Atlanta, Georgia, focusing on new marketing opportunities in OFP-NA and existing account coverage.

Litle has a degree in chemical engineering from Montana State University (Bozeman, USA) and a master's in business administration degree from Brenau University (Gainesville, Georgia). He comes to Westfalia Separator with 23 years of experience in the vegetable oil industry, earned via Cargill and Süd-Chemie (Clariant).

## USDA recognizes Cannon

In June 2013 the US Department of Agriculture's Agricultural Research Service presented its 2013 Herbert L. Rothbart Outstanding Early Career Research Scientist Award to **Steven B. Cannon** of the agency's Corn Insects and Crop Genetics Research Unit, Ames, Iowa. He was recognized for research and leadership in genomics of legume crops.

Cannon was one of the lead authors reporting the sequencing of the soy genome, using a “whole-genome shotgun” approach to sequence 85% of the 1.1 billion nucleotide base pairs that spell out soy's entire DNA code. The work was published in *Nature* (Genome sequence of the palaeopolyploid soybean, *Nature* 463:178–183, 2010; doi:10.1038/nature08957).

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# IN MEMORIAM

## ROBERT MAIN BURTON SR.

Former AOCS President Robert Burton died in Corvallis, Oregon, USA, on June 3, 2013.

Burton was a 50-year member of AOCS, having joined in 1963, when he was an assistant professor of pharmacology at Washington University School of Medicine (St. Louis, Missouri, USA). He was especially active as an AOCS volunteer from 1965 through 1996.

He served as an associate editor for *Lipids* from its inaugural issue in 1966 through 1993 and continued on the editorial advisory board for the journal until 2002.

He organized the first AOCS European short course in 1972—on the fundamentals of lipid chemistry—held in Portugal; served as general chairperson for the 1978 Annual Meeting, held in St. Louis; and served on a number of AOCS committees as well as the AOCS Foundation Board of Directors. AOCS presented him with its Award of Merit in 1983.

Besides being AOCS president (1994–1995), Burton served a term as treasurer (1987–1989) and as vice president (1993–1994).

Burton was born in Oklahoma City, Oklahoma, in 1927, and lived there during the Depression and the days of the Dust Bowl. His father died when he was an adolescent, and his mother moved their family closer to family in Maryland. He enrolled in the University of Maryland in September 1944, but then enlisted in the US Navy in January 1945, where he learned electronics. After World War II ended, Burton returned to the University of Maryland, where he received a B.S. in chemistry in 1950, followed by a master's degree at Georgetown University in 1952 and a Ph.D. in biochemistry from Johns Hopkins University in 1955.

From 1950 through 1957 Burton worked at the National Heart Institute, Johns Hopkins University, and the National Institute of Neurological Diseases and Health, all in the Washington, DC area. He and his family then moved to St. Louis, where he taught pharmacology in the School of Medicine of Washington University. He continued there until 1978, when he left to set up the pharmacology department at the new Oral Roberts University School of Medicine in Tulsa, Oklahoma, and serve as department chairman and professor.

He returned to the St. Louis area in 1979 and established his consulting business, Burton International Biomed Ltd., working primarily in the field of biomedical sciences. He also taught, on a non-regular basis, at Webster University (Webster Groves, Missouri) and Harris-Stowe State College (St. Louis), and he served on the St. Louis Board of Education. He was a registered patent agent, and held a commission in the US Public Health Service Reserve.



Burton's research interests were in lipid metabolism, function of lipids in the nervous system and membranes, childhood precursors of atherosclerosis, and drugs affecting lipids.

He is survived by three sons, 11 grandchildren, and 13 great-grandchildren, Maurine, his wife of 60 years, two sons, and a daughter predeceased him.

## YAAKOB BIN CHE MAN

AOCS has received word that Yaakob Che Man died on July 15, 2012, in Serdang, Selangor, Malaysia at the age of 58. Che Man first joined AOCS in 1993.

He received his Diploma in food technology from Institut Teknologi Mara, Malaysia, in 1976, and his B.Sc. and M.Sc. degrees in food technology in 1977 and 1979, respectively, from the University of Tennessee, Knoxville, USA. He returned to Malaysia and took a position in 1980 as a lecturer in the Department of Food Technology, Universiti Pertanian Malaysia (UPM; now known as Universiti Putra Malaysia). Returning to the United States, he obtained his Ph.D. in food chemistry from the University of Illinois at Urbana-Champaign in 1988, based on his work with soybeans in cooperation with Professors Lun-Shin Wei and A.I. Nelson.

Che Man again returned to Malaysia, and affiliated with the department of food technology at UPM. He remained with the university until his death, variously heading the department of food technology, serving as deputy dean of the faculty of food science and biotechnology, and serving as the founding director of the Halal Products Research Institute.

His research focused on developing rapid methods for oils and fats analysis, in particular for palm oil products. Che Man was also intensely interesting in providing new approaches for authentication of halal products—using instrumental techniques such as differential scanning calorimetry, Fourier transform infrared spectrometry, electronic nose technology, and gas chromatography–time-of-flight–mass spectrometry—for the benefit of the Muslim community. He was especially known for devising a system, patented in 2008, to detect porcine DNA in foods in under an hour by means of a polymerase chain reaction.

In 1996–1997, he was a Research Fellow in Palm Oil Research Institute of Malaysia (PORIM) during his sabbatical leave, and in 1997, he was a visiting professor of oils and fats at McGill University, Canada, where he worked with Frederick van de Voort.

Che Man published over 600 papers in journals such as the *Journal of the American Oil Chemists' Society*, the *Journal of Food Science*, the *Journal of the Agriculture and Food Chemistry*, and *Meat Science*. He also served on the editorial boards of a number of international journals.

He received numerous awards including the National Halal Scientist Award, the National Intellectual Property Award, National Mawlid Persons (2010), the Khwarizmi International Award from the Iranian Research Organization, as well as several other awards at national and international levels.

He is survived by his wife Jamilah Wan Abdullah, eight children, and one grandchild.

# PATENTS

## Process for producing esterified propoxylated glycerin

Strecker, L., *et al.*, Choco Finesse LLC, US8354551, January 15, 2013

Highly pure esterified propoxylated glycerin suitable for use as a fat substitute in various foodstuffs may be efficiently manufactured using a process involving direct esterification of propoxylated glycerin with excess fatty acid, bleaching, deacidification/deodorization, and treatment with activated carbon.

## Plant acyltransferases specific for long-chained, multiply unsaturated fatty acids

Renz, A., *et al.*, University of Bristol, US8354569, January 15, 2013

The invention relates to a process for the production of long-chain polyunsaturated fatty acids in an organism by introducing, into the organism, nucleic acids coding for polypeptides with acyltransferase activity. These nucleic acid sequences, if appropriate together with further nucleic acid sequences coding for polypeptides of the fatty acid or lipid metabolism biosynthesis, can advantageously be expressed in the organism. Furthermore, the invention relates to a method for the production of oils and/or triacylglycerides with an elevated content of long-chain polyunsaturated fatty acids. The invention furthermore relates to the nucleic acid sequences, and constructs, vectors and organisms comprising the nucleic acid sequences. A further part of the invention relates to oils, lipids, and/or fatty acids produced by the process according to the invention and to their use.

## Catalyst and method for producing carboxylic acid and/or carboxylic anhydride in the presence of the catalyst

Okamoto, A., Mitsubishi Gas Chemical Co., Inc., US8357625, January 22, 2013

An object of the present invention is to provide a catalyst exhibiting excellent performance particularly in partial oxidation reaction. Another object is to provide a method for efficiently producing carboxylic acid or carboxylic anhydride through vapor-phase partial oxidation of an organic compound by use of an oxygen-containing gas in the presence of the catalyst. The catalyst contains (i) diamond; (ii) at least one species selected from among Group 5 transition element oxides, collectively called oxide A; and

(iii) at least one species selected from among Group 4 transition element oxides, collectively called oxide B. The method for producing a carboxylic acid or a carboxylic anhydride includes subjecting an organic compound to vapor phase partial oxidation by use of an oxygen-containing gas in the presence of the catalyst, wherein the organic compound is an aromatic compound having one or more substituents in a molecule thereof, the substituents each including a carbon atom bonded to an aromatic ring.

## Method for preparing chocolates and/or chocolate-/cocoa-flavored compositions

Bouvier, P., and V. Detalle, Barry Callebaut AG, US8357418, January 22, 2013

The invention relates to a computer-aided method for preparing chocolates and/or chocolate-/cocoa-flavored compositions from a bank of ingredients  $P_j$  using tools such as a valuation system  $E$  which can be used to assign a numerical value  $v_{ij}$  to the taste descriptor  $G_i$  of each ingredient  $P_j$  and a function  $f$  designating the set of rules that can be used to calculate the values  $v_{ic}$  characterizing the taste of a combination  $C$  of chocolates. The invention also relates to a device for performing the inventive method.

## Composition comprising triglycerides

Zand, I., and H. Slager, Loders Croklaan B.V., US8357421, January 22, 2013

A composition comprising triglycerides may be used as a coating fat. The triglyceride content of the composition comprises: SSS in an amount of from 10 to 20%; SUS in an amount of from 45 to 65%; SSU in an amount of from 10 to 18%; SU2 in an amount of less than 15%; and S2U in an amount of greater than 70%; wherein: the weight ratio of SUS/SSU is from 3:1 to 6:1; S is a saturated fatty acid residue having from 12 to 24 carbon atoms; U is an unsaturated fatty acid residue having from 12 to 24 carbon atoms; and all percentages are by weight based on the total triglycerides present in the composition.

## Lubricants derived from plant and animal oils and fats

Benecke, H., *et al.*, Battelle Memorial Institute, US8357643, January 22, 2013

A lubricant from plant and/or animal oils and fats; methods for producing a lubricating oil, and the oil produced thereby. The lubricant is derived from an animal or plant fat or oil having an iodine number above about 7, and produced by epoxidizing the fat or oil and (i) reacting the epoxidized fat or oil with a carboxylic acid anhydride in the presence of a basic catalyst to produce a diester, or (ii) hydrogenating the epoxidized fat or oil to generate mono-alcohols and acylating the alcohol functionality with



acid anhydrides, acid chlorides, or carboxylic acids to produce a mono-ester.

## Method for producing a soluble cocoa product from cocoa powder

Bernaert, H., *et al.*, Barry Callebaut AG, US8372456, February 12, 2013

The present invention relates to a method for producing a soluble cocoa product from cocoa powder comprising the steps: (i) preparing an aqueous suspension of cocoa powder (1), (ii) treating said suspension with one or more degrading enzymes (2), (iii) submitting (3) the suspension obtained in step (ii) to a pH treatment comprising treating said suspension for at least 2 hours at a suitable pH, a temperature of at least 100°C, and a pressure which is at least 1 bar higher than the ambient pressure, (iv) optionally bringing the pH of the suspension obtained in step (iii) to a pH value corresponding with the pH of the suspension obtained in step (i), (v) treating (4) the suspension obtained in step (iii) or (iv) with one or more degrading enzymes, (vi) separating (6) the suspension (5) obtained in step (v) into insoluble material (8) and a soluble part (7), and (vii) obtaining soluble cocoa components (10) from the soluble parts (7). The present

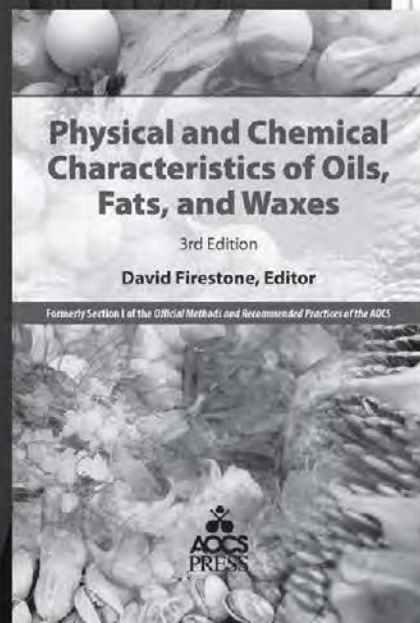
invention further relates to cocoa products obtained by the present method and use thereof.

## Method for making a rolled snack food product having a light, crispy texture

Crosby, T.G., *et al.*, Frito-Lay North America, Inc., US8377493, February 19, 2013

A method for making a cooked rolled dough snack food from a starch-based dough. The starch-based dough is admixed with a small average particle size monoglyceride. The dough is then rolled and cooked in hot oil. The fatty acid chain is disposed within the helical amylose molecules in the starch-based dough and provides structural support within the helix. This support helps control inward expansion of the rolled dough snack during frying.

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](mailto:scott.bloomer@adm.com).



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## Physical and Chemical Characteristics of Oils, Fats, and Waxes

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David Firestone, Editor

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# EXTRACTS & DISTILLATES

## Encapsulation of flaxseed oil using a benchtop spray dryer for legume protein–maltodextrin microcapsule preparation

Karaca, A.C., *et al.*, *Agric. Food Chem.* 61: 5148–5155, 2013.

Flaxseed oil was microencapsulated employing a wall material matrix of either chickpea (CPI) or lentil protein isolate (LPI) and maltodextrin using a benchtop spray dryer. Effects of emulsion formulation (oil, protein and maltodextrin levels) and protein source (CPI vs LPI) on the physicochemical characteristics, oxidative stability, and release properties of the resulting capsules were investigated. Microcapsule formulations containing higher oil levels (20% oil, 20% protein, 60% maltodextrin) were found to have higher surface oil and lower encapsulation efficiencies. Overall, LPI–maltodextrin capsules gave higher flaxseed oil encapsulation efficiencies (~88.0%) relative to CPI–maltodextrin matrices (~86.3%). However, both designs were found to provide encapsulated flaxseed oil protection against oxidation over a 25 d room temperature storage study relative to free oil. Overall, ~37.6% of encapsulated flaxseed oil was released after 2 h under simulated gastric fluid, followed by the release of an additional ~46.6% over a 3 h period under simulated intestinal fluid conditions.

## Effects of pomegranate seed oil on glucose and lipid metabolism-related organs in rats fed an obesogenic diet

Miranda, J., *et al.*, *J. Agric. Food Chem.* 61: 5089–5096, 2013.

Studies conducted in mice have revealed positive effects of punicic acid (PUA). The aim of this study was to analyze the effects of PUA on fat accumulation and glycemic control in rats fed an obesogenic diet. Rats were randomly divided into two groups: control group and PUA group (diet supplemented with 0.5% PUA). No changes were observed in adipose tissue weights. The glucose tolerance test showed that the glycemic value in the PUA group had decreased significantly at the final time (120 min) (–19.3%), as had fructosamine levels (–11.1%). However, homeostasis model assessment (HOMA-IR) showed that insulin resistance did not improve. No changes were observed in the liver, skeletal muscle composition, or peroxisome proliferator-activated receptors (PPARs) activation. Low levels (mg/g tissue) of PUA

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## Journal of the American Oil Chemists' Society (July)

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( $0.04 \pm 0.01$  in both tissues) and higher levels of *cis*-9,*trans*-11 conjugated linoleic acid ( $0.31 \pm 0.08$  in liver,  $0.52 \pm 0.11$  in muscle) were found. PUA supplementation induced hypoplasia ( $-16.1\%$ ) due to the antiproliferative effect on hepatocytes. In conclusion, dietary supplementation of 0.5% PUA did not lead to decreased fat accumulation in adipose tissue, liver, or skeletal muscle, or to improved glycemic control. The hypoplasia induced in liver is a negative effect that should be considered before proposing PUA as a functional ingredient.

## A comparison of five lipid extraction solvent systems for lipidomic studies of human LDL<sup>[S]</sup>

Reis, A., *et al.*, *J. Lipid Res.* 54: 1812–1824, 2013.

Lipidome profile of fluids and tissues is a growing field as the role of lipids as signaling molecules is increasingly understood, relying on an effective and representative extraction of the lipids present. A number of solvent systems suitable for lipid extraction are commonly in use, though no comprehensive investigation of their effectiveness across multiple lipid classes has been carried out. To address this, human LDL from normolipidemic volunteers was used to evaluate five different solvent extraction protocols [Folch, Bligh and Dyer, acidified Bligh and Dyer, methanol (MeOH)-tert-butyl methyl ether (TBME), and hexane-isopropanol] and the extracted lipids were analyzed by LC-MS in a high-resolution instrument equipped with polarity switching. Overall, more than 350 different lipid species from 19 lipid subclasses were identified. Solvent composition had a small effect on the extraction of predominant lipid classes (triacylglycerides, cholesterol esters, and phosphatidylcholines). In contrast, extraction of less abundant lipids (phosphatidylinositols, lyso-lipids, ceramides, and cholesterol sulfates) was greatly influenced by the solvent system used. Overall, the Folch method

was most effective for the extraction of a broad range of lipid classes in LDL, although the hexane-isopropanol method was best for apolar lipids and the MeOH-TBME method was suitable for lactosyl ceramides.

## Key points for maximum effectiveness and safety for cholesterol-lowering properties of plant sterols and use in the treatment of metabolic syndrome

Rondanelli, M., *et al.*, *J. Sci. Food Agr.* 93: 2605–2610, 2013.

According to the American Diabetes Association and the Adult Treatment Panel III, the starting point for treating metabolic syndrome (MS) is a change of lifestyle. In addition, action on the main symptoms of MS by means of dietary supplements, can be helpful in view of the chronic course of the disease. The term 'phytosterols' refers to sterols and stanols composed of lipophilic triterpenes, a family that is widely distributed in the plant kingdom and whose cholesterol-lowering properties have been amply demonstrated. In the light of the recent literature, the key points for maximum effectiveness and safety of sterols are the following. (A) Plant sterols should be taken with meals: clinical trials have shown that when plant sterols are consumed close to mealtimes, low-density lipoprotein cholesterol may decrease by 9.4%, while when they are taken between meals, the reduction is about 6%. (B) The optimal dosage is  $2\text{--}2.5\text{ g day}^{-1}$  in a single dose. More than  $3\text{ g day}^{-1}$  has not been found to have any additional beneficial effect and increases the risk of side effects. (C) The food matrix used to dissolve the phytosterols should contain a certain amount of fat. A milk-based matrix appears optimal from this point of view.

# Vitamin D in the military (cont. from page 488)

## Forgot your vitamin D chemistry?

More information on the forms, molecular structures, production, and metabolism of vitamin D can be found on page 481 of the September 2012 issue of *Inform*.

commands in an effort to determine whether providing vitamin D and calcium beyond the current RDA may be beneficial for the optimization of bone health during military training.

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*Medicine in Natick, Massachusetts. He earned his bachelor's and master's degrees from the University of New Hampshire (Durham, USA) and his Ph.D. from Cornell University (Ithaca, New York, USA). He currently serves on the editorial boards of the Journal of Nutrition and the British Journal of Nutrition and can be contacted at james.p.mcclung8.civ@mail.mil.*

\*The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Army or the Department of Defense. Any citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations.



## Changes in fatty acid profile of feta cheese including conjugated linoleic acid

Laskaridis, K., *et al.*, *J. Sci. Food Agr.* 93: 2130–2136, 2013.

During the last two decades much attention has been given to conjugated linoleic acid (CLA) because of its potentially beneficial biological effects. Cheese is one of the major dietary sources of CLA. However, the CLA content of Greek cheeses is variable and affected by many factors. Fatty acid analysis of feta cheese, made of sheep's milk, was conducted at different stages of the manufacturing process in order to monitor and explain fatty acid and especially CLA changes. CLA content in fresh milk and during the early stages of manufacture was  $0.66 \pm 0.02$  g 100 g<sup>-1</sup> fatty acids; it increased during the ripening process ( $0.75 \pm 0.06$  g 100 g<sup>-1</sup> fatty acids) and decreased during storage ( $0.52 \pm 0.15$  g 100 g<sup>-1</sup> fatty acids). Saturated fatty acids (SFA), increased after 37 and 48 days of aging, while monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), showed the opposite tendency. CLA content significantly increased during the ripening stages and decreased during aging ( $P \leq 0.05$ ). CLA is not stable during manufacture and storage of feta cheese, a fact which should be resolved, since this biologically active substance can be obtained from the diet.

## Literature review on production process to obtain extra virgin olive oil enriched in bioactive compounds: potential use of byproducts as alternative sources of polyphenols

Frankel, E., *et al.*, *J. Agric. Food Chem.* 61: 5179–5188, 2013.

This review describes the olive oil production process to obtain extra virgin olive oil (EVOO) enriched in polyphenol and byproducts generated as sources of antioxidants. EVOO is obtained exclusively by mechanical and physical processes including collecting, washing, and crushing of olives, malaxation of olive paste, centrifugation, storage, and filtration. The effect of each step is discussed to minimize losses of polyphenols from large quantities of wastes. Phenolic compounds including phenolic acids, alcohols, secoiridoids, lignans, and flavonoids are characterized in olive oil mill wastewater, olive pomace, storage byproducts, and filter cake. Different industrial pilot plant processes are developed to recover phenolic compounds from olive oil byproducts with antioxidant and bioactive properties. The technological information compiled in this review will help olive oil producers to improve EVOO quality and establish new processes to obtain valuable extracts enriched in polyphenols from byproducts with food ingredient applications.

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## STATISTICAL ANALYSIS FROM MINTEC

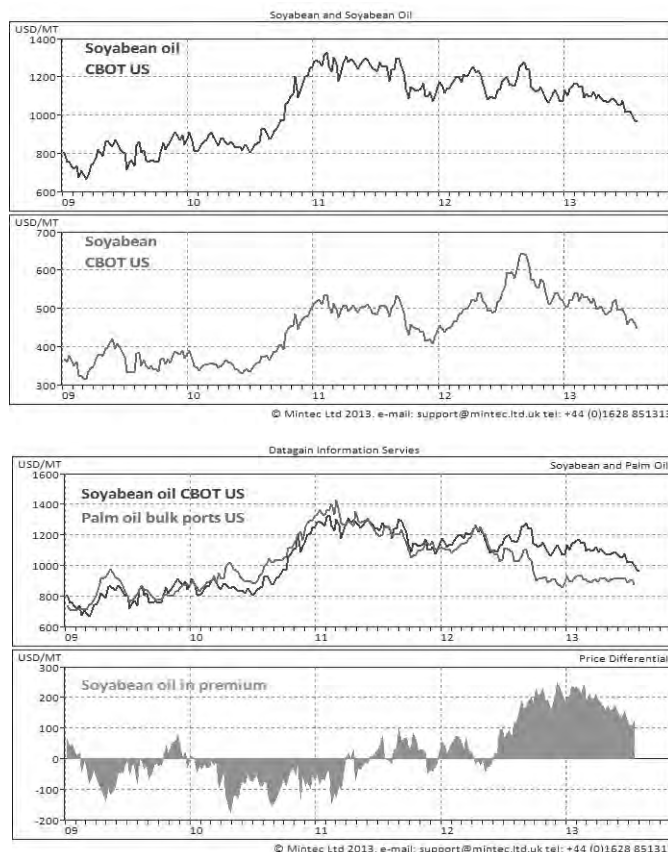
James Hutchings

Soyabean oil prices fell to their lowest level since winter 2010, as good weather conditions and an increase in planted area boosted production prospects in the US. Weak demand for soyabeans and soyabean meal has also helped create a downwards pressure on prices. The global soyabean forecast for 2013/14 has been recently revised up to 285.9m tonnes, a 7% rise year-on-year.

Soyabean oil production for 2013/14 is forecast to reach 44.6m tonnes, up from 43.0m tonnes in 2012/13. Global soyabean oil ending stocks have been revised up to 3.4m tonnes, but this is still a slight fall from last season's 3.5m tonnes.

Global palm oil production is forecast to reach a record 58.1m tonnes in 2013/14, up from 55.3m tonnes in 2012/13. Global palm oil stocks are forecast to increase by 21% y-o-y to 9.55m tonnes driven by higher production in Indonesia, the world's largest palm oil producer. Production in Indonesia in 2013/14 is forecast to increase 9% y-o-y to 31m tonnes.

Since the middle of 2012, soyabean oil has enjoyed a price premium over palm oil. However, as soyabean prospects improved, this premium fell from USD200/tonne at the start of 2013 to USD100/tonne by the end of July.



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# Professional Pathways

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

*Bryan Yeh has held several jobs in the oilseed industry ranging from consulting to oilseed processing. He is the current executive vice president of technology at ZeaChem Inc., a start-up renewable chemicals company in Menlo Park, California, USA.*



## Why did you join AOCS?

I first became aware of AOCS back in 1987 when I had responsibility for expanding Cargill's edible oil refinery in Gainesville, Georgia, USA. I was given copies of *JAOCS* and found them quite helpful in enabling me to better define the requirements for the project. After successfully completing the expansion project, I spent two years in Australia, where I found great value in maintaining and expanding my oilseed processing network. When I returned from Australia in 1991, I joined AOCS both to maintain my industry network and benefit from the information that I gleaned from its publications.

## Please describe your career path.

I worked as a summer research assistant in the Department of Chemical Engineering at Villanova University (Villanova, Pennsylvania, USA) from 1980–1984, where I had my first exposure to process unit operations and issues regarding the commercialization of new technology. After I had graduated from the University of Wisconsin–Madison, (USA) with a degree in chemical engineering, I worked at Cargill for 18 years

(1985–2003), starting as a shift supervisor at a soybean plant and progressing to project engineer, production supervisor, plant superintendent, project manager of a major capital project, general manager and business development manager for the oilseed processing, corn milling, biofuel, and nutraceutical business units. From 2003–2005, I was president of Thermodyne Corporation (Walnut Creek, California, USA) managing a business that built and sold wastewater treatment equipment and provided consulting services. Then I was the assistant vice president of GE (headquartered in Fairfield, Connecticut, USA) from 2005–2008 before taking a job at SAIC (McLean, Virginia, USA) as assistant vice president from 2008 to July 2012. For the last year, I have been executive vice president of technology at ZeaChem Inc. (Menlo Park, California, USA). I also did some consulting between jobs.

## How has your industry changed since you entered the field?

One of the biggest changes is the consolidation within the industry. When I joined Cargill in 1985, it was in the process



of acquiring Ralston Purina's soybean processing plants. Similarly, ADM took over the A.E. Staley plants. Later, there were further acquisitions including Cargill's purchase of the Continental and Vandemoortele plants, as well as an increase in integrated crush/refining facilities. The industry has also seen a consolidation of technology providers. More recently, there have been other changes such as increased production of oilseeds other than soy; increased sensitivity to the health benefits of different fatty acids; and increased interest in biofuels, renewable chemicals, and alternative feedstocks such as algae.

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

I believe continued interest in the area of health/nutrition as well as renewable chemicals will influence our industry. I also believe that our industry will have a significant voice in the area of food security, which in turn may affect the feedstock, products, and processes utilized by our industry today.

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

I was very fortunate to have started my career at Cargill. During the 18 years that I spent there, I had the fortune of working for some exceptional individuals including Ian Purtle, Hersh Austin, Bob Foote, Joe Goebel, Doug Collison, Mike Beaver, H.S. Muralidhara (Murali), Rolf Buelter, and many others. However, being part of the Cargill network also enabled me to meet many people outside of Cargill such as Ken Carlson (RBD/Danisco), Ted Bather (Amec), Philip Vando (DeSmet), and Peter MacSmith (MSM Milling). The diverse backgrounds of these individuals—and many others—provided motivation to advance within this industry.

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

One needs to embrace networking, and it needs to go beyond "linkedin.com" or other virtual media. You need to get to know people, their stories, and what makes them tick. I strongly recommend young professionals engage with professional societies such as AOCS by contributing material to the annual meeting, actively participating in its many divisions, and volunteering their time when they can. It is a great way to get to know some highly accomplished and genuinely nice people.

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

I wouldn't change a thing.

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

There is a plethora of opportunities out there. However, you need to constantly push yourself outside of your comfort zone and seek opportunities that leverage your attributes. I think it is important to stay up to date with technology and build your professional network to help gain insight on trends and opportunities. Don't be afraid to explore new areas. When I look at my career, I was able to stay relevant in different areas because I was willing to learn new things. Although I started in the oilseed processing industry, I spent time in corn milling, ethanol, fermentation, nutraceuticals, and wastewater treatment. After Cargill, I had my own consulting business, then I worked for General Electric in the water industry, then to SAIC for biofuels and food security, and now I manage R&D/engineering for a start-up renewable chemicals company (ZeaChem).

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

Within the oilseed/fats/oils industry, I believe we have a very friendly and passionate culture. Being a relatively stable industry, the industry domain knowledge is very high, and I believe that people truly enjoy working in the industry. With regards to the industry that I work in today (renewable energy and chemicals), it is fast paced and operates with a high degree of uncertainty in terms of technology readiness and financing.

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

I believe in being a well-rounded specialist. While it is impossible to be good at everything, it is important to be able to transfer your specialization to new and/or emerging areas. Your domain knowledge can be relevant in multiple areas. I believe that if you can accomplish this, you will have access to more opportunities.

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

I think the first question that needs to be asked is: "Why am I taking the time to get a graduate degree?" If the reason is to expand your network and domain knowledge, then it is probably a good idea whether the economy is challenging or not. If the reason is just to get a degree (i.e., "everyone" has an MBA), then I think it is a bad idea. Your motivation for this kind of undertaking will say a lot about your character, which in turn is a part of your qualification. ■



## 2013–2014 AOCS Approved Chemists

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

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**John Dillard and Gordon**

**Whitbeck:** Tallow and Grease (Moisture, Insoluble Impurities, and Unsaponifiable Matter only), Unground Soybean Meal, Aflatoxin in Corn Meal (test kit), Oilseed Meal

**A & L Plains Lab**

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**Tami Brown:** Oilseed Meal, Aflatoxin in Corn Meal (test kit)

**AAK**

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**James Houghton:** Edible Fat

**Jack M. Stearns:** Edible Fat

**Adams Vegetable Oils Inc.**

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**Abdul Bath:**

Gas Chromatography

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**Algood Food Company**

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**Brantley Freeman:** Aflatoxin in Peanut Paste (test kit)

**Analytical Food Laboratories**

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**Cheri Turman:** Marine Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit), Nutritional Labeling

**Archer Daniels Midland Co.**

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**Mick Ashley:**

Oilseed Meal



**ATC Scientific**

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**Eskridge:** Oilseed Meal,  
Unground Soybean Meal,  
Soybean Oil, Cottonseed Oil,  
Phosphorus in Oil. Aflatoxin in  
Corn Meal (test kit)

**Bakels Edible Oils Ltd.**

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Chromatography

**Barrow-Agee**
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**Michael Hawkins:** Oilseed  
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Gas Chromatography

**Blue Diamond Growers**

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Aflatoxin in Peanut Paste,  
Aflatoxin in Almond

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USA

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**Bunge Analytical Team:**

Gas Chromatography,  
*trans* Fatty Acid Content

**Campi Alimentos S.A. de C.V.**

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Mexico

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**Ana L. Pomar:** Unground  
Soybean Meal

**Canadian Food Inspection**
**Agency**

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**Angela Sheridan:**

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**Ann Puvirajah:**

Gas Chromatography

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**Steve Lim:** *trans* Fatty Acid  
Content

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**Rashid Ali:** Tallow and Grease

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Services, LLC**

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**Brad N. Beavers, Jennie B.**

**Stewart:** Oilseed Meal

**Certispec Services, Inc.**

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**Cipriano Cruz:** NIOP Fats and

Oils

**Chemiservice SRL**

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Italy

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**Giorgio Cardone:** Olive Oil  
(Parts A, B and C), Olive Oil  
Sensory Analysis

**Conagra Grocery Products**

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USA

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**Carl Whitney:** Gas Chroma-  
tography, Soybean Oil, Cot-  
tonseed Oil, Vegetable Oil  
(color only), *trans* Fatty Acid  
Content, Solid Fat Content  
by NMR

**Cumberland Valley  
Analytical Services**

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**Sharon Weaver:** Oilseed Meal

**Dallas Group of America**

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**Joseph Caldwell:** Vegetable  
Oil for Color Only, NIOP Fats  
and Oils

**Melanie Greer:** Vegetable  
Oil for Color Only, NIOP Fats  
and Oils

**George Hicks:** Vegetable Oil  
for Color Only, NIOP Fats and  
Oils

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Laboratories**

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**Shirley Elliott:** Tallow and  
Grease, Gas Chromatography

**Denele Analytical, Inc.**

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USA

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**Wayne Scott:** Olive Oil  
(Part A)

**Diversified Laboratories**

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USA

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**Thomas Scott:** Tallow and  
Grease

**DSM Nutritional Products**

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Mulgrave, NS B0E 2G0  
Canada

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**Mark Arsenault:** AOCS/GOED  
Nutraceutical Oils

**Enzymotec**

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Israel

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**Gregory Blinder:** Marine Oil  
FAP

**Eurofins Central Analytical  
Laboratory, Inc.**

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USA

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**John Reuther:** Oilseed Meal,  
Unground Soybean Meal,  
Soybean, Trace Metals in  
Oil, Fish Meal, AOCS/GOED  
Nutraceutical Oils, Marine  
Oil, Marine Oil FAP, Palm Oil,  
NIOP Fats and Oils, Specialty  
Oils, Aflatoxin in Corn Meal,  
Aflatoxin in Corn Meal (test  
kit), Aflatoxin in Almond and  
Pistachio

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**Ardin Backous:** Edible Fat,  
Oilseed Meal, Unground Soy-  
bean Meal, Soybean, Choles-  
terol, Fish Meal, AOCS/GOED  
Nutraceutical Oil, Marine Oil  
Fatty Acid Profile, NIOP Fats  
and Oils, Aflatoxin in Corn  
Meal (test kit), Nutritional  
Labeling

**Kent Karsjens:** Oilseed Meal,  
Unground Soybean Meal,  
Soybean, Fish Meal, Aflatoxin  
in Corn Meal (test kit), Nutri-  
tional Labeling

**Keith Persons:** Cholesterol,  
AOCS/GOED Nutraceutical  
Oils, Marine Oil FAP, NIOP  
Fats and Oils, Edible Fat, *trans*

CONTINUED ON NEXT PAGE

Fatty Acid Content, Nutritional Labeling

**Anders Thomsen:** Edible Fat, Oilseed Meal, Unground Soybean Meal, Soybean, Cholesterol, Fish Meal, AOCS/GOED Nutraceutical Oils, Marine Oil FAP, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit), Nutritional Labeling

**Fieldale Farms Corp.**

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**Janet Smith:** Oilseed Meal, Aflatoxin in Corn Meal (test kit)

**Fuji Vegetable Oil, Inc.**

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**Gregg Newman:** *trans* Fatty Acid Content, Gas Chromatography

**Golden Peanut Company**

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**Mary Nell Harry:** Aflatoxin in Peanut Paste (test kit)

**Grupo Agroindustrial**

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**Ricardo Arevalo:** Solid Fat Content by NMR

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**Joe Boyd:** Aflatoxin in Pistachio and Almond, Aflatoxin in Cottonseed Meal

**INOLASA**

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Contiguo a la Zona Franca  
Puntarenas 6651-1000  
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**Jesus Gomez Salgado:** Edible Fat, Unground Soybean Meal, *trans* Fatty Acid Content, Soybean

**Inspectorate America**

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**Mumtaz Haider:** Tallow and Grease, Oilseed Meal, Soybean, Gas Chromatography, Soybean Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit)

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**Carmen Catter de Bueno:** Fish Meal

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**Tuyen Mai:** Oilseed Meal, Soybean, Gas Chromatography, Soybean Oil, NIOP Fats and Oils, Aflatoxin in Corn Meal (test kit), Nutritional Labeling, Olive Oil Part A

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**R. Bruce Kerr, George**

**Ducsay:** Tallow and Grease, Oilseed Meal

**Jacob Stern & Son**

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**Robert Poullard, Jr.:** Tallow and Grease

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**JLA China Analytical Team:**

Aflatoxin in Peanut Paste

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**Edgar Tenent, Frank Tenent:** Oilseed Meal

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**Tae Yong Kim:** Marine Oil Fatty Acid Profile

**Youn-Hee Kim:** Aflatoxin in Cottonseed Meal

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**Lysi hf**

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**Malaysian Palm Oil Board, AOTD**

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**Dr. Hazimah Abu Hassan, Mrs. Hajar Musa:** Palm Oil, Gas Chromatography, *trans* Fatty Acid Content

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**Garlon Beckwith:** Oilseed Meal, Cottonseed, Soybean, Soybean Oil, Cottonseed Oil

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**Donald Britton:** Oilseed Meal, Cottonseed, Soybean, Cottonseed Oil

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**Joel Sieh:** Oilseed Meal



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**Richard A. Meyer,**  
**Timothy S. Meyer:** Tallow  
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**Modern Olives Laboratory  
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**Claudia Guillaume:** Olive Oil  
(Parts A, B and C), Olive Oil  
Sensory Analysis

**National Beef**  
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**Mike Clayton:** Tallow and  
Grease

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**Adalberto Coronado, Jose  
Garcia:** Tallow and Grease

**New Jersey Feed Lab, Inc.**  
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**Pete Cartwright:** Oilseed  
Meal, Gas Chromatography,  
Fish Meal, AOCS/GOED Nutra-  
ceutical Oils, Marine Oil,  
Marine Oil Fatty Acid Profile

**NSW Department  
of Primary Industries**  
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Australia  
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**Jamie Ayton:** Gas Chromatog-  
raphy, Olive Oil (Part A, B and  
C), *trans* Fatty Acid Content  
**Helen Taylor:** Olive Oil Sen-  
sory Analysis

**Nu-Mega Ingredients  
Pty. Ltd.**  
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**Nathaniel Irving:** AOCS/  
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Marine Oil Fatty Acid Profile

**Nutreco Canada Shur Gain**  
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Cholesterol, Nutritional  
Labeling, Marine Oil

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Nutraceutical Oils

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**OGEO Lab:** Gas Chromatogra-  
phy, Soybean Oil, *trans* Fatty  
Acid Content

**PA Bachoco Baijo**  
Carretera Panamericana  
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**Chris Barrett:**  
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**Pompeian Inc.**  
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**Maria Garzon:** Olive Oil Parts  
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Analysis

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**Karen Letourneau:** Oilseed  
Meal, Cholesterol, Marine  
Oil, Marine Oil Fatty Acid Pro-  
file, *trans* Fatty Acid Content,  
Phosphorus in Oil

**PT Musim Mas**  
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Medan II  
Saentis Percut Sei Tuan,  
Deli Serdang  
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**Goh Tiam Huat:** Gas  
Chromatography, Palm Oil,  
Solid Fat Content by NMR,  
*trans* Fatty Acid Content,  
Trace Metals in Oil,  
Phosphorus in Oil

**Russell Marine Group—  
PNW, LLC**  
2580 NW Upshur St.  
Portland, OR 97210  
USA  
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**Robert Carr:** Oilseed Meal,  
Soybean

**Sanimax-ACI, Inc.**  
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**Jean-Francois Harvey:**  
Tallow and Grease

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**Green Bay Analytical Team:**  
Tallow and Grease

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**Dennis Hogan:** Tallow and  
Grease (MIU, FFA), Aflatoxin  
in Corn Meal (test kit)

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**Norma Hernandez:**  
Peanut

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**Foong Ming Koh:** Tallow and  
Grease, Oilseed Meal, NIOP  
Fats and Oils, Aflatoxin in  
Corn Meal (test kit)

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**William Spence:** Oilseed  
Meal, Cholesterol, Olive Oil  
(Parts B & C)

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Bangkok, 10120  
Thailand  
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**Chin Chaothaworn:**

Fish Meal

**Silliker Canada Co.**

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Unit #4  
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Canada  
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**Jocelyn Alfieri:** Cholesterol,  
Gas Chromatography, *trans*  
Fatty Acid Content, Aflatoxin  
in Peanut Paste (test kit),  
Marine Oil Fatty Acid Profile

**Southern Acids (M) Bhd.  
Industries Sdn. Bhd.**

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**Tan Pei Fong:**

Gas Chromatography

**Southern Edible Oil Ind. (M)  
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**Low Thing:** Palm Oil**Sovena Oilseeds Laboratory**

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Borges  
No 2 Ed Arquiparque 2 3o  
Andar  
Lisbon 1495-131  
Portugal  
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**Sovena Oilseeds Laboratory:**

Unground Soybean  
Meal, Soybean, Gas  
Chromatography, Phosphorus  
in Oil, Trace Metals in Oil

**Stratas Foods—RDI Center**

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USA

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**Eddie L. Baldwin,****Helen Cianciolo, Howard**

**Payne:** Gas Chromatogra-  
phy, *trans* Fatty Acid Content,  
Solid Fat Content by NMR,  
Edible Fat

**Testing Services  
(Sabah) Sdn. Bhd.**

1st Floor, Lot 1, BLK N  
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Malaysia  
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**Kong Khim Chong:** Palm Oil**Thai Vegetable Oil**

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Bukhalow Thonburi  
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**Piyanut Boriboonwiggai:**

Unground Soybean Meal

**Thionville Laboratories, Inc.**

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**Paul C. Thionville,  
Andre Thionville, Kristopher  
Williams, Boyce H. Butler:**

Tallow and Grease, Oilseed  
Meal, Soybean, Gas Chro-  
matography, Trace Metals  
in Oil, Fish Meal, Marine Oil,  
Soybean Oil, Cottonseed Oil,  
Palm Oil, NIOP Fats and Oils,

*trans* Fatty Acid Content,  
Aflatoxin in Corn Meal

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Gas Chromatography

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Cholesterol, Gas Chromatog-  
raphy

**Viterra Canola Processing**

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Canada

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**Mike Adelino:** Gas

Chromatography, Trace  
Metals in Oil, *trans* Fatty Acid  
Content ■

# AOCS MEETING WATCH

November 6–8, 2013. Australasian Section AOCS Biennial Meeting and Workshops, NOAH's on the Beach, Newcastle, New South Wales, Australia. [www.aocs.org/australasian](http://www.aocs.org/australasian)

May 4–7, 2014. 105th AOCS Annual Meeting & Expo, Henry B. Gonzalez Convention Center, San Antonio, Texas, USA. <http://annualmeeting.aocs.org>

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

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

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





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# CALL FOR NO



## A. Richard Baldwin Distinguished Service

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

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

**Deadline:** November 1

## AOCs Award of Merit

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

*Nature of the Award:* A plaque.

**Deadline:** November 1

## AOCs Fellow

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

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

**Deadline:** December 1

## CALL FOR NOMINATIONS

Each award has its own specific and unique nomination requirements. For award consideration, it is essential that all paperwork be complete and received at AOCs by the nomination deadline. Self-nominations are welcomed and encouraged. Please refer to the website for the nomination requirements and submission deadlines.

## ELECTRONIC SUBMISSIONS ONLY!

AOCs is accepting nomination material only by electronic communication. Window based programs (WORD) and PDF material emailed to AOCs must include the award name and candidate name in the email subject line.



## Supelco/Nicholas Pelick-AOCs Research

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

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

**Deadline:** November 1

## Stephen S. Chang

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

*Nature of the Award:* A cash prize and a jade horse, provided by the Stephen and Lucy Chang endowed fund.

**Deadline:** October 15

## AOCs Young Scientist Research

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

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

**Deadline:** November 1

## The Schroeffer Medal

Originated by colleagues of George Schroeffer, this award recognizes a scientist who has made significant and distinguished advances in the steroid field. The work may represent a single major achievement or an accumulation of data.

*Nature of the Award:* An honorarium and a bronze medal.

**Deadline:** October 15



## ACI/NBB Glycerine Innovation

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

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

**Deadline:** November 1

## Samuel Rosen Memorial

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

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

**Deadline:** November 1

## Herbert J. Dutton

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

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

**Deadline:** November 1

## Timothy L. Mounts

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

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

**Deadline:** November 1



# COMBINATIONS

## Edible Applications Technology Outstanding Achievement

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

*Nature of the Award:* \$500 and a plaque.

**Deadline:** November 1 

## Ralph Holman Lifetime Achievement

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

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

**Deadline:** November 1 

## Processing Distinguished Service

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

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

**Deadline:** December 1

## Surfactants and Detergents Distinguished Service

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


*Nature of the Award:* A plaque.

**Deadline:** December 1

## Alton E. Bailey Award

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

*Nature of the Award:* \$750 and a plaque.

**Deadline:** November 1 



## Thomas H. Smouse Fellowship

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

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

**Deadline:** February 1

## Ralph H. Potts Memorial Fellowship

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

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

**Deadline:** October 15 

## Honored Student

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

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

**Deadline:** October 15 

## Kalustian and Manuchehr Eijadi

Each award recognizes outstanding merit and performance of one Honored Student award recipient and includes a scholarship of \$1,000.

## Hans Kaunitz

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

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

**Deadline:** February 1 

## AOCs Division Awards for Students

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

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

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

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

**Deadline:** Varies from October 15 to January 15 



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

The 105th AOCs Annual Meeting & Expo will be held in San Antonio, Texas, USA from May 4–7, 2014.

**AOCs Awards contact** ➤ [awards@aocs.org](mailto:awards@aocs.org) • [www.aocs.org/awards](http://www.aocs.org/awards)

# Phenolipids: novel quercetin-enriched lecithin for functional foods and nutraceuticals

Mohamed Fawzy Ramadan

The effectiveness in food systems of any antioxidant depends on its chemical reactivity, interaction with food components, environmental conditions, and physical location of the antioxidant. The polarity of the environment, in particular, strongly affects antioxidant activity. This observation, which was first reported two decades ago, led to the prevailing hypothesis known as the antioxidant polar paradox: Hydrophilic antioxidants are more effective in bulk oils, whereas lipophilic antioxidants are more effective in systems of high surface/volume ratio, such as emulsions.

Because phenolic antioxidants are highly polar, grafting a lipid onto them (i.e., lipophilization) can potentially extend their application in oil-based foods and cosmetics and make them more efficient in emulsions (1). Consequently, lipophilized surface-active phenolic antioxidants have been developed to improve their ability to counteract lipid oxidation in emulsions. These functionalized molecules resulting from the grafting of lipid onto a phenolic moiety are prepared via different synthesis strategies such as esterification, amidation, and etherification.

Phenolic compounds have received much attention due to their biological activities. The flavonoid quercetin (3,5,7,3',4'-pentahydroxyflavonol) is found as an aglycone in many foods, including apple, tea, onion, and berries. Quercetin is anti-inflammatory and antiallergenic, and it has positive effects on cardiovascular health. However, it is generally recognized that flavonoid glycosides are poorly absorbed in the small intestine because of sugar moieties that elevate their hydrophilicity. Several factors affect flavonoid absorption, such as the presence or absence of glycosylation on hydroxyl groups, the type of attached sugar moiety, plant/food matrix and interactions with proteins, micelles, and emulsifiers. Thus, the efficiency of intestinal absorption of quercetin is strongly affected by the compound's solubility. *In vitro* studies revealed the health-promoting properties of quercetin. However, there is limited knowledge about the bioavailability of

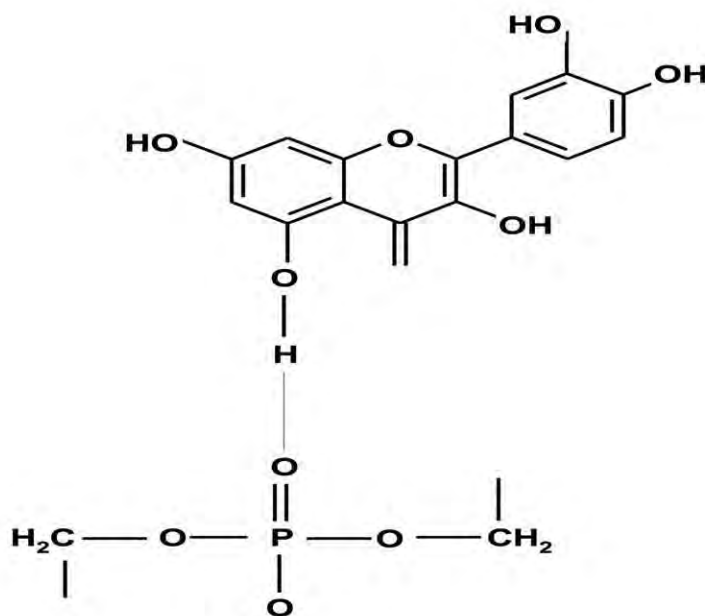


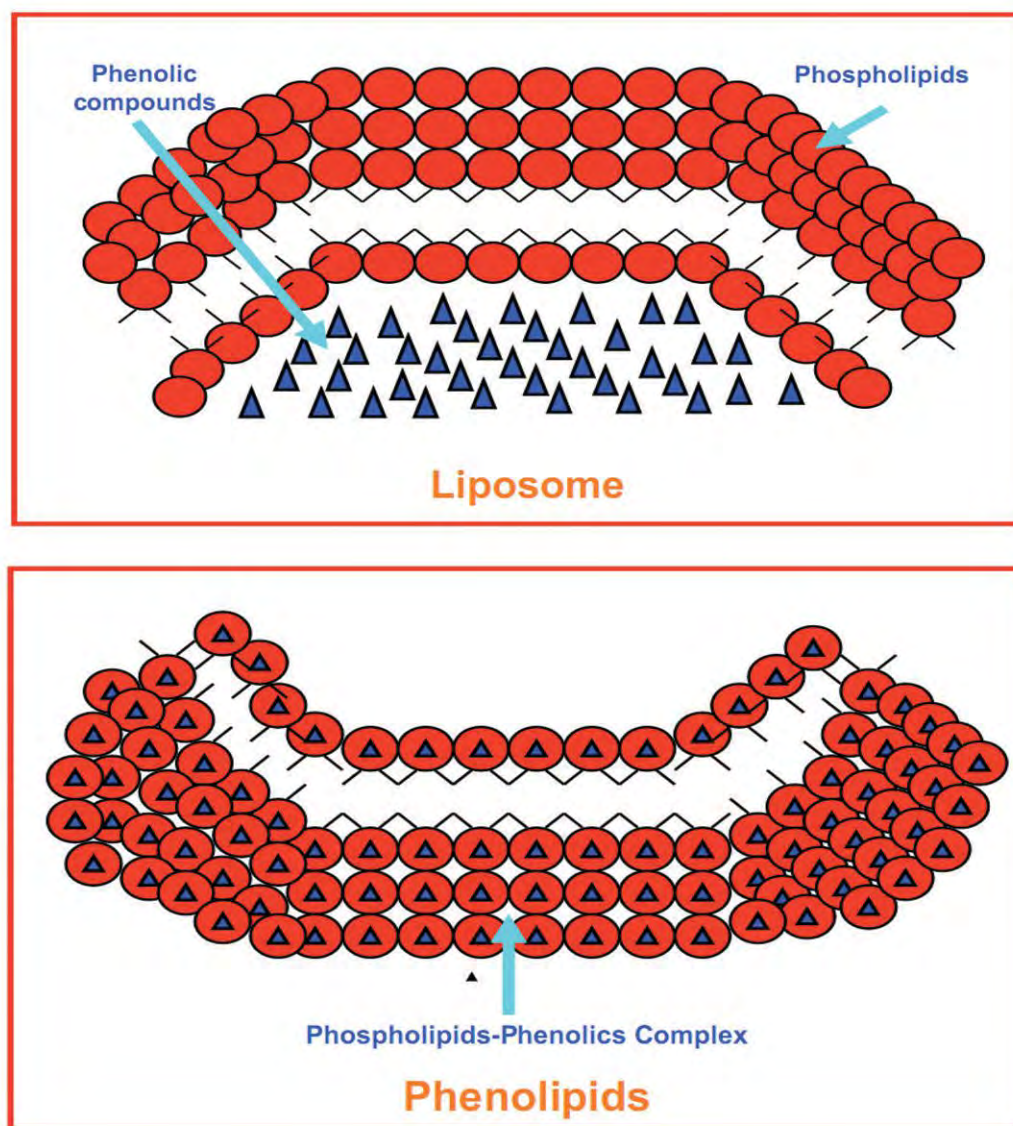
FIG. 1. Chain-like structure of quercetin linked to phosphatidylcholine.

quercetin in humans. A recent study suggested that absorption of quercetin glycosides in grape juice is less than from pure aglycones. Little quercetin was observed in the plasma after ingestion of pure aglycone or grape juice. A combination of lipids and emulsifiers is necessary to increase quercetin absorption. Similarly, green tea catechins, which are flavonoids, were absorbed to a greater extent when administered as a phospholipid complex compared to the absorption of free catechins. Therefore, quercetin dispersion in lipid micelles may be an important factor for increasing its absorption from the alimentary tract.

Phospholipids are constituents of cell membranes and present in many foods. Soy lecithin is a mixture of the phospholipids phosphatidylcholine, phosphatidylethanolamine, and phosphatidylinositol. Lecithin serves as an emulsifying agent in margarine, chocolate, caramels, and chewing gum. Production of cosmetics and pharmaceuticals is an example of the growing field of lecithin application as emulsifier.

Antioxidant characteristics of phospholipids have been reported. Two crucial polyunsaturated fatty components of phospholipids are linoleic acid (C18:2) and linolenic acid (C18:3), and the unsaturation sites on their carbon chains are the most sensitive to oxidation. Thus, phospholipids are also





◀ **FIG. 2.**  
Structural differences  
between liposomes and  
phenolipids.

easily oxidized, and this oxidation is likely to modify some characteristics of phospholipids. The ability of quercetin and phosphatidylcholine to form chain-like structures linked by hydrogen bonds (Fig. 1) has been demonstrated with nuclear magnetic resonance spectroscopy.

### PHENOLIPIDS: NOVEL FORMULATIONS OF PHENOLICS-ENRICHED LECITHIN

Liposomes are formed by mixing water-soluble substances with phospholipids; no chemical bonds are formed. Phenolipids, unlike liposomes, result from the reaction of phospholipids with selected phenolic compounds. They are lipophilic and freely soluble in some solvents and in fats (Fig. 2).

In this research, novel phenolipid formulations (quercetin-enriched lecithin) were prepared in ethyl acetate. To study the interaction between lecithin and quercetin, we determined the antioxidant potential of the lecithin as well as phenolipid formulations (quercetin-enriched lecithin) when added to sunflower oil (SFO) during an accelerated oxidation test. The antimicrobial and antiviral effects of the phenolipids and lecithin were also

investigated (2,3). The results might be applied to increase the biological activity and health impact of lecithin and phenolics in food and pharmaceutical products.

### STABILITY AND RADICAL SCAVENGING ACTIVITY (RSA) OF PHENOLIPIDS-ENRICHED SFO

Characterization of phenolipids-enriched SFO stability was monitored during accelerated oxidation during heating in an oven. To evaluate the oxidative stability (OS) of SFO and triolein models, peroxide value (PV), ultraviolet light absorptivity, and RSA were determined. On the basis of PV, the OS of SFO models varied, with the models enriched with quercetin-lecithin mixture (3:97, wt/wt) being most stable. The PV clearly showed that as the storage time increased the OS of SFO models decreased (Fig. 3, page 534). Phenolipids-enriched models had a much lower PV than that of models enriched with lecithin and quercetin. The OS of phenolipids-enriched models was better during heating in an

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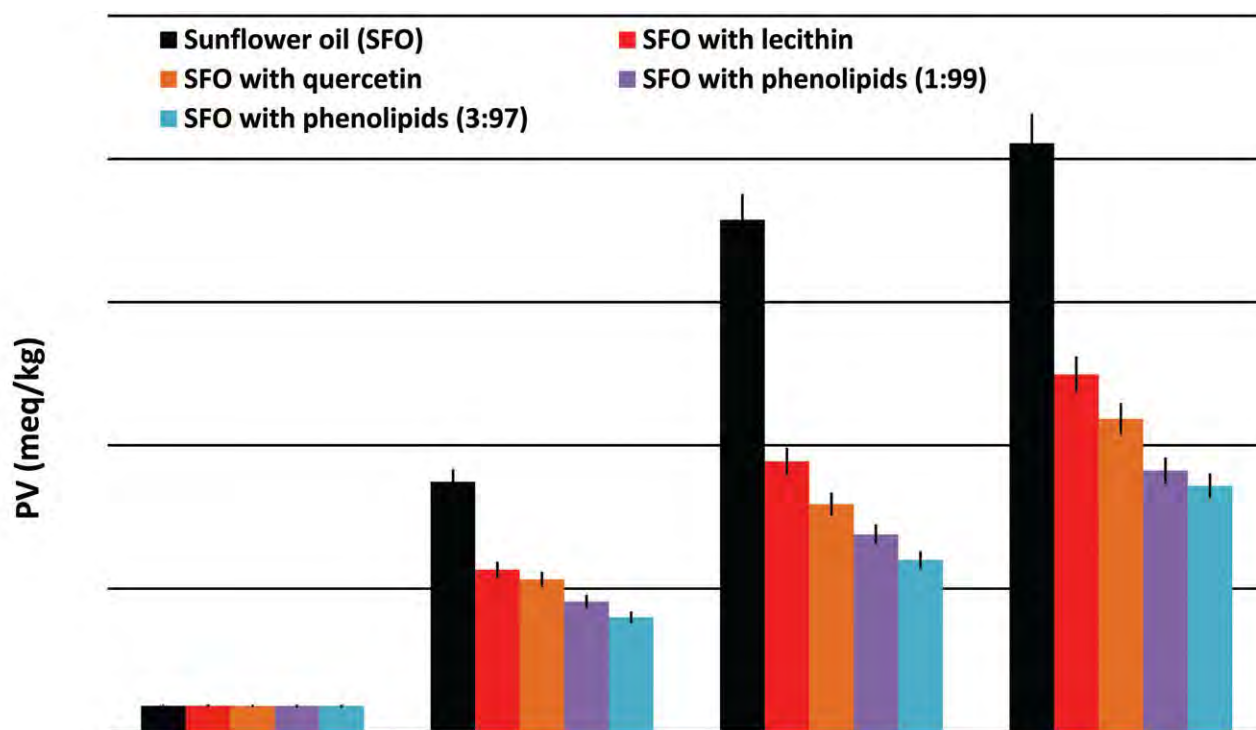


FIG. 3. Changes in peroxide value (PV) of SFO models during heating in an oven.

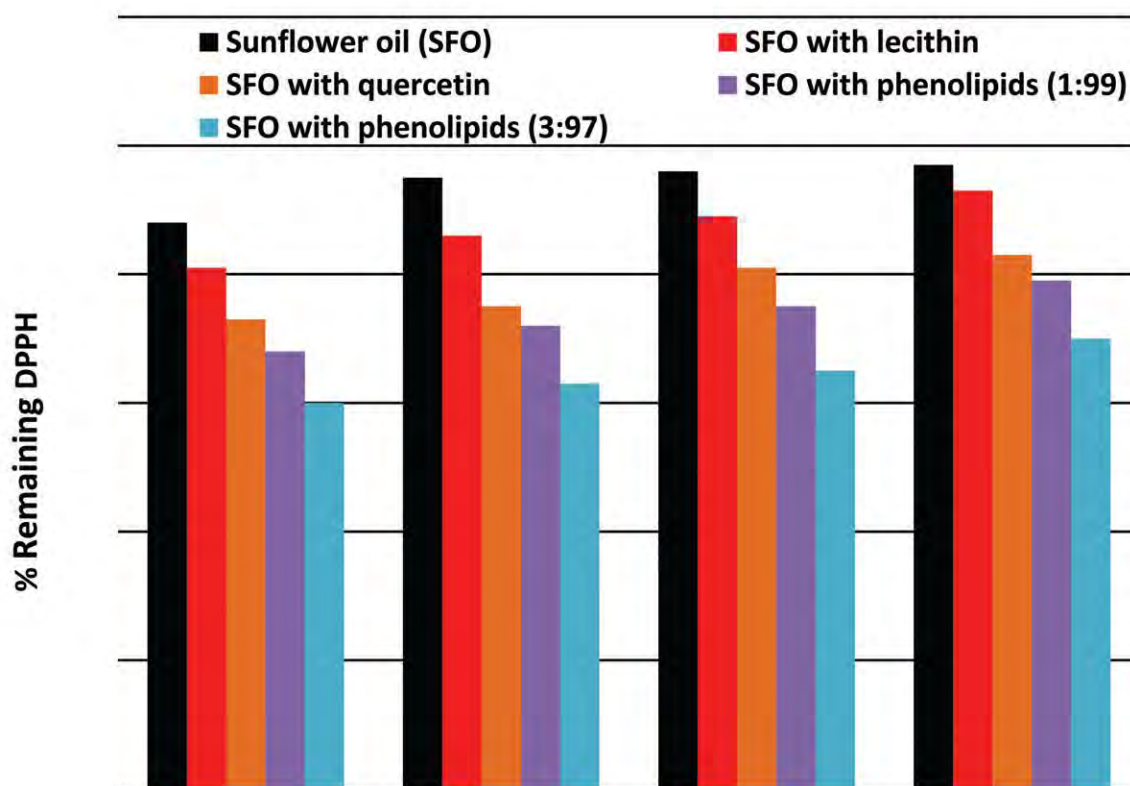


FIG. 4. Scavenging effect at 60 min incubation time of SFO models on DPPH (diphenylpicrylhydrazyl) radical as measured by changes in absorbance values at 515 nm. Phenolipids terminology: (parts quercetin/parts lecithin, wt/wt).



oven. The high content of conjugated oxidative products in lecithin-enriched models can be attributed to the high linoleic acid content (55.4 % of total fatty acids) of the added lecithin, which is readily decomposed to form conjugated hydroperoxides.

The ability of phenolipids to prevent lipid peroxidation was screened using diphenylpicrylhydrazyl radicals (DPPH•). From the data presented in Figure 4, one can see that phenolipids were very efficient antioxidants in SFO models, their inhibition efficiency being different from that of other models containing lecithin and quercetin individually. The impact of quercetin and lecithin as single additives on SFO oxidation was weak and gave 7–17 % inhibition of DPPH•. The strong RSA of lipid models containing phenolipids is likely due to the synergism of quercetin with lecithin as well as tocopherols in SFO and to different kinetic behaviors of potential antioxidants.

## ANTIMICROBIAL AND ANTIVIRAL ACTIVITY OF PHENOLIPIDS

To determine their antimicrobial activity, quercetin, lecithin, and quercetin-enriched lecithin (1:99 and 3:97, wt/wt) were tested against gram-positive (*B. subtilis* and *S. aureus*) and gram-negative (*E. coli* and *P. aeruginosa*) bacteria. The results of the antibacterial screening assay conducted at 2000 ppm are shown in Table 1 (page 537). The antibacterial activity profile of quercetin against tested bacteria indicated that *B. subtilis* was the most susceptible. Lecithin exhibited less antibacterial activity than quercetin against these gram-positive and gram-negative bacteria. Phenolipids

exhibited the strongest antibacterial action. Antibacterial action also increased with increasing level of quercetin in the formulation. Lecithin may bind both  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions, thereby reducing the  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  from lipopolysaccharide of the bacterial outer membrane causing a release of lipopolysaccharide, thereby destabilizing the membrane, which may increase the activity of phenolipids.

The activities of quercetin, lecithin, and phenolipid formulation (3:97, wt/wt) against HAV (hepatitis A virus: MBB strain) were evaluated using the plaque reduction assay. When HAV was exposed to phenolipids (3:97, wt/wt) at 37°C for one hour during and after its adsorption to cells from the Vero cell line (derived from the kidney of an African green monkey), the complex exhibited dose-dependent inhibition of plaque formation with the virus (Table 2, page 537). The antiviral activity of phenolipids (3:97 wt/wt) against the HAV reached maximal inhibitions at the level of 40 µg/mL. Quercetin exhibited antiviral activities higher than lecithin. It was suggested that the mode of action is not derived from inhibiting the absorption of virus but resulted from inhibition at early stages of viral replication after infection.

Tentatively, one may conclude that at different concentrations of quercetin-lecithin formulations, OS as well as antimicrobial and antiviral activities of phenolipids are superior to native

CONTINUED ON PAGE 537

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# 105th AOCS Annual Meeting & Expo

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**TABLE 1.** Antibacterial activity of quercetin, lecithin, and treated lecithin and phenolipid formulations against two Gram-negative and two Gram-positive bacteria

Compound/ formulation	µg/mL	Diameter of inhibition zone (mm) <sup>a</sup>			
		Gram-negative		Gram-positive	
		<i>E. coli</i>	<i>P. aeruginosa</i>	<i>B. subtilis</i>	<i>S. aureus</i>
Quercetin (Qu)	2000	15.66	13.0	19.0	15.3
Lecithin (Le)	2000	9.67	10.3	9.00	8.33
Qu/Le (1:99, wt/wt)	2000	18.6	17.6	19.6	17.0
Qu/Le (3:97, wt/wt)	2000	23.3	24.3	27.0	22.0

<sup>a</sup>*E. coli*, *Escherichia coli*; *P. aeruginosa*, *Pseudomonas aeruginosa*; *B. subtilis*, *Bacillus subtilis*; *S. aureus*, *Staphylococcus aureus*.

**TABLE 2.** Antiviral activity of quercetin, lecithin, and a phenolipid formulation (3:97 wt/wt) against an HAV strain

Compound/ formulation	µg/mL	HAV (MBB strain)		
		Initial virus count	Final virus count	Inhibition
		(PFU/mL)	(PFU/mL)	(%)
Quercetin	20	$0.96 \times 10^7$	$0.59 \times 10^7$	37
	40	$0.96 \times 10^7$	$0.51 \times 10^7$	45
Lecithin	20	$0.96 \times 10^7$	$0.72 \times 10^7$	24
	40	$0.96 \times 10^7$	$0.63 \times 10^7$	33
Phenolipid (3:97, wt/wt)	20	$0.96 \times 10^7$	$0.43 \times 10^7$	53
	40	$0.96 \times 10^7$	$0.21 \times 10^7$	75

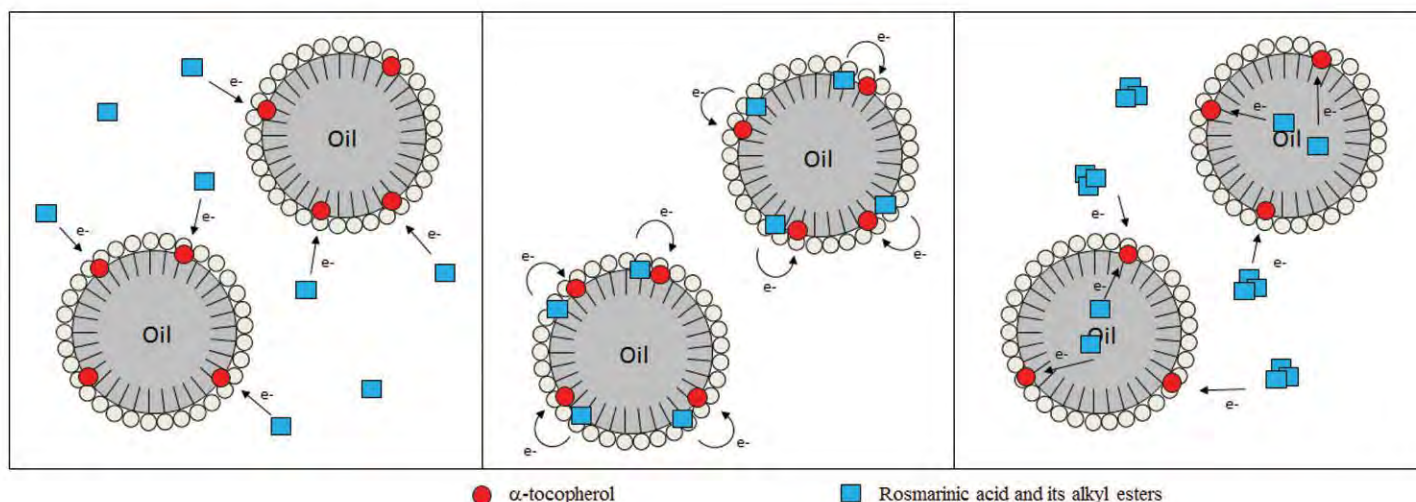
<sup>a</sup>Abbreviations: HAV, hepatitis A virus; PFU, plaque-forming units.

lecithin and/or quercetin. These results confirm the complexity of the antioxidative potential and bioactivity of phenolipids including the synergism of phospholipids, quercetin, and tocopherols in SFO. The optimal concentration of phenolipid formulations will depend on the application. In the current study, ethyl acetate was used to dissolve both lecithin and quercetin; however, other techniques may be applied to increase the stability. Recent information indicates that flavonoids are relatively stable compounds with respect to various modes of processing and thermal treatments (e.g., boiling, frying, etc.). Thus, this synergism can be used, for example, to increase the antioxidant activity of lecithins that are usually employed as food additives, analogously to the increase in the stability observed for lipid/protein samples submitted to slight oxidation. These results open potential new applications for phenolipids in the food, pharmaceutical, and cosmetic or personal care industries.

*Mohamed Fawzy Ramadan Hassanien is an associate professor of biochemistry in the Biochemistry Department, Faculty of Agriculture, Zagazig University (Egypt). He recently developed different phenolics-enriched lecithin for functional foods and nutraceuticals. In 2009, he received the European Young Lipid Scientist Award from Euro Fed Lipid. He can be contacted at hassanienmohamed@yahoo.com.*

## INFORMATION

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**FIG. 1.** The conceptual model showing the influence of physical locations on the ability of antioxidants such as alkyl esters of rosmarinic acid and  $\alpha$ -tocopherol to interact in oil-in-water (O/W) emulsions. Possibilities of interactions of antioxidants with  $\alpha$ -tocopherol at the O/W interface include (left) high polarity, (center) medium polarity, and (right) low polarity antioxidants.

# Mechanisms of antioxidant interactions in oil-in-water emulsions: the influence of their physical locations and environmental pH

**Atikorn Panya, Ketinun Kittipongpittaya, Mickaël Laguerre, Christelle Bayrasy, Jérôme Lecomte, Pierre Villeneuve, D. Julian McClements, and Eric A. Decker**

A classic example of synergistic antioxidant interactions can be observed between  $\alpha$ -tocopherol (vitamin E) and ascorbic acid (vitamin C) in cell membranes. This synergism is due to “antioxidant regeneration” via the recycling of a stronger (primary) antioxidant with a weaker (secondary) antioxidant. By this principle, the primary antioxidant ( $\alpha$ -tocopherol) scavenges free radicals in the lipid phase and is then regenerated by the secondary antioxidant (ascorbic acid). From a thermodynamic point of view,

the reaction is favorable because the reduction potential of ascorbic acid is much lower than  $\alpha$ -tocopherol, indicating that ascorbic acid prefers to give an electron to oxidized  $\alpha$ -tocopherol. From a physical property viewpoint, this reaction is also favorable because  $\alpha$ -tocopherol is in the membrane where it can inactivate lipid radicals and yet is also at the membrane interface where it can react with ascorbic acid.

## $\alpha$ -TOCOPHEROL AND ROSMARINIC ACID ESTERS IN OIL-IN-WATER (O/W) EMULSIONS

Whereas  $\alpha$ -tocopherol and ascorbic acid work synergistically in biological membranes, this is not always the case in food systems where lipids can be in the form of triacylglycerols and exist as emulsion droplets. In addition, the range of antioxidant that could



interact synergistically is limited because most natural antioxidants have higher reduction potentials than  $\alpha$ -tocopherol. Therefore, in foods it is not well understood if natural antioxidants can regenerate  $\alpha$ -tocopherol or if  $\alpha$ -tocopherol is actually a secondary antioxidant that regenerates other antioxidants to produce synergistic effects. In addition, it is not well understood how physical locations of antioxidants in O/W emulsions influence antioxidant regeneration.

To address these issues, rosmarinic acid and its esters provide an excellent tool for analyzing the influence how physical locations can impact interactions with  $\alpha$ -tocopherol because rosmarinic acid can be esterified with fatty acids to alter polarity and thus physical location in O/W emulsions. Rosmarinic acid and its esters have higher oxidation peak potentials (approximately 1115 mV) than  $\alpha$ -tocopherol (635 mV). Moreover, 90% of rosmarinic acid (R0) partitions in the aqueous phase, whereas butyl (R4), dodecyl (R12) and eicosyl (R20) rosmarinate esters as well as  $\alpha$ -tocopherol are highly associated with the emulsion droplets (approximately 2–9% in the aqueous phase). A conceptual model is shown in Figure 1 of how these differences in physical location could impact interactions between  $\alpha$ -tocopherol and rosmarinic acid and its alkyl esters used O/W emulsions.

## SYNERGISTIC, ADDITIVE, OR ANTAGONISTIC EFFECTS?

In the absence of  $\alpha$ -tocopherol, rosmarinic acid and its alkyl esters exhibited nonlinear antioxidant activity, the so-called cut-off effect as shown in Figure 2 (page 540). The combination of  $\alpha$ -tocopherol (T) with R0 showed strong synergistic activity (synergistic index = 5.25) as calculated from the induction period of hexanal formation in O/W emulsions. R4 and R12 showed slight synergistic effects (synergistic index = 1.9–2.0). However, an antagonistic effect was observed with combinations of  $\alpha$ -tocopherol with R20 (synergistic index = 0.3). Also, the synergistic interactions between  $\alpha$ -tocopherol and the alkyl esters of rosmarinic acid were pH dependent. Under acidic conditions (pH 3–5), synergistic interaction between  $\alpha$ -tocopherol and rosmarinic acid decreased to an additive effect. For example, the synergistic index of T + R0 at pH 3 was 1.2. This highlights the problem that predicting synergistic interactions between antioxidants in food systems is difficult and may involve more than just electron-transfer mechanisms.

## EVIDENCE OF ANTIOXIDANT INTERACTIONS MECHANISMS

Front-face fluorescence quenching and electron parametric resonance techniques are two techniques that can be used to analyze direct physical interactions and direct electron transfer among the antioxidants. Figure 3 (page 540) shows that rosmarinic acid (mostly dispersed in aqueous phase) highly interacted with and/or regenerated  $\alpha$ -tocopherol at the interface of emulsion droplets more than with the other rosmarinate alkyl esters. In addition, the regeneration efficiency of rosmarinic acid decreased with decreasing pH, which could explain why synergistic activity also decreased under acidic conditions.

CONTINUED ON PAGE 541



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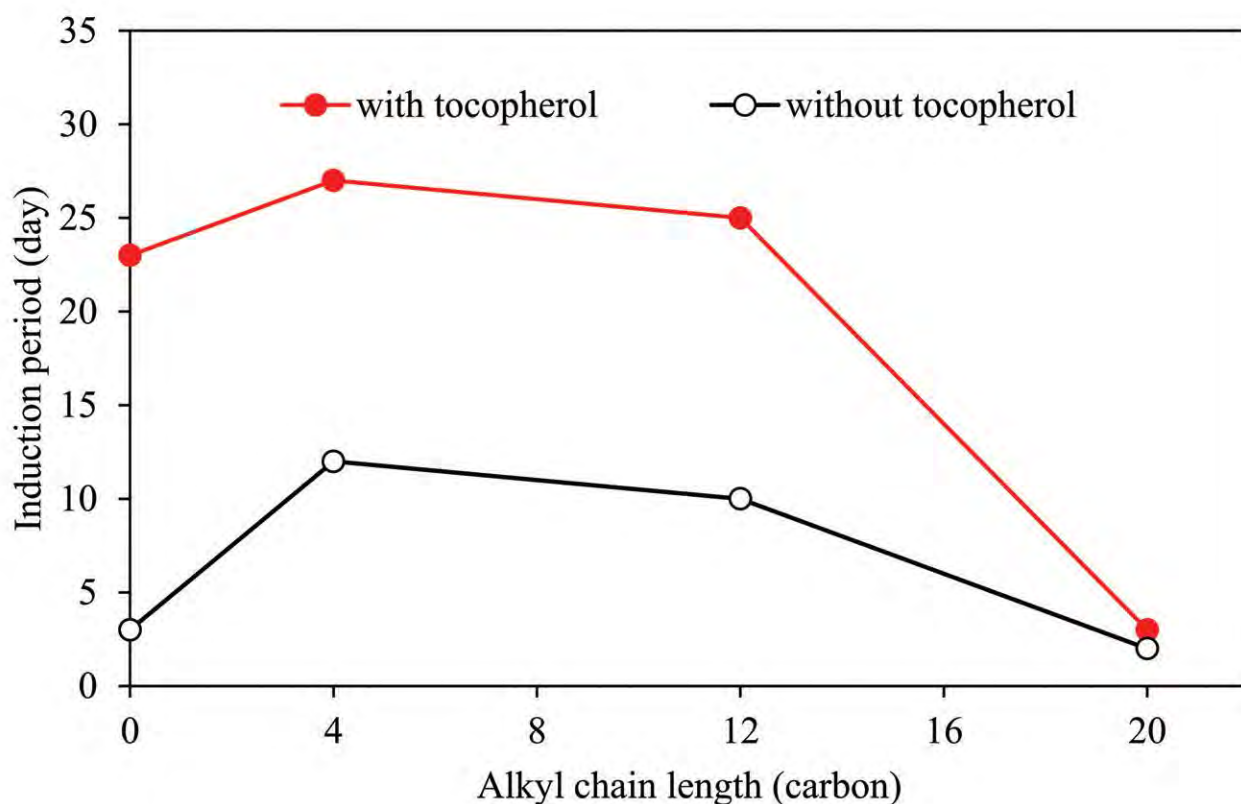


FIG. 2. Induction periods of rosmarinic acid and its alkyl esters in the presence or the absence of  $\alpha$ -tocopherol.

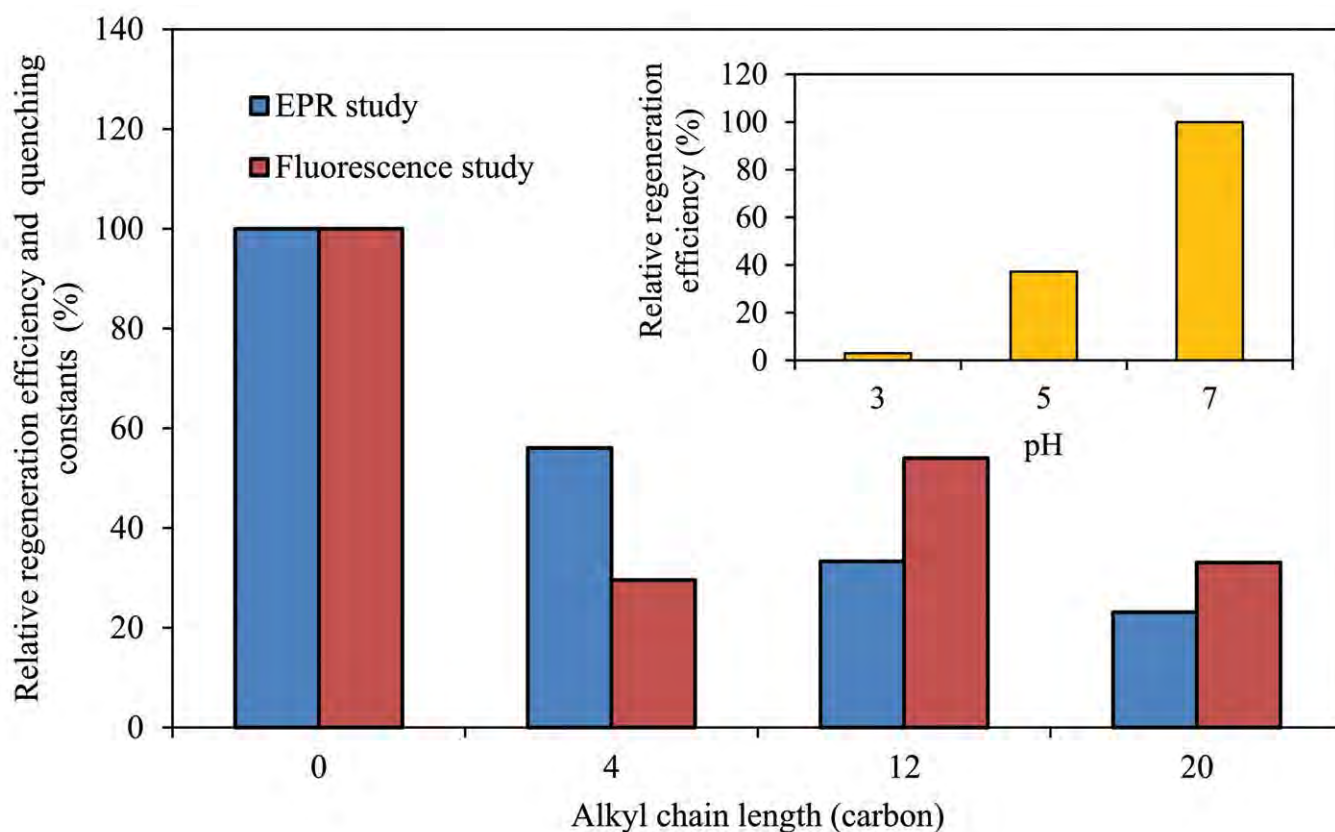


FIG. 3. Fluorescence quenching constants (fluorescence study) and regeneration efficiencies (electron paramagnetic study, EPR) of the capacity of rosmarinic acid and its alkyl esters to physically interact with and to regenerate  $\alpha$ -tocopherol in O/W emulsions, respectively. The insert figure shows changes in regeneration efficiencies between  $\alpha$ -tocopherol and rosmarinic acid under different pH conditions.



Another way to study antioxidant interactions is to look at the kinetics of their decay during storage of O/W emulsions. In this method, if one antioxidant is regenerating another then one would expect to see one of the antioxidants decompose faster than the other. Interestingly, a significant reduction of the oxidation rate of  $\alpha$ -tocopherol was observed in the presence of rosmarinic acid, but this did not seem to be only due to regeneration of  $\alpha$ -tocopherol, as rosmarinic acid degradation resulted in the formation of caffeic acid (a part of the rosmarinic acid molecule). Since caffeic acid also has antioxidant activity in O/W emulsions, it is possible that the formation of this second antioxidant is responsible for the observed synergistic activity. Thus, synergistic antioxidant interaction cannot be explained solely by electron-transfer mechanism; the complexity of several other mechanisms, antioxidants, and their oxidation products must be considered as well. Overall, this study shows the importance of understanding antioxidant interactions in complex food systems so that better predictions can be made on which antioxidant combination could result in synergistic inhibition of lipid oxidation.

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**Ketnun Kittipongpittaya** is a doctoral student, **D. Julian McClements** is a Professor and **Ferguson Clydesdale Endowed**

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**Chair**, and **Eric Decker** is professor and head of the Department of Food Science, University of Massachusetts, Chownoweth Laboratory.

**Mickaël Laguerre**, **Christelle Bayrasy**, **Jérôme Lecomte**, and **Pierre Villeneuve** are researchers at CIRAD in Montpellier, France.



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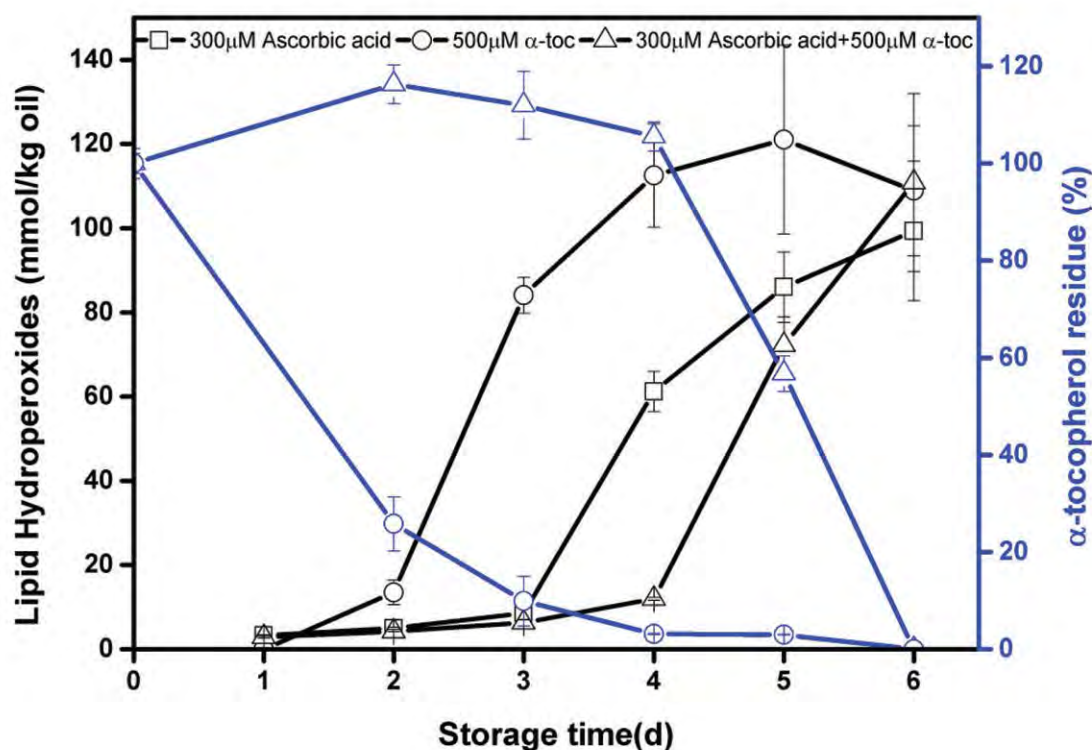
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**FIG. 1. ►**  
The formation of lipid hydroperoxides (black line) and the depletion of  $\alpha$ -toc ( $\alpha$ -tocopherol; blue line) in bulk algal oil in the presence of 300  $\mu$ M ascorbic acid, 500  $\mu$ M  $\alpha$ -tocopherol, or antioxidants combined (300  $\mu$ M ascorbic acid + 500  $\mu$ M  $\alpha$ -tocopherol) at 45°C.



## Antioxidant regeneration: a rational strategy to improve oxidative stability in algal oil

**Bingcan Chen, Julian McClements, and Eric Decker**

Interest has been growing in consuming long-chain polyunsaturated fatty acids (LC-PUFA) owing to their promising health benefits, such as the inhibition of cardiovascular disease, cancer, and inflammatory disease (see *Inform* 24:7–11, 2013). Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the two principal LC-PUFA accounting for the putative benefits, have been widely used for food and beverage fortification. Marine fish and algae are the two major sources for LC-PUFA. Among them, algal oil is increasingly of significant commercial interest in that it exclusively contains a large amount of DHA.

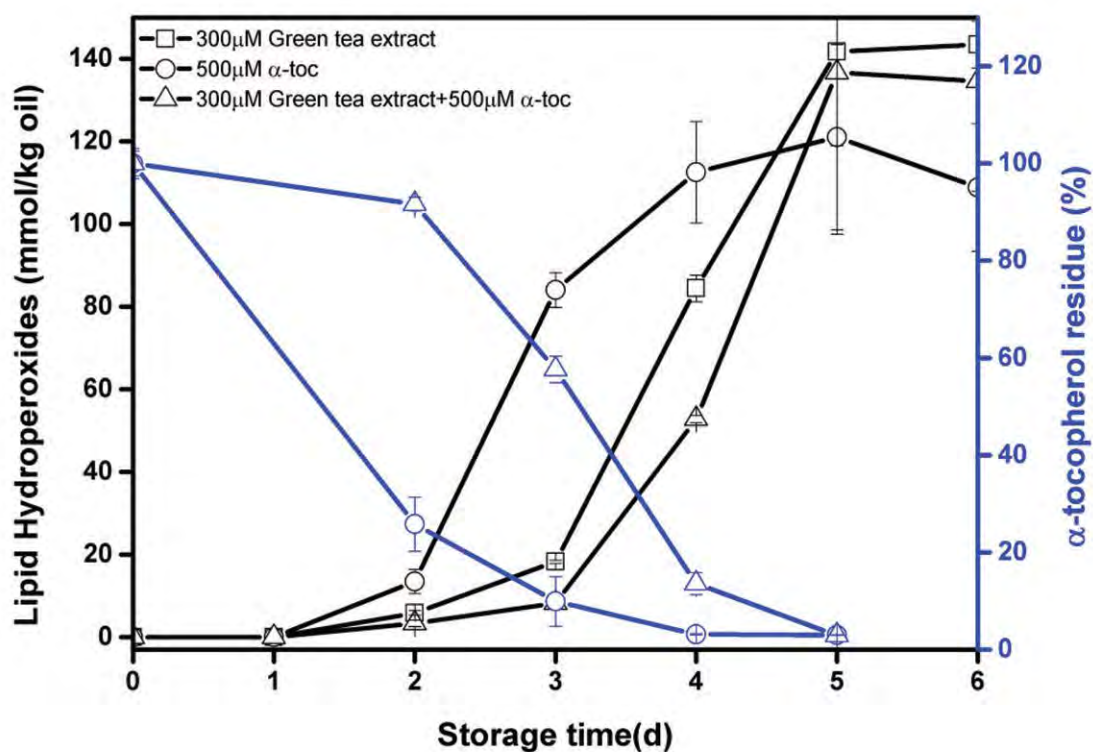
However, LC-PUFA are vulnerable to oxidation during oil extraction, food processing, and storage. This generates oxidation products that negatively affect the flavor, color, nutrient value, and functionality of the fortified foods and food components. In addition, some lipid oxidation products are detrimental to the health of consumers. Thus, the benefits of LC-PUFA can be realized only when no oxidation occurs before consumption.

The incorporation of antioxidants is the most successful way to achieve that goal and has been broadly applied in the food industry. But the traditional natural antioxidants that are applied to prevent common food oil oxidation are inefficient in inhibiting LC-PUFA oxidation. The obstacles impeding the oxidative stability of foods having LC-PUFA are the higher susceptibility of LC-PUFA to oxidation and the relatively lower efficacy of antioxidants. Hence, special strategies should be developed to maximize the oxidative stability of oil or food product containing LC-PUFA.

Our previous study suggested the existence of nanoreactors in bulk heterogeneous vegetable oil that form by self-assembly of endogenous surface-active minor compounds and trace water (~200 ppm). We also found that those reactors could potentially affect the activity of antioxidants of different polarity in bulk vegetable oil by altering their locations (*Inform* 21:577–578, 2010).

CONTINUED ON PAGE 544





**FIG. 2.** The formation of lipid hydroperoxides (black line) and the depletion of  $\alpha$ -toc ( $\alpha$ -tocopherol; blue line) in bulk algal oil in the presence of 300  $\mu$ M green tea extract, 500  $\mu$ M  $\alpha$ -tocopherol, or antioxidants combined (300  $\mu$ M green tea extract + 500  $\mu$ M  $\alpha$ -tocopherol) at 45°C.

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Consequently, we proposed that the combination of appropriate hydrophilic/lipophilic antioxidant pairs could enhance the oxidative stability of algal oil.

Thus, the oxidative stabilities of algal oil in the presence of lipophilic antioxidant  $\alpha$ -tocopherol, hydrophilic antioxidant (ascorbic acid or green tea extract), and a combination of hydrophilic/lipophilic antioxidants were compared by the lag phase estimated by the formation of lipid hydroperoxides. In the meantime, the depletion of  $\alpha$ -tocopherol was also determined using high-performance liquid chromatography.

We found that hydrophobic  $\alpha$ -tocopherol alone does not give a distinct protective effect, as it had a similar lag phase to the algal oil (Fig. 1, page 542). After day two, only 20% of  $\alpha$ -tocopherol was left, and the lipid hydroperoxides increased sharply thereafter. The protective effect of hydrophilic antioxidants, that is, ascorbic acid and green tea extract, is greater than  $\alpha$ -tocopherol. It extends the lag phase to three days (Figs. 1,2, pages 542 and 543). The combination of  $\alpha$ -tocopherol and ascorbic acid contributed to a lag phase of four days. Meanwhile, ascorbic acid decreased the depletion of  $\alpha$ -tocopherol dramatically. The concentration of  $\alpha$ -tocopherol did not start to decline until day four after which oxidation rates increased exponentially. Unlike ascorbic acid, the addition of green tea extract does not further the oxidative stability of algal oil containing  $\alpha$ -tocopherol, and the protective effect of green tea extract on  $\alpha$ -tocopherol degradation was weaker than that of ascorbic acid.

We postulated the protective effect of ascorbic acid on  $\alpha$ -tocopherol depletion was due to the antioxidant regeneration, that is, a chemical reaction where a primary antioxidant neutralizes a free radical and is then regenerated with the help of a secondary antioxidant, resulting in superior antioxidant activity. One

parameter, one electron reduction potential, could be used to predict the feasibility of antioxidant regeneration. Any compound that has a reduction potential lower than the reduction potential of a free radical is capable of donating a hydrogen ion to that free radical unless the reaction is kinetically unfeasible.

Antioxidant regeneration has been observed in biological systems such as in cell membranes, in homogeneous solutions, and in aqueous dispersions of lipids. Besides, the reduction potential can be affected by many factors, such as environment pH and solution composition. For instance, the reduction potentials of  $\alpha$ -tocopherol; epigallocatechin gallate, or EGCG (the green tea extract used in this study had an EGCG content higher than 90%); and ascorbic acid are reported to be 500, 430, and 280 mV, respectively, in solutions. Interestingly, the reduction potential order of the antioxidants used in this study is consistent with their performance in protecting both algal oil oxidation and  $\alpha$ -tocopherol depletion. Ascorbic acid, which has the lower reduction potential, could regenerate  $\alpha$ -tocopherol radicals back to  $\alpha$ -tocopherol faster than green tea extract due to its lower reduction potential.

We still do not know if the reduction potential of antioxidants can be entirely extrapolated to predict the antioxidant regeneration in bulk oil system since reduction potential cannot be measured in organic solvents. But, antioxidant regeneration is a rational means to improve the oxidative stability of LC-PUFA using currently available natural antioxidants.

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## SUPPLEMENT

Response to recent paper on omega-3 fatty acids and prostate cancer risk

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Global Omega-3 Summit 2013 highlights

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Dividing and rules: What do you do when you reach the end of the line?

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More Extracts & Distillates

# Response to recent paper on omega-3 fatty acids and prostate cancer risk

## Summary

Brasky, *et al.*, from the Ohio State University Comprehensive Cancer Center in Columbus, Ohio, USA, recently reported on the relationship between higher blood levels of omega-3 fatty acids and the risk of prostate cancer. Their paper, “Plasma phospholipid fatty acids and prostate cancer risk in the SELECT trial, *J. of the National Cancer Institute*, in press on July 10, 2013, reported the results of a “case-cohort” study in the United States wherein the blood levels of long-chain omega-3 fatty acids—eicosapentaenoic acid (EPA) and docosapentaenoic acid (DPA)—were measured in men aged 50 and over who were confirmed to have prostate cancer and those (controls) who were free of prostate cancer. The authors reported a positive relationship/trend based on statistical analyses between higher levels of long-chain omega-3 fatty acids (the sum of EPA/DPA/DHA omega-3 fatty acids) in the blood biomarker (omega-3 levels in blood plasma phospholipid) and total prostate cancer. They reported a significant positive relationship between higher blood levels of DHA and prostate cancer risk but no statistically-significant trend was found in the case of EPA. The authors concluded that “Recommendations to increase LCommega-3 PUFA intake should consider its potential risks.”

**Bruce Holub**

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## Response

It is noteworthy that this study did not evaluate the intake of long-chain omega-3 fatty acids to the risk of prostate cancer. The levels of EPA/DPA/DHA in the circulation are influenced by the metabolism of these fatty acids which differ between individuals including the metabolic conversion of dietary LNA (alpha linolenic acid, the short-chain and major omega-3 fatty acid in the North American diet—representing 90 % of the total omega-3 intake) to these long-chain omega-3 fatty acids. The blood levels of EPA/DPA/DHA also reflect the dietary intakes of these fatty acids (particularly EPA and DHA) from dietary sources (mainly fish/seafood) plus other foods (including food enriched in EPA/DHA) plus supplements (nutraceuticals) containing EPA/DHA.







Numerous lifestyle factors (smoking, etc.) have also been associated with differing blood levels of omega-3 fatty acids in the blood. Thus, this study does not allow for any direct connection of the higher blood levels of EPA/DPA/DHA combined, as associated with a moderately higher risk of prostate cancer (as reported in this paper), to a specific source such as dietary intake of total fish /seafood; specific types of fish/seafood; preparation of salted, pickled, or other such food sources; fish oil supplements; and other influencing factors. Thus, a quote from the research team in a recent widespread release that efforts to increase long-chain omega-3 fatty acid intakes (particularly from supplement sources) should consider the potential risks is premature and not well-founded in my opinion without directly assessing omega-3 intakes (via diet, fish/seafood, other foods enriched in EPA/DHA, fish oil supplementation) in relation to the risk of prostate cancer—which, these researchers did not do.

It is noted that even moderate supplementation with EPA plus DHA omega-3 (one gram daily) over a 12-week

period causes a very marked rise in EPA plus DHA levels in blood plasma phospholipid – to an average level of 7.93 % of total fatty acids (Thies, *et al.*, *Am. J. Clinical Nutr.* 73: 539-548, 2001.) However, the average level of EPA plus DHA in the circulating phospholipid of those with prostate cancer was only 3.6 % in the study by Brasky, *et al.*, such that relating blood levels of long-chain omega-3 fatty acids to the risk of prostate cancer due to omega-3 supplementation appears to be inappropriate.

The topic of dietary intake of fish and EPA/DHA prostate cancer was reviewed by MacLean, *et al.*, *J. Am. Medical Assoc.* 295: 403-415, 2006. In the four studies as reviewed directed to fish consumption, one demonstrated a favorable effect, one showed a trend for a favorable effect, and two did not find an association. This review also reported on no significant association with the incidence of prostate cancer with marine omega-3 fats, EPA, or DHA consumption.

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It is of interest to note that the present authors (who submitted their revised article on May 24, 2013) did not include reference to the publication by Torfadottir, *et al.*, *Plos One* 8: e59799, April 2013. These latter researchers reported upon finding no association between overall fish consumption in early or midlife and prostate cancer risk. However, there was some evidence that 'salted' or 'smoked' fish may increase the risk of advanced prostate cancer. Interestingly, men consuming fish oil in later life had a lower risk of advanced prostate cancer and no association was found for early life or midlife consumption. They concluded that fish oil consumption may be protective against the progression of prostate cancer in elderly men.

Finally, it is important to emphasize that Mozaffarian, *et al.* have recently published their findings from a major popu-

lation study relating the levels of the summed and individual levels of long-chain omega-3 fatty acids in older US adults to all-cause mortality (*Ann. Intern. Med.* 158: 515-525, April 2, 2013). Interestingly, the same biomarker (omega-3 fatty acids in blood plasma phospholipid) was used in the study by Mozaffarian, *et al.*, as was used in the study by Brasky, *et al.* Also, the distributions of long-chain omega-3 levels across the subject sub-groups (quintiles/quartiles) were generally quite similar. The study by Mozaffarian, *et al.*, published in 2013, reported a highly significant trend for total and individual long-chain omega-3 fatty acids such that higher blood levels were associated with less mortality. Individuals with higher levels of total omega-3 fatty acids had a 27 % lower risk while higher levels of EPA and DHA were respectively associated with 17 % and 20 % less total all-cause mortality.

# Global Omega-3 Summit 2013 highlights

## Marleen Nys and Ignace Debruyne

*Marleen Nys has been a freelance nutrition author since 2004, and is a member of the editorial advisory panel of AT&A, Amsterdam, The Netherlands. Nys has paramedical training and did her postgraduate work in nutritional biochemistry. She worked several years for the Flemish Institute of Orthomolecular Sciences and for the journal Orthofyto in Belgium. She can be reached at marleennys@telenet.be.*

*Ignace Debruyne is an independent consultant who specializes in oils & fats, foods, soy foods, process and product technology, marketing and communication. His company, Ignace Debruyne & Associates, Belgium, is also involved in organizing technical short courses as well as health, nutrition related legislation, communication, marketing and policy development. He can be reached at ignace.debruyne@advalvas.be.*

V. Krishnakumar (Giract, Switzerland) opened the summit with an overview of the current situation and the main concerns for global health. Namely, deficits in two LC-Omega-3s—eicosapentaenoic acid (EPA) and docosahexaenoic acid (DPA)—will put a heavy burden on humanity worldwide, with major impacts on:

- Cardiovascular diseases, the leading cause of death worldwide, with a forecast of 23.3 million deaths by 2030! People with low and medium incomes are most at risk.
- Brain diseases (see also <http://www.omega3summit.org/pdf/Inform-Jul-Aug2011-pp397-399.pdf>)
- Strong associations between omega-3 deficiencies and other mental disorders, such as bipolar disorder, have also been demonstrated.

According to Krishnakumar, there is an urgent need for standardization of methods and biomarkers in other areas where the lack of well-conducted studies has hampered the establishment of clear relationships with LC Omega-3 deficiencies. But it is clear that an omega-3 Index of 8–11 can protect 98% of the world population against serious risk for disease or death. Reaching this level in the red cell membrane will require a minimum of 1000 mg LC omega-3s per day. At the same time an urgent reduction in omega-6s should be realized in feed and food. This will result in a much better balance and more efficient conversion rate for short-chain (SC) omega-3s into LC-Omega-3s.

Jogeir Toppe (Fisheries Officer of the FAO of the UN: [www.fao.org](http://www.fao.org)) defended the right to safe and secure food and omega-3s for everyone. Fish not only delivers essential LC omega-3s, but also is a complete source of nutrients, essential for world health. To realize this, it is clear that most people must ultimately enjoy fish from wild catch as well as from aquaculture.

However wild catch supply is shrinking and a substantial reform of fisheries policies is urgently needed. Franz Lamplmair (EC DG MARE, Adviser Maritime Affairs and Fisheries, Belgium) outlined the efforts of the European Commission to ensure a steady supply of





fishery and aquaculture products, guaranteeing long-term sustainability and resource efficiency, while protecting the environment and jobs.

## Science update session

The “Science Update” session focused on the role of omega-3s and -6s in health and the importance of omega-3/Omega-6 ratio and bioavailability. Kuan-Pin Su (Mind-Body Interface Lab, Institute of Neural and Cognitive Sciences, Department of Psychiatry, China Medical University & Hospital, Taiwan), opened with an impressive review of the role of LC omega-3s in depression. His conclusion that “the antidepressant effect of LC omega-3s is already sufficiently demonstrated,” was primarily based on the observation of how LC omega-3s influence inflammation and neuroplasticity. His recent research findings can be summarized as follows:

- Depression is hard to deal with, and the safety and effectiveness of antidepressants is disappointing. LC Omega-3 supplementation, on the other hand, is safe.
- During pregnancy, when the use of antidepressant drugs is undesirable, LC omega-3 supplementation is a safe way to treat and prevent depression—particularly since pregnancy has been associated with LC omega-3 deficiencies.
- One study showed that LC omega-3 supplementation had a significant effect in preventing the development of psychotic episodes in groups at high risk groups for psychosis.
- In the elderly, LC omega-3 supplementation significantly reduces cognitive decline. A noticeable improvement was even noted in patients.
- LC Omega-3 supplementation can also prevent interferon-induced depression. About 1/3<sup>rd</sup> of patients treated with interferon develop a related depression. Unfortunately, prophylaxis with drugs has significant side effects. Prof. Su showed that LC omega-3 supplementation for 2 weeks prior to interferon treatment prevents depression.

- This year’s Global Omega-3 Summit on product availability and purity—how to influence policy and grow consumer awareness—was designed for leading food industry, food ingredient, dietary supplement, and industry association professionals as well as leading European Union (EU) and global policy makers and professionals from industry sectors involved in the production of fish oil and other sources of long-chain (LC) omega-3 fatty acids and their precursors.
- As in 2011 and 2012, the meeting on May 30 drew numerous experts from around the world to Brussels, where they shared key research into the effects of long-chain omega-3s on human health.
- The Main goal of the meeting, in line with what M. Crawford (UK) initiated in 2011 was “spreading recommendations for developing improved health by improved nutrition in a sustainable way.”

Su confirmed that DHA and EPA act as a “Mind-Body interface,” providing a fundamental link between diet and health. However, LC omega-3 supplementation is not a one size fits all solution; it must be personalized.

Clemens von Schacky (Omegamatrix and University of Munich, Germany) discussed the factors influencing uptake and bioavailability of LC omega-3 fatty acids, and what standards should be used:

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- Uptake varies for different individuals and depends very much on the bioavailability in the specific preparation, on genetic differences, and gastrointestinal status. There is no such thing as one dose for everybody.
- Plasma values are no reference; only the fatty acid concentration provides a good measure and insight into health status and risk. This is expressed in the level of LC omega-3 in the fatty acid composition in red blood cells. The HS-Omega-3 Index ideally should be between 8 and 11 (% LC omega-3s on total fatty acids in the red blood cell membrane). The validity of the HS-Omega-3 Index has now been demonstrated in many studies, particularly concerning cardiology and brain function.
- There is no such thing as an omega-6/omega-3 ratio. Omega-6s and omega-3s compete for the same enzymes, partly with antagonistic, partly with synergistic results. It remains to be demonstrated whether reducing omega-6 intake improves conversion of SC omega-3 to EPA and, especially, to DHA.
- An important observation is that uptake is optimal when it is part of a high-fat meal! Bioavailability is also dependent on the form presented: for example, a “gelled emulsion” performs better than simple capsules, which are, in turn, better than tablets.
- Krill oil with part of the LC omega-3s in phospholipid form shows best bioavailability, and will have a similar effect as fish oil, even at lower EPA-DHA contents.
- The main reason for the variable and rather chaotic conclusions found in the literature may be related to a combination of these factors. For example, many studies are compromised by the use of less adequate formulations, less adequate dosages, or non-optimal time of administration (omega-3 supplementation at breakfast is different from use with a main meal).

Isabelle Sioen (Ghent University, Belgium) analyzed the risk/benefit of fish consumption and the nutritional-toxicological conflict. Fish not only contains high quality protein; it is also a good source of vitamins (A, D, B3, B12) and minerals (iodine, heme iron, zinc, selenium); and fish is the most important source of LC omega-3 polyunsaturated fatty acids (PUFAs), while being low in saturated fatty acids.

Unfortunately in the past, some fish has been contaminated. In practice, though, contaminant load from eating fish has always been considerably below that obtained from consuming a regular food portfolio with milk, egg and meat, bread and cereal products, and fats and oils. This means that the possible benefits of fish consumption are considerably more important than the statistically insignificant risk. This is true for sensitive consumers such as pregnant women (and the developing fetus), as well as for the population at large (Report of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption, Rome, 2010; FAO Fisheries and Aquaculture Report No. 978 FIPM/R978)..

The advantages of fish consumption are primarily optimal neurodevelopment and prevention of cardiovascular disease. Eating fish instead of fish oil adds a combination

of healthful components to a diet. A healthy food portfolio involves replacing meat, fat cheese, etc. with fish, at least several times a week.

## Session on quality, purity, oxidation stability and contaminant control

Asgeir Sæbø, (Aker Biomarine, Norway) and Annett Schubert (KD Pharma, Germany) addressed fish and krill oil quality issues and oxidation stability management, contaminant removal and quality management in fish oil refining, and concentrate production. Fish and krill oil are very different in composition, but also in terms of processing:

- Fish oil has a simple composition (99% neutral lipids), but needs a complex refining process (extraction, bleaching, and deodorization followed by stabilization). During this process some of the natural antioxidants are removed and must be replaced. Freshness may be somewhat less important (except in raw fish oil), since most contaminants and primary oxidation products will be removed during the process. This very often is sufficient to produce high quality products.
- Krill oil has a more complex composition (50% triglycerides + 40% neutral phospholipids, among other components). Luckily, it requires less and softer processing. The natural antioxidant, asthaxanthin, will mostly be retained which benefits quality. However, the freshness of the starting material remains essential.
- Omega-3s are characterized by a high degree of insaturation, and thus are very sensitive to oxidation. The oils must therefore be well-protected against oxidation throughout the production process. The materials and packaging used are also very important, as is avoiding high temperatures. Follow-up on the oxidation status is essential. Oxidation status can be expressed as TOTOX (= 2 X POV + ANV). POV (peroxide value) gives an indication of primary oxidation products. It goes down when oxidation proceeds with production of secondary oxidation and more breakdown products; the ANV (Anisidine value), a measure for secondary oxidation products, will rise. Rancid oil can have a good POV, but a high ANV betrays this!

A hot issue is the availability and shrinking supplies of LC omega-3 sources, and possible measures to account for the increasing demand and shrinking level of supply. Adam Ismail (Executive Director of GOED, U.S.A.) outlined the current situation. What is market availability of LC omega-3s? And does it match with availability?

Depending on recommendations (World Health Organization (WHO): 250 mg/day, Mortality paper: 400 mg/day, Japan: 1000 mg/day) we need 0.65 to 2.55 million tons per year. The oceans' capacity for providing fish/krill oil is limited (0.53 million tons for human consumption today). Because of this nutrition gap it is important to protect the sources we have against overfishing. We also urgently need new



sources. Luckily the process to make concentrated omega-3s is becoming more efficient, which helps keeping the market/supply gap pressure down.

Today, anchovy, with his high EPA-DHA content, is the main source of fish oil, but the demand will exceed the supply shortly. This is not sustainable. Algal sources of omega-3s are being researched and developed, but even if we address all sources there will be a shortage in the very near future.

Olga Sayanova (Rothamstead Research, U.K.) gave an overview of the possibilities to create plant sources with significant levels of LC-omega-3s.

- An economic option may be adding LC-PUFA biosynthetic pathways to oilseed crops. The challenge is to add 3 to 5 new genes in omega-3-producing plants such as flax, *Arabidopsis*, camelina, soy. After evaluation of a lot of genes and gene combinations, the preferential combination is now established. A reasonable amount of EPA and DHA can be reached in *Camelina sativa*, in a level comparable to fish oil.
- Algae are already used for production of LC omega-3s, but the composition is not always optimal. This can further be improved through selection, genetic engineering and manipulating conditions.

## Session on policy and consumer awareness

The final Summit session evaluated methods for influencing policy development and growing consumer awareness, one of the major objectives identified during previous Summits. Adam Ismail gave a very comprehensive overview of the newest market data, based upon "The Omega-3 Nutritional Consumers Survey". The study showed significant differences in understanding and in levels of consumption by country, gender, age, relationships and household size, employment and economic status, and preferential use of supplements or functional foods.

Such gaps in consumer awareness and understanding of benefits are just as critical as consumption and can be addressed through marketing communication and education. Dominic Dyer (Network Research, U.K.) outlined the changing conditions affecting the consumption of LC omega-3s:

- There is the rising cost of food, which lays claim to an increasing share of income. This leaves less room for purchasing expensive supplements and healthy omega-3-rich food products. There is also a trend towards purchasing local and Fair Trade-sourced food.
- Other more global concerns include the growth in world population, and the land, water, and energy needed to feed that population. What can we do to address these challenges in the next 30 years? Global freshwater supplies may become very short, and the energy requirements are too high. The impact of climate change, major disasters, and global terrorism is a major concern.
- In large parts of the world, people lack sufficient access to food. This is in strong contrast to the

obesity epidemic in other parts of the world, and is linked to unbalanced food consumption.

- The use of pesticides and other technologies will eventually turn against humans (as in the loss of bees).

Humans will have to deal with food and water in the future. Cheap food may be gone for good! The question is: Who will we take responsibility? The cost of health is enormous and is definitely a political issue. But without control over the food chain, governments will have no power to turn the situation around.

Rukmini Gupte (The Healthy Marketing Team, UK) gave a passionate presentation on what producers can do to turn the current economic situation to their advantage by "Taking Advantage of Claims and Nutrition Information in Growing Consumer Awareness." LC Omega-3s have approved claims in several regions around the world. This is a significant advantage in the food and dietary supplement market where claimed effects take priority in successful marketing.

Each Summit session was followed by a discussion, and the conference was concluded with a brainstorming session in which the experts presented the consensus statements as adopted at the end of the Omega-3 Summit 2011. For clarity, please find below the (marginally) updated consensus statements and mid-term policy recommendations as supported by the Omega-3 Summit 2013:

1. Brain functioning and heart disorders resulting from LC-Omega-3 (EPA+DHA) deficiency are the biggest challenges to the future of humanity
  - Associated costs are currently bankrupting health care systems and threatening wider economic instability worldwide.
2. Tissue concentrations of LC-Omega-3 (relative to SC Omega-3) are the key variable for health – not dietary intakes.
  - Biomarkers need to be standardized and used as public health targets
  - LC Omega-3 Index 8-11, Omega-3 in HUFA 50+% would protect 98% of population
3. Dietary intake of > 1000mg LC-Omega-3 is needed if consuming western-type diet (but this depends on dietary % LA vs. ALA, and ARA.)
  - Most people fall far short of these basic needs
4. Shorter-Chain Omega-3 (ALA, SDA, and EPA) have poor conversion to DHA in humans
5. To make tissue targets feasible, we urgently need to
  - Reduce LA and increase ALA in human and animal diets
  - Increase the availability of LC-Omega-3 (especially DHA) for human consumption in a sustainable, environmentally responsible way
6. EDUCATION of all stakeholders is key to achieving these changes

(More info: Omega-3 Consensus Statements 2011 and a review of the 2011 Summit can be found at <http://www.omega3summit.org/pdf/ConsensusStatements.pdf> and <http://www.omega3summit.org/pdf/Inform-May2011-pp314-315.pdf>)

# Dividing and rules: What do you do when you reach the end of the line?

Proofreading is an integral part of publishing, and checking whether words have been properly divided at the end of a line is an integral part of proofreading. I always check these divisions at the end of my proofreading since previous corrections may have affected the need to divide or the likely location of the division. It is not surprising that German and French printers have difficulty in dividing English words correctly, but when I recently read the proofs of a French chapter on oils and fats to be printed in France, incorrect word divisions accounted for over a third of the corrections and comments I made. One of the possible reasons is that most of these incorrect divisions concern chemical names<sup>1</sup>. These names can be long and are thus more likely to have to be divided. Besides, there are hardly any rules telling people how to divide chemical names. It is the purpose of this contribution to propose novel, unambiguous, and generally applicable dividing rules for chemical names.

**Albert J. Dijkstra**  
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When finding out how to divide an English word properly, I never rely on my memory but look up every word concerned in Webster's since this dictionary tells me how to divide individual words. Collins, my English dictionary, and the Oxford English Dictionary, which I have on hard disk, provide no guidance in this respect. Moreover, I find it very difficult to remember what strikes me as somewhat arbitrary.

Take the words *analyze* and *analysis*. They have the same origins and you might therefore expect them to be divided identically. No way: *an-a-lyze* and *anal-ysis*. Having learned Greek at grammar school<sup>2</sup>, I recognize from which elements these words were assembled<sup>3</sup>. To me, it is only to be expected that a word combining several elements should be divided between these elements: *ana-ly* . . . but Webster is apparently not aware of this.

Different languages have different ways of dealing with the division of words at the end of a line. Their needs also differ. Some languages such as German and Dutch combine elements into a single word whereas English maintains these elements as separate words<sup>4</sup>. The French language also tends to keep them separate but often reverses their order.

Language	Lemma <sup>a</sup>
German	Sandbad
Dutch	Zandbad
English	Sand bath
French	Bain de sable

<sup>a</sup>Lemma: citation form of a word.



So for the English language, the need to divide words at the end of a line is of less importance than for some other languages, and this may well be the reason that systematic chemical names, which can be very long indeed, pose a problem. Accordingly, I think we could do with some clear rules describing the ways we should divide chemical names at the end of a line. The division problem is aggravated because these systematic names often contain hyphens and, according to word processing software, these hyphens show where a word is to be divided if it happens to be longer than the space left on the line. Accordingly, said programs cause chemical names to be divided in an illogical manner. To discuss this aspect in more detail, I first include definitions of the various hyphens<sup>5</sup>:

- *Normal hyphen.* This is the hyphen that results from typing a hyphen. It shows on screen and it is printed as such. If it happens to be at the end of the line, it just functions as a hyphen.
- *Soft hyphen.* Formerly, authors just handed their handwritten articles to their secretaries. Nowadays, most authors submit their manuscripts themselves, and publishers often only accept electronic versions. So these poor authors must (learn how to) work with a computer and word processing software and perhaps even devote some attention to copyediting. The latter means that they can make life easier for the typesetter by indicating where a word can be divided. Authors can do this by inserting a so-called soft hyphen, which shows up in print as a hyphen when the word must be divided at the location indicated by said soft hyphen but does not show up in print when the word is not divided. When using MSWord, a soft hyphen can be inserted by typing "Ctrl + hyphen." When the Show/Hide (Ctrl + \*, or the ¶) reveals some of the codes, the hyphen shows up on screen as a hyphen with a small line descending from the right side of the hyphen. Like any letter, the soft hyphen can be deleted by using Delete or Backspace. (Microsoft Word 2010 refers to this as an *optional hyphen*.)
- *Hard hyphen.* This hyphen is not regarded as a hyphen by the word processing software. Consequently, a line never ends on a hard hyphen. When using MSWord, it can be introduced into a word by typing "Ctrl/Shift + hyphen"; it shows on screen like a slightly elongated hyphen and it is also printed as a hyphen. (Microsoft Word 2010 refers to this as a *non-breaking hyphen*.)
- *Dash (long hyphen; also called an en-dash).* According to IUPAC (Recommendations 1993) R-1.2.3.4, this should be used to connect the names of components of an addition compound, and the example used is carbon monoxide–borane.

My wife is English and when discussing how to divide words at the end of a line with her, she pointed out that the bit left at the end of the line should preferably indicate how the entire word should be pronounced. So the words *li-bel* and *li-cense* have the hyphen after the "l," indicating this "i" will be pronounced as in "light." Words like *lib-eral* and *lim-onene* are divided after the letter after the "l," causing the "i" to be pronounced as in "fish." We agreed that this approach might well stem from the lack of phoneticism in the English language<sup>6</sup>. This led us to discover why *The ACS Style Guide* divides *meth-yl* the way it does, whereas a slightly longer alkyl group is divided as *pro-pyl*. That is just American pronunciation. When I pronounce *propyl*, it rhymes with *se-nile* and not with *dev-il*. This discovery reinforced my notion that there is a need for a multilingual method of dividing chemical names at the end of a line.

*The ACS Style Guide* (3rd edition, page 247) has an example of a chemical name,

5-(2-chloroethyl)-9-(diaminomethyl)-2-anthracenol

and it indicates all the places (15 in all) where this word can be divided:

5-(2-chlo-ro-eth-yl)-9-(di-ami-no-meth-yl)-2-anth-ra-cenol

CONTINUED ON NEXT PAGE

<sup>1</sup>The only one I have come across so far is that there should be at least three letters at the end or the beginning of a line. The number at the end of a line can be controlled by setting a minimum right-hand margin in the word processing program, but I haven't discovered how to prevent a new line from starting with only two letters. The compound 2,5-cyclohexadiene-5-on could be divided in such a way that only two letters move to the next line. Widows [a single, usually short line of type, as one ending a paragraph, carried over to the top of the next page or column] and orphans [a line of type beginning a new paragraph at the bottom of a column or page] refer to the number of lines at the top and bottom of a page. Something similar for letters at the end or beginning of a line has not been designed.

<sup>2</sup>This was the former Latin school in Rotterdam, Netherlands, which was founded in 1328. It is now called *Gymnasium Erasmianum*.

<sup>3</sup>These are the preposition *ανα* meaning "spread out", and the verb *λυειν* meaning "to loosen". So *αναλυειν* means: to detach, unravel, reduce to.

<sup>4</sup>The Dutch for acetic acid anhydride (three separate words) is *azijnzuuranhydride* (one word).

<sup>5</sup>There is some confusion in the nomenclature of these hyphens. One of the first word processor programs I used was WordPerfect; it used the term *soft hyphen*, but in Word97, this is called an *optional hyphen*. What WordPerfect calls (or called?) a *hard hyphen* is a *non-breaking hyphen* in Word97 and the *normal hyphen* is called a *regular hyphen* in Word97.

<sup>6</sup>Written and spoken English have little in common. For example, in Japan, they are taught separately. The standard course comprises the Roman alphabet and reading English. Then there is a separate course called "English conversation"

I disagree with this approach and therefore want to propose the following novel end-of-line dividing system for systematic chemical names:

<sup>7</sup> There are other inconsistencies in this list: *acet-amide* vs. *ac-ryl-am-ide*; *ac-ry-late* vs. *acryl-ic*.

<sup>8</sup> This is the Greek word *ανθραξ*, meaning charcoal.

<sup>9</sup> This is how Webster divides the word, but I wonder how generally accepted this is.

<sup>10</sup> Often, people do not know the roots of a word. Ascorbic acid (vitamin C) is effective against scurvy (Latin: *scorbutus*) so the “a” in *ascorbic* acts as a privative “a” (i.e., a prefix indicating the absence of something). Logically, it should be divided according to *a-scor-bic*. Nobody does.

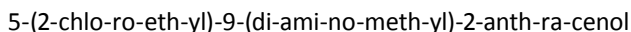
1. If a systematic chemical name must be divided at the end of a line, this can be done by a hyphen separating its “moieties.” So what do I call a moiety in the present context? What about a descriptor of a chemical structure? In the above example, there are three moieties: 5-(2-chloroethyl), 9-(diaminomethyl), and 2-anthracenol. As you can see, I have included the numbers in the anthracene molecule where the groups are attached.
2. Moieties themselves can be divided at the end of a line between “terms” unless this makes them awkward to pronounce or a generally accepted way of hyphenation can be applied. So how do I define a “chemical term?” This can be an element such as *hydrogen*, a root such as *palmit*, *cholester*, *methyl*, *amino*, a prefix such as *ortho*, *mono*, *iso*, whereby I want to exclude numbers indicating positions (such as in *4-methyl*) and letters indicating isomers (such as in *α-tocopherol*), or a suffix like *anoic*, *ate*, *amide*. Terms mean something to a chemist. Because this proposal keeps terms together, it reduces the number of places where a chemical name can be divided. *The ACS Style Guide* gives a number of end-of-line hyphenation examples that I compare with my proposal in the table below:

<i>ACS Style Guide</i>	<b>My proposal</b>
ace-to-ni-trile	aceto-nitrile
ac-ryl-am-ide <sup>7</sup>	acryl-amide
cy-clo-hex-ane	cyclo-hexane
iso-cy-a-nate	iso-cyanate
per-chlo-rate	per-chlorate
phos-pho-lip-id	phospho-lipid
sul-fu-rous	sulfur-ous
tol-u-ene	toluene
vi-nyl-i-dene	vinyl-idene

3. The above rule has a clause about “awkward pronunciation.” Take the word *anthracene*. This consists of two chemical terms: the root word *antrac*<sup>8</sup> and the suffix *ene* but nobody says *antrac-ene*, people say *anthra-cene*, making it rhyme with *Magdalene*. Moreover, if the line had ended on *antrac-*, people might have started to pronounce this as *antrak*. So *anthra-cene* is the generally accepted way of dividing this word.
4. There are also generally accepted ways of hyphenating long terms such as *phos-pho-rus*, *pra-seo-dym-i-um* (a rare earth element), and *si-toster-of*<sup>9</sup>. However, this last example shows that divisions presented by Webster may lack chemical sense. Sitosterol is a sterol and should be divided as *sito-sterol*<sup>10</sup>. Again, by focusing on terms, I reduced the number of hyphenations from three to just one.
5. In general, the division of terms should be avoided, and no syllable shall have less than three letters. So prefixes such as *iso*, *meta*, *neo*, *ortho*, and *para* will not be divided, which makes reading the name much easier.
6. As general rule I could say: “When in doubt, don’t divide.”



In the example from *The ACS Style Guide* mentioned above, the number of potential dividing points has also been reduced. According to my proposed end-of-line dividing system, this word would only be divided at the underlined hyphens shown below:



So the number of possible dividing points has been reduced from 15 to five, which in practice should be enough, especially since they are spread fairly evenly. Let's have a look at the various hyphens. Dividing after the "5" would leave this number on its own at the end of the line. Printers know that a single number or letter by itself at the end of the line is not allowed, so the name should not be divided at this location anyway. According to the proposed system, this "5" forms an integral part of the first moiety. Dividing after the "2" would be prevented by the novel dividing system since it concerns a prefix indicating a position and dividing *chlo-ro* is not permitted either, since this would lead to a syllable with only two letters. This brings us to the first hyphen that has been underlined; it is between *chloro* and *ethyl*, both chemical terms and thus a logical dividing point. The novel system would not allow *ethyl* to be divided according to *eth-yl* or *e-thyl* and thus avoid this controversy.

The next hyphen is after the bracket that closes the grouping 5-(2-*chloroethyl*). A division at this point is between two moieties and thus fully in line with the novel end-of-line dividing system, but just as the "5" belongs to the first moiety, so does the "9" to the second. Accordingly, a division after the "9" is not allowed. No divisions are possible as in *di-ami-no*, because they would lead to syllables with only two letters. Just as *ethyl* was not divided, the term *methyl* is not divided either; but after the moiety bracket, division is allowed. The subsequent "2" clearly belongs to the moiety thereafter so the hyphen between the two should be regarded as a hard hyphen that does not permit division at the end of a line. Finally, the division of the term *anthra-cene* is generally accepted as shown, so the corresponding alcohol can be divided in an analogous manner.

When proposing a hyphenation system, we must ask ourselves who will be involved in its use. That will first of all be the authors, then there may be copyeditors, and finally there are the printers. Authors of a paper containing chemical names will nearly always be chemists for whom the end-of-line dividing rules outlined above will be quite straightforward.

In other words, authors should type their manuscripts in such a way that what appears in print cannot be but correct. So they should make use of the possibilities offered by word processing programs. Where a name contains a hyphen that should not be used to divide the name at the end of a line, the author should type a hard hyphen. Hyphens in the name that can be used to divide the name should be typed as normal hyphens. This ensures that they appear in print as a hyphen and can also divide the name. Locations where the name can be divided but that do not show a hyphen in normal print should be indicated by a soft hyphen. In *chloro-ethyl* the author should insert the hyphen as a soft hyphen. Then it is printed as *chloroethyl* except when it is divided at the end of a line.

So when I use the symbol "=" for a hard hyphen, the symbol "~" for the soft hyphen, and the symbol "-" for the normal or regular hyphen, the name of the anthracenol compound used above would look like:



My main reason for submitting this paper is to solicit comment on how the system could be improved. It would be great if readers were to think of names that they feel that cannot be divided in an acceptable manner when adhering to the rules that I listed above. If I knew about them, that might cause me to amend these rules to accommodate these names. So please let me know them. My postal and e-mail addresses are given below.

I have already received some comment<sup>11</sup> on a draft of this paper that mentioned that IUPAC nomenclature books have a small section on the use of punctuation and hyphens but do not bother about how to divide a chemical name at the end of a line—about time someone did.

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<sup>11</sup> I acknowledge this contribution by Dr Ir L. Maat, who is the secretary of the Dutch/Flemish Committee for the Nomenclature of Organic Chemistry.

# EXTRACTS & DISTILLATES

## Influence of hydrogenation and antioxidants on the stability of soybean oil biodiesels

Alexandrino, C.D., *et al.*, *Eur. J. Lipid Sci. Tech.* 115: 709–715, 2013.

This study examined the influence of hydrogenation and antioxidant activity of natural products derived from *Mangifera indica* on soybean biodiesel stability. Biodiesels were prepared with refined, semi-refined, and partially hydrogenated soybean oil and the stability was evaluated in a Rancimat apparatus. The biodiesel from partially hydrogenated soybean oil showed greater stability (11.9 h), exceeding the standard limit established by the Brazilian National Petroleum Agency (6 h). Gallic acid, tannic acid, and mango seed kernel extract were evaluated as antioxidants. The gallic acid showed higher antioxidant ability than the other products, increasing twofold the oxidative stability (20.8 h). The results indicate the importance of mango seed as a source of efficient antioxidants for biodiesel just like gallic acid.

## Influence of chloride and glycidyl-ester on the generation of 3-MCPD- and glycidyl-esters

Shimizu1, M., *et al.*, *Eur. J. Lipid Sci. Tech.* 115: 735–739, 2013.

Heating tests of pure diolein with various chloride and glycidyl ester (GE) levels at 240°C were conducted. Tetrabutylammonium chloride (TBAC) was used as a chloride source. The GE levels tended to converge on equilibrium around 100 mg-as monochloropropane-1,2-diol (MCPD)/kg, regardless of the initial GE content, which suggested that the GE level was the result of competitive reactions between generation and decomposition. Chloride content had no influence on GE generation. On the other hand, 3-MCPD ester levels were greatly influenced by both chloride and initial GE content, and the reactions were estimated to reach completion in the early stage of the heating period due to the run-out of the chloride source. The conversion ratios of chloride to 3-MCPD ester were 2–8%. These low ratios indicated that most of the TBAC was converted to inactive compounds for 3-MCPD ester formation. Not only the quantity but also the type of chloride compound is important to control the 3-MCPD ester level. Although generation of 3-MCPD esters via GE was confirmed, practical impact was estimated to be small. However, this pathway should be taken into consideration, because GE is thought to make 3-MCPD monoester, which could show different bioavailability compared with the diester that predominantly occurs in edible oils.

## Influence of lipids on the properties of solid lipid nanoparticles from microemulsion technique

Boonme, P., *et al.*, *Eur. J. Lipid Sci. Tech.* 115: 820–824, 2013.

Solid lipid nanoparticles (SLN) are colloidal lipid carriers widely employed as efficient drug delivery systems. In this report, SLN were produced by microemulsion technique, and the influence of lipid composition on the physical properties of SLN was evaluated. Lipids with different molecular structures in carbon number of the fatty acid residue and their polarity were selected (i.e., glyceryl trimyristate, glyceryl tripalmitate, glyceryl tristearate, stearic acid, and glyceryl monostearate). A warm oil-in-water microemulsion containing 7% lipid, 30% water, and 63% surfactant mixture (polysorbate 80:1-butanol 4:1) was prepared by simple mixing at 60°C, following its dilution in cold water at various ratios at constant stirring. The obtained SLN were analyzed for appearance, particle size, zeta potential, and sedimentation rate. The chemical structure of the selected lipids affected both the microemulsion formation and the physical characteristics of SLN. From the obtained results, a dilution ratio of 1:50 was selected for the production of SLN composed of glyceryl trimyristate as solid lipid matrix. The obtained particles were of  $154.9 \pm 0.7$  nm mean particle size, with a polydispersity index (PI) of 0.274 and zeta potential of  $-7.46 \pm 0.68$  mV.

## An improved SPE method for fractionation and identification of phospholipids

Fauland, A., *J. Sep. Sci.* 36: 744–751, 2013.

This work reports an efficient and universal SPE method developed for separation and identification of phospholipids derived from complex biological samples. For the separation step, sequential combination of silica gel-aminopropyl-silica gel SPE cartridges is applied. This setup enables separation of phosphatidylcholine, lysophosphatidylcholine, phosphatidylethanolamine, phosphatidylglycerol, phosphatidic acid, phosphatidylinositol, phosphatidylserine, cardiolipin, and sphingomyelin into four fractions according to the polarity of their headgroups. Sample acquisition of the SPE fractions is performed by a high-resolution LC-MS system consisting of a hybrid linear IT Fourier transform ion cyclotron resonance mass spectrometer coupled to RP-HPLC. The unequivocal advantage of our SPE sample preparation setup is avoidance of analyte peak overlapping in the determination step done by RP-HPLC. Overlapping phospholipid signals would otherwise exert adverse ion suppression effects. An additional benefit of this method is the elimination of polar and nonpolar (e. g. neutral lipids) contaminants from the phospholipid fractions, which highly reduces contamination of the LC-MS system. The method was validated with fermentation samples of organic waste, where 78 distinct phospholipid and sphingomyelin species belonging to six lipid classes were successfully identified.



## Lipid composition analysis of milk fats from different mammalian species: potential for use as human milk fat substitutes

Zou, X., *et al.*, *J. Agric. Food Chem.* 61: 7070–7080, 2013.

The lipid compositions of commercial milks from cow, buffalo, donkey, sheep, and camel were compared with that of human milk fat (HMF) based on total and sn-2 fatty acid, triacylglycerol (TAG), phospholipid, and phospholipid fatty acid compositions and melting and crystallization profiles, and their degrees of similarity were digitized and differentiated by an evaluation model. The results showed that these milk fats had high degrees of similarity to HMF in total fatty acid composition. However, the degrees of similarity in other chemical aspects were low, indicating that these milk fats did not meet the requirements of human milk fat substitutes (HMFSs). However, an economically feasible solution to make these milks useful as raw materials for infant formula production could be to modify these fats, and a possible method is blending of polyunsaturated fatty acids (PUFA) and 1,3-dioleoyl-2-palmitoylglycerol (OPO) enriched fats and minor lipids based on the corresponding chemical compositions of HMF.

## Lipid turnover during senescence

Troncoso-Ponce, M.A., *et al.*, *Plant Sci.* 205: 13–19, 2013.

Rapid turnover of stored triacylglycerol occurs after seed germination, releasing fatty acids that provide carbon and energy for seedling establishment. Glycerolipid and fatty acid turnover that occurs at other times in the plant life cycle, including senescence is less studied. Although the entire pathway of beta-oxidation is induced during senescence, Arabidopsis leaf fatty acids turnover at rates 50 fold lower than in seedlings. Major unknowns in lipid turnover include the identity of lipases responsible for degradation of the wide diversity of galactolipid, phospholipid, and other lipid class structures. Also unknown is the relative flux of the acetyl-CoA product of beta-oxidation into alternative metabolic pathways. We present an overview of senescence-related glycerolipid turnover and discuss its function(s) and speculate about how it might be controlled to increase the energy density and nutritional content of crops. To better understand regulation of lipid turnover, we developed a database that compiles and plots transcript expression of lipid-related genes during natural leaf senescence of Arabidopsis. The database allowed identification of coordinated patterns of down-regulation of lipid biosynthesis genes and the contrasting groups of genes that increase, including 68 putative lipases.

## Health benefits of seafood., Is it just the fatty acids?

Lund, E.K., *Food Chem.* 140: 413–420, 2013.

There is a considerable body of literature suggesting a wide range of health benefits associated with diets high in seafood.

However, the demand for seafood across the world now exceeds that available from capture fisheries. This has created a rapidly increasing market for aquaculture products, the nutrient composition of which is dependent on feed composition. The use of fishmeal in this food chain does little to counteract the environmental impact of fisheries and so the on-going development of alternative sources is to be welcomed. Nevertheless, an in-depth understanding as to which nutrients in seafood provide benefit is required to permit the production of foods of maximal health benefit to humans. This paper reviews our current knowledge of the beneficial nutrient composition of seafood, in particular omega-3 fatty acids, selenium, taurine, vitamins D and B12, in the context of the development of environmentally sustainable aquaculture.

## Influence of emulsifier structure on lipid bioaccessibility in oil–water nanoemulsions

Speranza, A., *et al.*, *J. Agric. Food Chem.* 61: 6505–6515, 2013.

The influence of several nonionic surfactants (Tween-20, Tween-40, Tween-60, Span-20, Span-60, or Span-80) and anionic surfactants (sodium lauryl sulfate, sodium stearyl lactylate, and sodium stearyl fumarate) showed drastic differences in the rank order of lipase activity/lipid bioaccessibility. The biophysical composition of the oil and water interface has a clear impact on the bioaccessibility of fatty acids (FA) by altering the interactions of lipase at the oil–water interface. It was found that the bioaccessibility was positively correlated with the hydrophilic/lipophilic balance (HLB) of the surfactant and inversely correlated to the surfactant aliphatic chain length. Furthermore, the induction time in the jejunum increased as the HLB value increased and decreased with increasing aliphatic chain length. The rate of lipolysis slowed in the jejunum with increasing HLB and with increasing aliphatic chain length.

## Effects of krill oil intake on plasma cholesterol and glucose levels in rats fed a high-cholesterol diet

Li, D-M., *et al.*, *J. Sci. Food Agr.* 93: 2669–2675, 2013.

In this study, whole krill oil (WKO) and phospholipid-type krill oil (PKO) with different lipid composition were prepared. The effects of KO intake on plasma cholesterol and glucose levels in Wistar rats fed a high-cholesterol diet (HCD) were investigated. WKO contained 37.63% triglycerides, 48.37% phospholipids, 13.54% free fatty acids and 0.66% cholesterol, whereas the corresponding values for PKO were 0.59, 69.80, 28.53 and 1.09% respectively. Meanwhile, PKO contained much more polyunsaturated fatty acids (PUFA, 37.76%) than WKO (28.36%). After 4 weeks of HCD consumption, plasma levels of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C) and glucose increased significantly, but that of high-density lipoprotein

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cholesterol (HDL-C) decreased significantly. The intake of PKO and WKO for 4 weeks caused a significant reduction in body weight gain and plasma levels of TC and LDL-C in HCD-fed rats. Compared with WKO, PKO was more effective in decreasing plasma TC and LDL-C levels.

## Trans fatty acids and cardiovascular health: research completed?

Brouwer, I.A., *et al.*, *Eur. J. Clin. Nutr.* 67: 541–547, 2013.

This review asks the question if further research on *trans* fatty acids and cardiovascular health is needed. We therefore review the evidence from human studies on *trans* fatty acids and cardiovascular health, and provide a quantitative review of effects of *trans* fatty acid intake on lipoproteins. The results show that the effect of industrially produced *trans* fatty acids on heart health seen in observational studies is larger than predicted from changes in lipoprotein concentrations. There is debate on the effect of ruminant *trans* fatty acids and cardiovascular disease. Of special interest is conjugated linoleic acid (CLA), which is produced industrially for sale as supplements. Observational studies do not show higher risks of cardiovascular disease with higher intakes of ruminant *trans* fatty acids. However, CLA, industrial and ruminant *trans* fatty acids all raise plasma low-density lipoprotein and the total to high-density lipoprotein ratio. Gram for gram, all *trans* fatty acids have largely the same effect on blood lipoproteins. In conclusion, the detrimental effects of industrial *trans* fatty acids on heart health are beyond dispute. The exact size of effect will remain hard to determine. Further research is warranted on the effects of ruminant *trans* fatty acids and CLA on cardiovascular disease and its risk factors.

## Triacylglycerol stereospecific analysis and linear discriminant analysis for milk speciation

Blasi, F., *J. Dairy Res.* 80: 144–151, 2013.

Product authenticity is an important topic in dairy sector. Dairy products sold for public consumption must be accurately labelled in accordance with the contained milk species. Linear discriminant analysis (LDA), a common chemometric procedure, has been applied to fatty acid% composition to classify pure milk samples (cow, ewe, buffalo, donkey, goat). All original grouped cases were correctly classified, while 90% of cross-validated grouped cases were correctly classified. Another objective of this research was the characterisation of cow-ewe milk mixtures in order to reveal a common fraud in dairy field, that is the addition of cow to ewe milk. Stereospecific analysis of triacylglycerols (TAG), a method based on chemical-enzymatic procedures coupled with chromatographic techniques, has been carried out to detect fraudulent milk additions, in particular 1, 3, 5% cow milk added to ewe milk. When only TAG composition data were used for the elaboration, 75% of original grouped cases were correctly classified, while totally correct classified samples were obtained when both total and intrapositional TAG

data were used. Also the results of cross validation were better when TAG stereospecific analysis data were considered as LDA variables. In particular, 100% of cross-validated grouped cases were obtained when 5% cow milk mixtures were considered.

## Impact of region on the composition of milk fatty acids in China

Yang, Y., *et al.*, *J. Sci. Food Agr.* 93: 2864–2869, 2013.

Milk composition and its fatty acid profile have received much attention with respect to improving human health. However, limited work has been conducted to assess the composition of milk fat in China, which is the third largest producer of milk in the world. In this study the effects of geographical region and seasonal changes (spring and summer) on the fatty acid composition of milk samples collected from six Chinese farms were investigated. Milk fat and protein contents, as well as some individual fatty acids and five fatty acid groups, were found to be unaffected by season, but they did show significant differences by geographical region. Levels of milk *cis*-9, *trans*-11 conjugated linoleic acid decreased in summer and increased in spring, increased in north (Hohhot), northeast (Harbin), north centre (Beijing) and northwest (Xi'an) China and decreased in far northwest (Urumqi) and east (Chuzhou) China. Mono-unsaturated fatty acids increased in east and northwest China and decreased in northeast China, while polyunsaturated fatty acids increased in far northwest and north centre China and decreased in northeast China. This study provides relevant information that contributes to the understanding of parameters affecting variability of milk fatty acid profiles.

## Tocopherol activity correlates with its location in a membrane: a new perspective on the antioxidant vitamin E

Marquardt, D., *J. Am. Chem. Soc.* 135: 7523–7533, 2013.

We show evidence of an antioxidant mechanism for vitamin E which correlates strongly with its physical location in a model lipid bilayer. These data address the overlooked problem of the physical distance between the vitamin's reducing hydrogen and lipid acyl chain radicals. Our combined data from neutron diffraction, NMR, and UV spectroscopy experiments all suggest that reduction of reactive oxygen species and lipid radicals occurs specifically at the membrane's hydrophobic-hydrophilic interface. The latter is possible when the acyl chain "snorkels" to the interface from the hydrocarbon matrix. Moreover, not all model lipids are equal in this regard, as indicated by the small differences in vitamin's location. The present result is a clear example of the importance of lipid diversity in controlling the dynamic structural properties of biological membranes. Importantly, our results suggest that measurements of  $\alpha$ Toc oxidation kinetics, and its products, should be revisited by taking into consideration the physical properties of the membrane in which the vitamin resides. ■