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Chocolate science

Chocolate may be soft, but the science behind it is not. This issue features the latest research on this delectable topic. An interactive crossword puzzle will allow you to test your chocolate knowledge. You can also enter a drawing for a special gift from AOCS that includes a box of gourmet chocolates and our latest book on cocoa butter and related compounds. The answers to the clues can be found in this issue's chocolate-related articles.

Letter to the editor

With interest I read your excellent panel discussion report, "Eight industry experts answer questions about enzymatic degumming," in the February 2012 issue of *inform* (*23*:75–80). I share the views and found the remarks of the experts to be informative. Nevertheless, I would like to comment on the last paragraph on page 80, which raises the questions: *"Can the reacted gums be used for anything else, other than send them to the meal? Can lecithin be produced when using enzymes for degumming?"*

My response would have been that it is likely that highly hydrolyzed gums from enzymatic oil degumming will have suboptimal balanced surface-active emulsifier properties. However, these lysophospholipids may be effective components in a mix of emulsifiers.

My expertise on enzymatic lecithin hydrolysis is based on the original porcine phospholipase A2 enzymatic hydrolysis of soy lecithin gums as carried out in continuous plant-scale hydrolysis reactors in two oil mills in Europe in the 1970s. After expiration of various Unilever patents, other European lecithin manufacturers started production. (See also my article about Herman Pardun in *inform 21*:113–115, 2010). Since then, hydrolyzed soy and other vegetable lecithins have become commercial products. The FAO/WHO-Codex Alimentarius and the European Union E322 regulatory definitions of lecithin include enzymatic hydrolyzed lecithin. In the 1990s, hydrolyzed lecithin received GRAS (generally recognized as safe) status in the United States.

In former days, lysophospholipid formation during the enzymatic reaction was characterized qualitatively or at best semiquantitatively by thin-layer chromatography (TLC). Development of high-pressure (HP) TLC, HP liquid chromatography–light scattering detection and recently ^{31}P-NMR (nuclear magnetic resonance) analytical procedures now makes it possible to analyze exactly a wide range of (lyso)phospholipids including the nonhydratable phospholipids in enzymatic oil degumming.

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Correction

The March issue of *inform* included an article titled, The future of LAB, which mistakenly attributed the reduced usage of linear alkylbenzene sulfonate (LAS) in laundry liquids to the reduced need for surfactants in this product form. Warren Schmidt, a chemical consultant based in Cincinnati, Ohio, USA, pointed out that in general, liquids have higher surfactant content than comparable powders. Liquid Tide, for example, is more than 30% surfactants, while most powder Tide is half that amount. This is because powders have builders, while liquids do not (or have just trace levels). LAS is easily precipitated by the calcium ions in hard water, but this deficiency is mitigated by the builders in a powder. Thus, the conclusion that LAS will grow slowly in the United States and Western Europe, is correct, because LAS has deficient chemistry for the preferred form of detergent product (laundry liquids)—not because liquids need fewer surfactants.

Index to advertisers

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Calendar

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

AOCS Meeting Watch

September 30–October 4, 2012. World Congress on Oleo Science & 29th ISF Conference (JOCS/AOCS/KOCS/ISF Joint Conference), Arkas Sasebo, Nagasaki Prefecture, Japan. Information: www2.convention.co.jp/wcos2012.

October 29–31, 2012. Singapore 2012: World Conference on Fabric and Home Care, Shangri-La Hotel, Singapore. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; email: meetings@aocs.org; singapore.aocs.org.

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

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

June

June 4–5, 2012. 9th European Workshop on the Biotechnology of Microalgae, Nuthetal, Germany. Information: microalgal-biotechnology.com.

June 10–13, 2012. The 2nd International Conference on Algal Biomass, Biofuels and Bioproducts, San Diego, California, USA. Information: algalbbb.com.

June 10–14, 2012. 3rd International Conference on the Olive Oil Revolution—Quality, Culinary and Health, Tel Aviv, Israel. Information: terraolivo.org/con_index.htm.

June 10–15, 2012. FASEB Conference: Retinoids, Snowmass Village, Colorado, USA. Information: https://secure.faseb.org/faseb/meetings/Summrconf/Programs/11621.pdf.

June 11–13, 2012. Sensory Properties of Canola Oil and Olive Oil, Würzburg, Germany. Information: dgfett.de/meetings/aktuell/index.htm.

June 11–15, 2012. Advances in Emulsion Polymerization and Latex Technology, Bethlehem, Pennsylvania, USA. Information: fp2.cc.lehigh.edu/inemuls/epi/Lehigh_sc.htm.

June 11–14, 2012. World Food and Agribusiness Forum, Symposium and Case Conference, Shanghai, China. Information: tinyurl.com/IFOMA2012.

June 12–13, 2012. Innovation Management—Key Principles and Best Practice, Leatherhead, Surrey, UK. Information: leatherheadfood.com.

June 12–13, 2012. 2nd Annual Waste Conversion Congress East Coast, Philadelphia, Pennsylvania, USA. Information: renewable-waste.com.

June 13–14, 2012. European Biodiesel 2012, Kraków, Poland. Information: tinyurl.com/EUBiodiesel.

June 14–15, 2012. CosmeticBusiness 2012, Munich, Germany. Information: cosmetic-business.com/en/tradefair.

June 17–22, 2012. Gordon Research Conference on Lipoprotein Metabolism, Waterville Valley, New Hampshire, USA. Information: grc.org/programs.aspx?year=2012&program=lipoprot.

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Why is milk chocolate softer than dark CHOCOLATE?

Alejandro G. Marangoni

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The physical properties of chocolate are largely determined by the physical properties of the underlying fat phase [1]. In milk chocolate, co-crystallization of cocoa butter (CB) triacylglycerols (TAG) and milkfat TAG takes place; this co-crystallization is a key factor influencing the appearance and physical properties of milk chocolate [2].

However, the amount of milkfat that can be added to chocolate is limited by the thermodynamic incompatibility between milkfat and CB TAG in the solid state. Because of molecular geometric constraints, as well as environmental factors that influence the kinetics of crystallization, milkfat and CB TAG do not form mixed crystals; they crystallize as separate milkfat and CB solids. This thermodynamic incompatibility results in the formation of a eutectic: a decrease in the melting point of the CB-milkfat mixture below the melting point of either of the two components. The formation of this eutectic therefore leads to a decrease in the hardness of the milk chocolate [3–10].

The exact amount of milkfat that can be added to chocolate before the functional properties of the material are significantly and adversely affected will depend on processing conditions such as tempering times and temperatures. Reddy *et al.* [8] reported the successful production of milk chocolates containing 40% (wt/wt of the total fat) milkfat with good gloss and demolding properties.

Adding milkfat to chocolate not only promotes a creamy flavor and texture, but it is also known to reduce the incidence of bloom formation in chocolate. Fat bloom is a defect of chocolate that results in a white-gray appearance and crumbly texture. Addition of milkfat and milkfat fractions is known to decrease the incidence of bloom [10–13], which is mainly associated with dark chocolate. Some manufacturers therefore add 2–3% milkfat to dark chocolate to control hardness and delay bloom formation [14].

Milkfat is a complex mixture of several hundred different TAG with an extremely heterogeneous fatty acid composition [15]. It is undoubtedly one of the most complex fats found in nature. The physical properties of milkfat, including melting behavior, solid fat content (SFC), and polymorphism, are dependent not only on the physical and chemical properties of the constituent TAG but also on the interactions between these constituent TAG. For these reasons, several studies have considered how TAG structure influences the phase behavior and polymorphism of milkfat [16–21].

A typical melting curve of untempered native milkfat determined using differential scanning calorimetry (DSC) shows three endothermic peaks, corresponding to high (>50°C)-, medium (35–40°C)-, and low (>15°C)-melting fractions [18]. From DSC measurements (ratios of enthalpies), Timms [18] determined that milkfat contains 11%

high-melting fraction (HMF), 23% medium-melting fraction (MMF), and 66% low-melting fraction (LMF) [18]. Marangoni and Lencki [20] reported 12% (wt/wt) HMF, 33% (wt/wt) MMF, and 55% (wt/wt) LMF yields from solvent fractionation experiments. These fractions are chemically distinct, with HMF containing principally long-chain saturated fatty acids, MMF containing two long-chain saturated fatty acids and one short-chain or *cis*-unsaturated fatty acid, and LMF containing one long-chain saturated fatty acid and two short-chain or *cis*-unsaturated fatty acids [18,20].

Knowledge of the chemical composition, phase behavior, and polymorphism of these fractions and their mixtures, and how their properties influence each other, will help us to better understand, predict, and control the physical properties of milkfat and mixtures of milkfat with other fats. To obtain this understanding, milkfat must first

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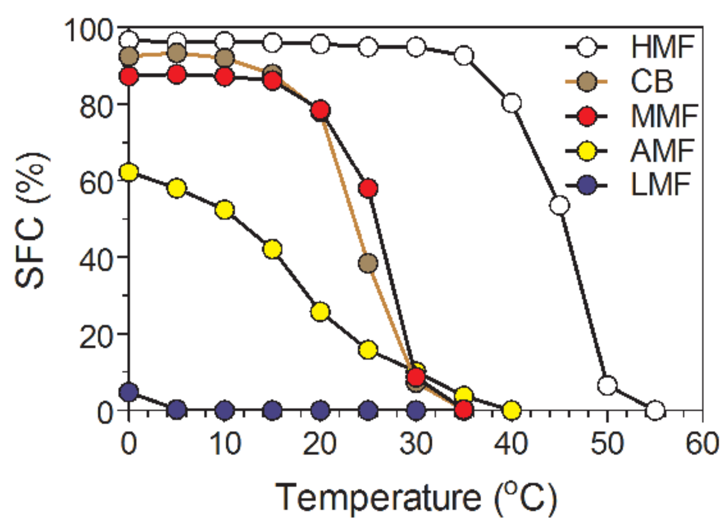

FIG. 1. *Solid fat content changes as a function of temperature for the high-melting fraction (HMF), medium-melting fraction (MMF), low-melting fraction (LMF) of anhydrous milkfat (AMF) and cocoa butter (CB) determined by pulsed nuclear magnetic resonance spectroscopy.*

TABLE 1. Fatty acid composition (% wt/wt) of ethyl acetate-fractionated anyhydrous milkfat (AMF), milkfat fractions, and cocoa butter[a]

Fatty Acid	HMF	MMF	LMF	AMF	CB
4:0	—	4.78	5.24	4.51	—
6:0	0.19	3.50	3.80	3.12	—
8:0	0.34	1.45	2.03	1.64	—
10:0	1.74	3.18	4.43	3.86	—
10:1	0.09	0.47	0.67	0.80	—
12:0	3.60	3.06	4.78	4.07	—
14:0	15.40	11.82	11.14	10.99	—
14:1	0.84	1.25	2.07	1.88	—
15:0	1.77	1.51	0.88	1.46	0.1
16:0	42.50	39.46	19.84	28.73	26
16:1	1.69	1.70	3.59	3.12	0.2
17:0	0.92	0.91	0.83	0.40	—
18:0	20.55	13.63	6.00	10.45	35
18:1	9.30	12.31	29.61	20.92	34
18:2	0.54	0.44	2.17	1.86	3.5
18:3	0.39	0.23	1.38	1.65	—
20:0	0.20	0.50	1.57	0.60	0.6

[a]Abbreviations: HMF, high-melting fraction; MMF, medium-melting fraction; LMF, low-melting fraction; CB, cocoa butter.

be efficiently separated into three fractions and the phase behavior and polymorphism of the individual fractions determined.

Timms [18] fractionated milkfat into three fractions using acetone as a solvent and proved that HMF, MMF, and LMF were, in fact, distinct fractions (at the time, MMF was believed to be a solid solution of HMF and LMF). He also studied the polymorphism of these fractions and the effects of LMF addition to HMF (50% LMF) and MMF (75% LMF). Marangoni and Lencki [20] fractionated milkfat into three major fractions using ethyl acetate as the solvent and studied the binary and ternary phase behavior of mixtures of these three fractions.

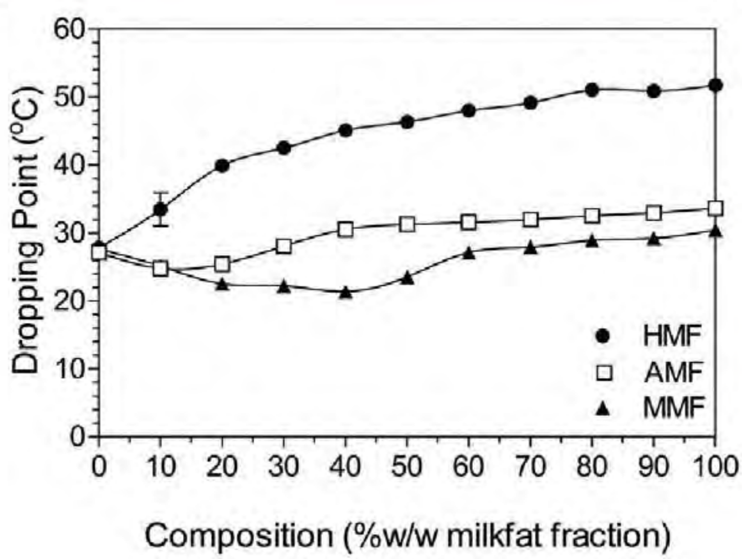

FIG. 2. Phase diagram for mixtures of AMF, HMF, and MMF and CB constructed using dropping point data. For abbreviations see Figure 1 (page 277).

Isosolid diagrams are useful tools in the study of the phase behavior of mixtures of natural fats [19], and they have been used in the study of the phase behavior of mixtures of confectionery fats with milkfat and milkfat fractions [3,4,10,22,23]. The type of solution behavior can usually be discerned with the aid of these diagrams. Their main use in this area has been in the identification of eutectics in mixtures of CB and CB substitutes with milkfat and milkfat fractions. This procedure constitutes a useful way of qualitatively judging the compatibility of fats.

The phase behavior of mixtures of CB and milkfat, fractionated milkfat, and interesterified milkfat was originally studied by Timms [3,4]. More recently, the phase behavior of binary and ternary mixtures of confectionery fats with milkfat and milkfat fractions has also been determined [7,10,23].

These studies led to a better understanding of the complex interactions between milkfat TAG, CB TAG, and palm kernel stearin TAG and of the resulting macroscopic properties of the blends (melting behavior, bloom formation, softening).

Because of the very high propensity of milkfat TAG to form mixed crystals [16,20], fractionation processes based on melt crystallization are not very efficient. Milkfat fractions obtained from the melt have different properties from those obtained by solvent crystallization. It is not possible to do justice to the large field of milkfat fractionation in this short report. Readers are directed to the comprehensive work of Kaylegian and Lindsay [24] on milkfat fractionation and fraction utilization in food products. In the present article, we will review the phase behavior of solvent-fractionated milkfat fractions–CB mixtures in order to evaluate their potential utilization as ingredients in confectionery products and plastic fats. The fatty acid compositions of the three milkfat fractions, anhydrous milkfat, and CB are presented in Table 1.

The SFC vs. temperature profiles of the HMF, MMF, and LMF fractions in milkfat, anhydrous milkfat (AMF), and CB are shown in Figure 1 (page 277). Both the HMF and MMF have narrow melting ranges, and the LMF is completely liquid above 0°C. The dropping points of the HMF, MMF, and LMF were, respectively, 51.7°C, 30.4°C, and 12.5°C, whereas that of native AMF was 34.3°C and CB, 27.6°C. Of particular interest is the similarity between the melting profiles of CB and MMF.

Eutectics in chocolate

A eutectic occurs when the melting point of a mixture is below the melting point of either of the individual components. For CB-AMF and milkfat fraction mixtures, this eutectic effect is particularly evident. Changes in dropping points as a function of mixture composition are shown in Figure 2.

Evident eutectics were detected in the range 0–30% AMF-CB and 0–60% MMF-CB. No eutectics were observed for HMF-CB mixtures, in contrast to work reported by Bystrom and Hartel [7]. Bystrom and Hartel [7] reported the formation of a strong eutectic between CB and HMF. This effect was probably because fractions used in their study were obtained via melt crystallization, and significant amounts of MMF were probably present (see next page).

To confirm these findings, we generated isosolid diagrams for AMF-CB, MMF-CB, and HMF-CB mixtures, which are shown in Figure 3. A slight eutectic formation was evident in the AMF-CB system (Fig. 3C), whereas extreme thermodynamic incompatibility was evident in the MMF-CB mixtures (Fig. 3B). From the isosolid diagram it was obvious that any mixture of CB and milkfat's MMF formed a eutectic. No eutectics

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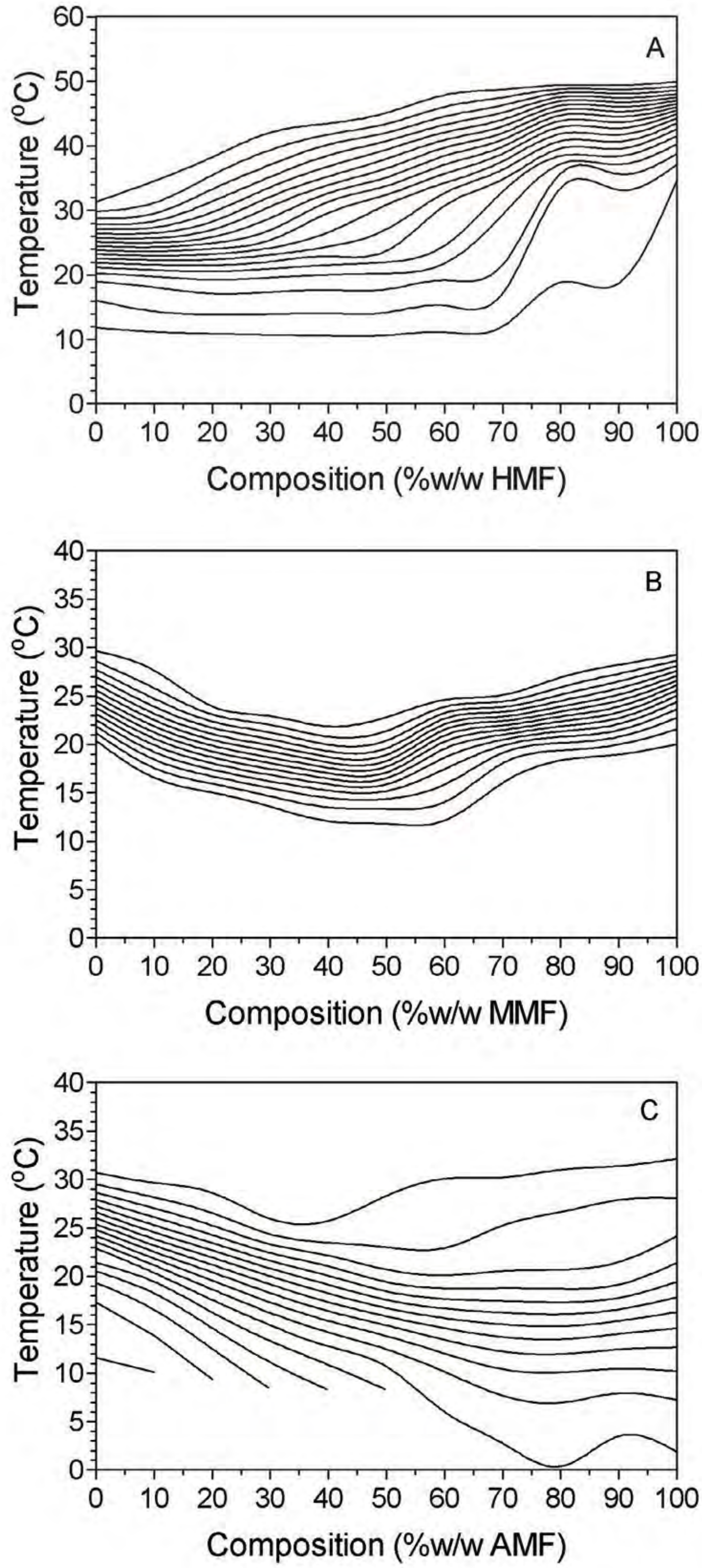

FIG. 3. *Isosolid phase diagrams for mixtures of HMF (A) and MMF (B) with CB as well as mixtures of CB with AMF (C). For abbreviations see Figure 1 (page 277).*

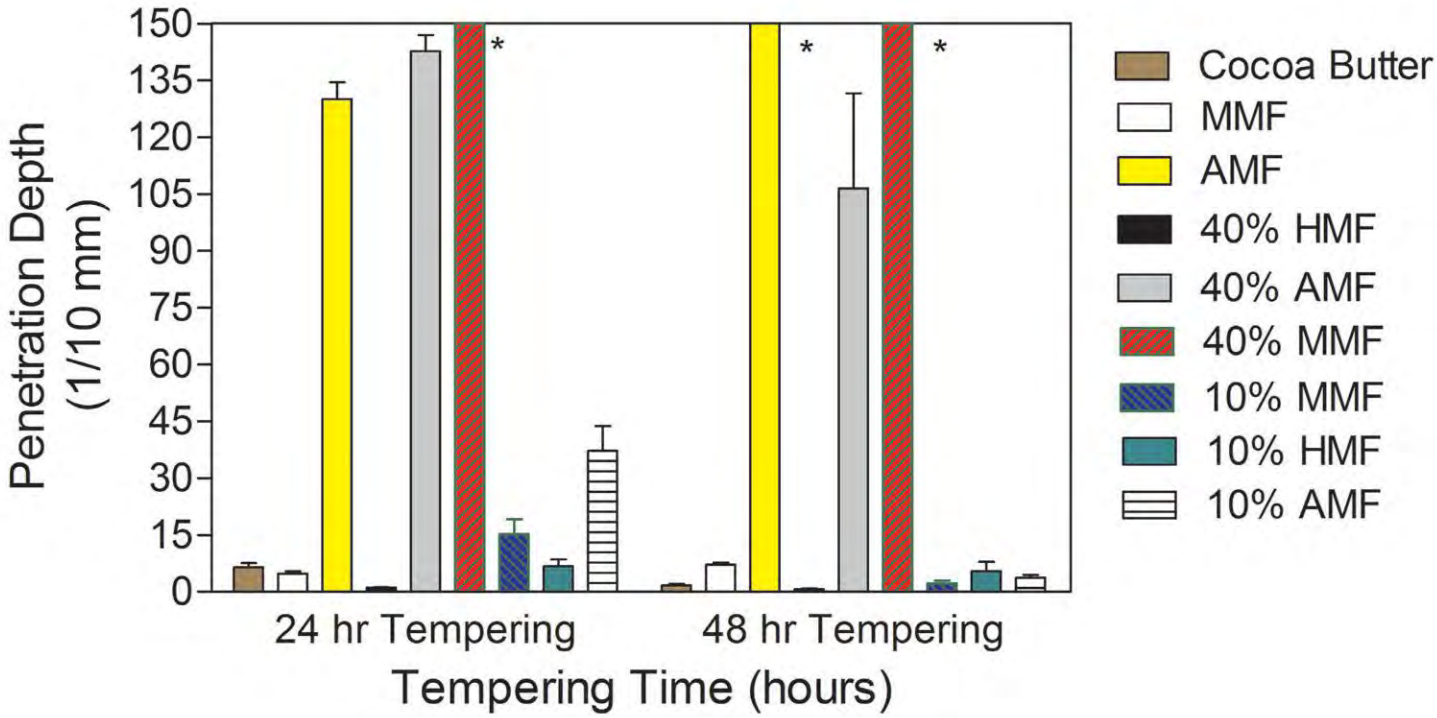

FIG. 4. *Cone penetrometry results for neat cocoa butter and mixtures of cocoa butter and milkfat fractions. The higher the penetration depth, the softer the fat mixture. For abbreviations, see Figure 1 (page 277). The asterisk signifies that the value is above 150.*

were formed between CB and milkfat's HMF (Fig. 3A). The patterns observed for the CB-HMF system are reminiscent of monotectic, partial solid solution formation [19], where a slight amount of thermodynamic incompatibility between the two components is evident. Kaylegian *et al.* [22] reported similar behavior for CB-HMF and CB-MMF mixtures using milkfat fractions obtained using acetone fractionation.

The dropping point data and the isosolid diagrams agreed qualitatively. HMF and CB TAG are thermodynamically compatible, and no eutectic is formed. MMF TAG are, however, extremely incompatible with CB TAG. The eutectic in the AMF-CB mixtures most probably arises from the incompatibility between MMF and CB. Our results disagree with the data reported by Bystrom and Hartel [7]. These authors reported on the thermodynamic incompatibility between HMF obtained via a dry fractionation process and CB. Most probably their HMF fraction was contaminated with MMF, giving rise to the reported patterns. The same group reported that HMF obtained by solvent fractionation did not decrease hardness of CB, probably suggesting that eutectics were not formed for CB mixtures containing HMF obtained via solvent fractionation [13].

Figure 4 exemplifies the problem with the addition of milkfat and milkfat fractions to CB. After 24 hours of crystallization at 22°C, addition of 10% and 40% (wt/wt) AMF or MMF to CB significantly decreased the hardness of the material, while HMF addition did not. After 48 hours of tempering, 40% CB mixtures containing AMF or MMF were still very soft, while mixtures containing 10% AMF or MMF did not appear softer than control CB anymore. Obviously, further crystallization, recrystallization, and/or polymorphic transformation and fat crystal network setting of the mixtures occurred between 24 and 48 hours, erasing any effects of AMF and MMF addition on hardness of CB. Our results disagree with those of Full *et al.* [9].

These authors reported a decrease in hardness of chocolate containing HMF. Again, this effect is probably due to MMF contamination of the HMF fraction. Melt crystallization-based fractionation of milkfat does not produce fractions that enhance the functionality of confectionery products. Lohman and Hartel [13] have clearly shown that the addition of HMF obtained via solvent fractionation does not decrease the hardness of CB. These authors also clearly demonstrated the ability of HMF to delay the incidence of bloom formation in chocolate, and their equivalent to the MMF reported here to enhance the rate of bloom formation. It would seem that the use of HMF obtained via dry fractionation (melt crystallization) is not a good idea since it forms eutectics with CB [7] and decreases the hardness of chocolate [9]. As far as the MMF is concerned, work in our laboratory has clearly shown that MMF can be used as a CB replacer. It is possible to manufacture high-quality confections using MMF as the sole confectionery fat. ■

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THE SECRETS of Belgian chocolate

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Like a bonbon nestled snugly in a box of chocolates, Belgium sits between France, Germany, the Netherlands, and Luxembourg. With a land area of only about 30,528 square kilometers (11,787 square miles), Belgium produces 270,000 metric tons of chocolate each year and boasts more than 2,000 chocolate shops. Belgium's chocolate obsession is fueled by a 150-year-old tradition of producing some of the world's finest chocolate. But what is it about Belgian chocolate that makes it so smooth, flavorful, and melt-in-your-mouth irresistible? The secret lies in quality ingredients and expert processing, combined with a spirit of innovation that continues to refine Belgian chocolate even today.

The history of Belgian chocolate reaches back to the 17th century, when Spanish explorers brought cacao beans from South America. The Spanish nobility, who then ruled Belgium, enjoyed cocoa as a luxury drink. However, chocolate did not gain popularity with the general public until the second half of the 19th century, when Belgium under King Leopold II colonized the Congo. During the age of European imperialism, cacao cultivation began to shift from the Americas to West Africa, which provided an ideal environment, as well as plentiful slave labor, for cacao production.

In 1857, Jean Neuhaus opened a pharmacy in Brussels, Belgium, where, among more traditional remedies, he sold bars of bitter chocolate. Eventually, the bars became so popular that Neuhaus focused his efforts on chocolate making. In 1912, Neuhaus' grandson, Jean II, invented the now-famous Belgian praline by filling hard chocolate shells with soft cream or nut pastes.

Today, the Neuhaus company continues to manufacture Belgian pralines (known as bonbons elsewhere in the world), joined by other large manufacturers such as Godiva, Leonidas, and Guylian. In addition, numerous small manufacturers and artisan chocolatiers attract loyal customers to their shops throughout Belgium. The country also supplies 20% of the world's industrial chocolate (Dewettinck, K., The secrets behind the quality and taste of Belgian chocolates, presented at the 103rd AOCS Annual Meeting and Expo, April 30, 2012), which food manufacturers use to create finished products such as bonbons, cookies, and ice creams. Large producers of industrial Belgian chocolate include Cargill, Belcolade, and Barry Callebaut. The Barry Callebaut factory in Wieze, Belgium, is the largest chocolate-producing factory in the world, says Mark Adriaenssens, a native Belgian and the company's director of research and development for the Americas.

From forest to factory

The story of Belgian chocolate, however, begins not in a factory but in the tropical rain forests of Africa, Central and South America, the Pacific islands, and Asia (Table 1 on page 284). Cacao trees (*Theobroma cacao*) thrive at altitudes of 30–300 m, with temperatures ranging from 18–32°C and annual rainfall of

1–5 L/m². The trees bear yellowish, 15–30-cm-long by 8–10-cm-wide pods that contain 20–60 whitish-gray, almond-shaped seeds embedded in a white pulp. When the pods ripen, workers at cacao plantations harvest the pods by cutting them from trees with a curved knife on a long pole. Then, they split the pods open with a machete, remove the pulp and seeds, and place them on banana leaves on the ground or in boxes. After covering the cacao pulp with more banana leaves, they let it ferment for about six days.

As the cacao sits in the sun, three types of microorganisms sequentially consume and transform compounds in the pulp. Because the inside of the unopened cacao pod is sterile, these microbes come from the cacao pod surface, workers' hands or knives, or elsewhere in the environment. The first microorganisms that act on the pulp are yeasts, which can grow under the anaerobic conditions found in the dense pulp. Yeasts convert glucose in the pulp into ethanol and produce pectinases that break down the pulp. The decreased pulp viscosity allows more air to penetrate, encouraging the growth of lactic acid bacteria. These bacteria convert fructose and citric acid in the cacao pulp into lactic acid and acetic acid. Finally, when the yeast and lactic acid bacteria have consumed all the sugars in the pulp, acetic acid bacteria convert the ethanol produced by the yeast into acetic acid. This reaction gives off heat, killing the microbes and ending the fermentation process. By this time, most of the pulp has liquefied and drained away.

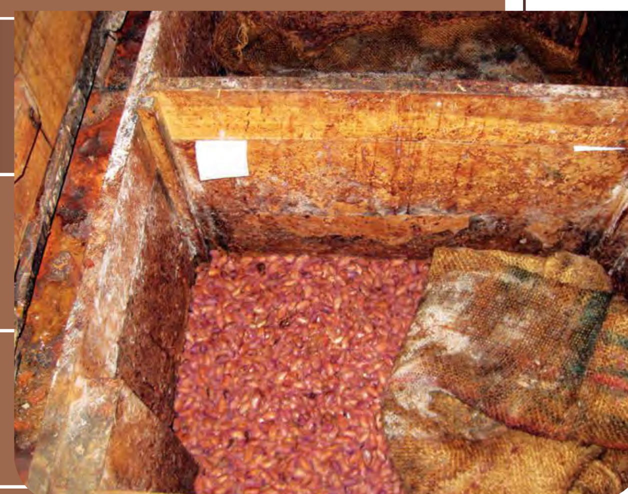
Proper fermentation is essential for producing high-quality chocolate, says Luc De Vuyst, food biotechnologist at the Vrije Universiteit Brussel. For one thing, the acetic acid produced by the microbes penetrates the cacao seed and kills the embryo. If the embryo remained alive, it could start to grow, consuming the fat in the beans needed for chocolate production. In addition, acetic acid disintegrates membranes within the cacao bean, releasing enzymes and substrates that mix and interact. "A whole series of enzymatic reactions takes place in the fermenting bean," says De Vuyst. "The chemical products of these reactions contribute to the color and flavor of the final chocolate."

Scientists used to think that the strains of yeast and bacteria responsible for fermentation varied with the cocoa-producing region, contributing to subtle flavor variations in cocoa from different parts of the world. However, when De Vuyst analyzed the microbes present in cacao fermentations from Ghana, the Ivory Coast, Brazil, Ecuador, and Malaysia, he found that the

CONTINUED ON PAGE 285

TABLE 1. Making chocolate

Harvesting	Workers cut ripe pods from cacao trees
Pulp and seed removal	Workers slice open cacao pods and collect white pulp and seeds
Fermentation	Microbes transform cocoa compounds into precursors of flavor and color
Drying	Flavor precursors continue to develop as beans dry in sun
Packaging and shipment	Beans delivered to factory for processing
Roasting and winnowing	Beans roasted and removed from shells
Chocolate liquor pressing	Beans ground and separated in cocoa butter and powder
Mixing and refining	Chocolate ingredients mixed, ground into small particles
Conching	Evaporation of undesired flavors
Tempering	Chocolate is heated and cooled in precise way to enhance appearance and shelf life
Molding	Chocolate is added to mold and solidified



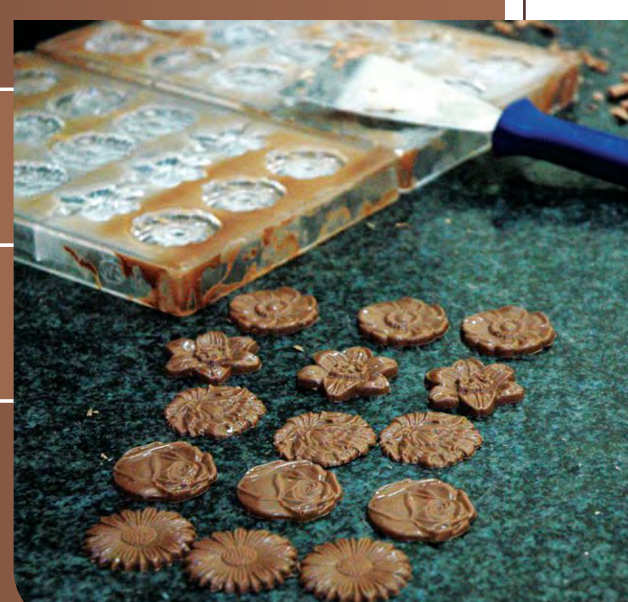


TABLE 2. Chocolate composition[a] (Europe)

Ingredient	Dark chocolate	Milk chocolate	White chocolate
Chocolate liquor (%)	40	12	—
Cocoa butter (%)	12	19	23
Milk powder (%)	—	20	30
Sugar (%)	47.5	48.5	46.5
Lecithin (%)	0.5	0.5	0.5

[a]Adapted from *J. Sci. Food Agric.*, doi: 10.1002/jsfa.1608, 2003.

microbial composition and fermentation process were everywhere the same, provided that the cacao plantations observed good agricultural and operational practices (e.g., *Food Microbiology*, doi:10.1016/j.fm.2011.06.003, 2011). In contrast, farms that harvested immature or fungus-infected cacao pods, used defective equipment, or practiced poor hygiene showed variations in the fermentation process. "Under these conditions, a whole zoo of microorganisms can develop and destroy the fermentation process, delivering sour beans from which you make sour chocolate," says De Vuyst.

Based on these findings, De Vuyst developed a fermentation starter culture consisting of strains of the yeast *Saccharomyces cerevisiae*, the lactic acid bacterium *Lactobacillus fermentum*, and the acetic acid bacterium *Acetobacter pasteurianus*. He found that adding this starter culture to newly harvested cacao pulp shortened the fermentation process from six to four days (*Food Microbiology*, doi:10.1016/j.fm.2011.12.021, 2012). Commercial use of the starter culture could enable faster and more uniform fermentation of cacao beans. Furthermore, "By manipulating the microbial composition of the starter culture, we may be able to steer the fermentation process to generate certain flavors in the final chocolate," says De Vuyst. He is currently working with the Barry Callebaut factory in Wieze to implement this controlled fermentation.

After fermentation, the beans have a rich brown color. Workers dry the fermented beans in the sun for 6–10 days, during which the chemical reactions in the beans continue. After drying, farmers or potential buyers can perform various tests to assess the quality of the beans. For example, in the grainage test they count the number of cacao beans present in 100 g, which should be fewer than 100 beans. In the cut test, inspectors randomly select 100 cacao beans and slice them in half lengthwise, looking for signs of mold, insect damage, shrinkage, germination, or a gray or violet color, all of which indicate lower-quality beans. In another test, inspectors weigh cacao beans before and after removing their shells. If the mass percentage of the shells is greater than 14%, then the cacao beans are too small or insufficiently fermented. With these tests, chocolate makers can ensure that the beans they purchase are of sufficiently high quality to produce good chocolate.

Making it Belgian

At this point, the cacao beans are finally ready to leave the farm. Workers package the dried beans and ship them to factories, the sites of roasting and grinding. During roasting, flavor compounds develop through numerous chemical conversions collectively known as Maillard reactions. Carbonyl and amino groups of molecules formed during cacao fermentation and drying react with each other, producing more than 600 flavor compounds that together give chocolate its characteristic taste and aroma. After roasting, a machine called a winnower cracks and deshells the beans. Then the deshelled beans, known as nibs, are ground into a thick paste called chocolate liquor. The chocolate liquor is pressed to extract cocoa butter, leaving behind a solid mass that is ground into cocoa powder.

Barry Callebaut produces its own chocolate liquor from cacao beans, whereas other industrial chocolate makers purchase liquor from companies outside of Belgium to make their chocolate. According to the Belgian Chocolate Code, a measure introduced by the Royal Belgian Association of the Biscuit, Chocolate, Pralines and Confectionary (abbreviated Choprabisco) industry and agreed on by most major chocolate makers, products labeled as "Belgian chocolate" must be refined and molded in Belgium. However, the grinding of beans and production of chocolate liquor, cocoa powder, and cocoa butter may occur elsewhere.

To produce industrial chocolate, manufacturers mix chocolate liquor with sugar and varying amounts of cocoa butter, depending on the type of chocolate (Table 2). Since 2000, the European Union has allowed chocolate makers to substitute up to 5% of the cocoa butter in their chocolate with other vegetable fats such as palm oil or shea butter. However, Belgian chocolate makers pride themselves on using 100% cocoa butter, which enhances the quality and smoothness of the chocolate, says Bram Beheydt, research and development manager at Belcolade, in Erembodegem. Milk powder is added to milk and white chocolates. Lecithin acts as an emulsifier, producing a smoother chocolate.

Also crucial to obtaining the typical smooth Belgian chocolate is the refining step, in which sugar and cocoa particles are ground down to a size of 18–20 μm. "In Belgium, we're very sensitive to having a fine chocolate—you will never have a grainy feeling in your mouth after eating our chocolate," says Beheydt. In contrast, chocolate factories in many other countries consider particle sizes of 25–30 μm to be acceptable. "The secret is making the size of the particles smaller than the distance between the papillae of the tongue, so that when you eat a chocolate you cannot feel the particles on your tongue,"

CONTINUED ON NEXT PAGE

FIG. 1. *Artisan chocolatier Geert Decoster, owner of Centho Chocolates, poses with his assortment of single-origin Belgian pralines.*

says De Vuyst. The papillae are the tiny bumps on the surface of the tongue that contain the taste buds. On the other hand, particles must not be ground too small, or they will produce a dry feeling in the mouth.

The precise conditions for the next step in chocolate making, known as conching, are a carefully guarded secret at most Belgian chocolate companies. In the conching stage, a shearing device heats and thoroughly mixes chocolate for up to 78 hours. Unwanted flavors, such as the acetic acid produced during the cacao fermentation stage, are removed by evaporation. Chocolate passes through three phases during the conching stage: dry, pasty, and liquid. "Belgian chocolate has become famous by the optimization of conching to drive off flavors we don't want in the final chocolate," says Adriaenssens. "The balance between dry and liquid conching develops the particular caramelized flavor of a good Belgian chocolate."

Different conching procedures help distinguish the typical flavors of Belgian chocolate from those of its major competitor, Swiss chocolate. "Swiss milk chocolate is conched very liquid—they use almost no dry conching," notes Adriaenssens. "That's what makes Swiss chocolate milkier, less caramelized, and with a different body than Belgian chocolate."

After conching, the chocolate is finally ready to be solidified into its final form, such as chocolate bars or chips. But to achieve chocolate that melts in the mouth and has a smooth, glossy finish, a crisp snap, and a long shelf life, chocolate makers must heat and cool the chocolate in a process known as tempering. At the microstructural level, chocolate consists of particles of sugar and cocoa solids embedded in a cocoa butter matrix. The cocoa butter can exist in six different crystal

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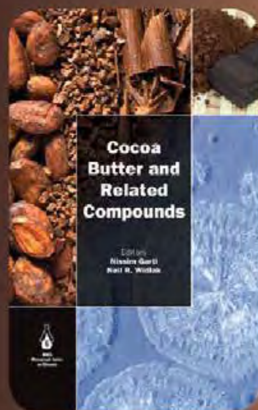
Test your chocolate knowledge with an interactive crossword puzzle found only in the digital online version of inform. Then, enter a drawing to receive a gift from AOCS that includes a box of gourmet chocolates and Volume 6 of the AOCS Monograph Series on Oilseeds: *Cocoa Butter and Related Compounds*, edited by Nissim Garti and Neil R. Widlak, 2012.



This 538-page book (plus CD) covers the last 10 years of studies on cocoa butter. It includes descriptions of physical characteristics, such as rheology, hardness, and melt profiles, as studied by new and advanced techniques, and reconsiders the polymorphism of cocoa butter in light of studies done by various techniques. Data are complemented by new understandings on the cause of the crystallization and transitions of the polymorphs. The effect of minor components, emulsifiers, and other fats are also discussed in great detail.

Hardbound. 538 pages. ISBN: 978-0-9830791-2-5. Product code 259 List: $270 • AOCS Member: $195

forms, designated by the Roman numerals I–VI. Each crystal form has a different melting temperature. Tempering forces the cocoa butter to adopt form V, which has the optimal melting temperature of 34–36°C. As a result, form V crystals remain solid at room temperature but melt in the mouth.

Tempering conditions depend on the type of chocolate, tempering equipment, and application, but in general the process involves cooling liquid chocolate from 45–50°C to about 25°C while stirring, bumping the temperature up to 30–32°C, and then cooling to the temperature at which the chocolate is poured into a mold and solidified. The first cooling step initiates mass crystallization of the cocoa butter. Then, by raising the temperature slightly, the less stable crystal forms melt, leaving primarily form V crystals. In the final cooling step, the form V crystals act as seeds or templates to drive further form V crystallization. As a result, the molded chocolate will consist mainly of form V crystals, which confer the desired textural and melting properties.

The fine art of pralines

After this lengthy processing from farm to factory, Belgian chocolate is finally ready to be packaged and sold. Belgian chocolatiers purchase chocolate bars and other products from industrial manufacturers such as Belcolade and Barry Callebaut, melt the

CONTINUED ON PAGE 312

News & Noteworthy

US olive oils mainly in spec

US olive oils mainly conform to the 2010 US Department of Agriculture (USDA) Standards for Olive Oil and Olive Pomace Oil, according to a new study.

Designed by University of California-Davis (UC Davis) Olive Center Research Director Selina Wang, the study looked at 60 US monovarietal extra virgin olive oils from the 2010 harvest. The UC Davis Olive Center, the USDA Blakely Laboratory, the Australian Oils Research Laboratory, and the California Olive Oil Council taste panel independently conducted chemical and/or sensory tests.

Study results indicate that:

- About 17% (10 samples) had sensory defects suggesting they were not extra virgin.
- All 60 samples had levels of free fatty acids below the 0.8% limit in both the USDA and International Olive Council (IOC; Madrid, Spain) standards. IOC chemical standards are based on the chemical characteristics of olive oils in Europe and North Africa.
- Two samples had campesterol levels above the IOC levels for extra virgin oils (4%); only one exceeded the campesterol limit of 4.5% set by the USDA.
- Ten samples failed sensory tests, four failed chemical quality tests (acidity, peroxide, and ultraviolet absorbency); and 16 failed purity tests (fatty acid profile, sterols, wax, and equivalent carbon number 42).
- None of the oils failed the PPP (pyropheophytin) and DAG (diacylglycerol) limits set by the Australian Standard for Olive and Olive-Pomace Oils, a voluntary standard put in place in July 2011.
- In all, more than 25% of the oils fell short of extra virgin quality.
- The study was funded by the USDA's Technical Assistance for Specialty Crops program and is the second arm of an earlier study. Both aim to evaluate the US standards and prevent trade limitations on American olive oil exports. The study results are available at tinyurl.com/2011TASC (pdf).

Meanwhile, US imports of olive oil have increased 11% in five years, reaching a record 292,049 metric tons (MT) in the 2010/11 crop year.

Italy continues to be the primary supplier for the US market, although both Italy and Turkey have lost ground to Spain, Morocco, and Tunisia (see Table 1 on next page). Italy's 149,444 MT—mainly bottled—accounted for 51% of total US imports last crop year (October 2010 to September 2011), down 8% from five years ago.

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Briefs

In late February 2012, Elevance Renewable Sciences, Inc. (Woodridge, Illinois, USA), a renewable specialty chemicals manufacturer, and chemical company Arkema (Colombes, France) announced a global partnership for the development and production of renewable specialty polymers. Elevance is providing novel, differentiated, functionalized renewable starting materials including the company's 9-decenoic methyl ester from its biorefineries.

■■■

Ocean Nutrition Canada (ONC; Dartmouth, Nova Scotia) has applied for European Union novel foods approval for an algal omega-3 oil it says is largely equivalent to an already approved oil manufactured by Martek BioSciences-DSM. ONC applied to the UK Food Standards Agency's Advisory Committee on Novel Foods and Processes; the application relates to a docosahexaenoic acid-rich oil from *Schizochytrium* microalgae.

■■■

Canadian scientists led by AOCS member Alejandro Marangoni have developed a gel that can replace saturated fat in foods such as sausages. These oleogels consist of a gelator—ethylcellulose—mixed with an oil, such as canola oil. The team made frankfurters with the oleogel and showed that, when cooked, there were no significant differences in chewiness or hardness compared to the control products made with beef fat. The work appeared in *Food & Function* (doi:10.1039/c2fo10202a, 2012). For more about replacement of animal fats with vegetable oils in processed meat products, see *inform 23*:168–171, 2012.

■■■

The latest specifi ations for the identity, quality, and purity of more than 1,100 food ingredients; test methods to verify specific tions; key guidance on critical issues such as impurities testing for metals; and full content from an upcoming Food Fraud Database are all included in the new *Food Chemicals Codex* (*FCC*), *Eighth Edition*. FCC is published by the U.S. Pharmacopeial Convention. See www.usp.org/food-ingredients/food-chemicals-code for more information. ■

TABLE 1. Trend of US imports by country over the last fi e crop years (MT[a])

	2006/07		2007/08		2008/09		2009/10		2010/11	
Origin	**MT**	**%**	**MT**	**%**	**MT**	**%**	**MT**	**%**	**MT**	**%**
France	611	0.2	700	0.3	237	0.1	108	0.0	99	0.0
Greece	5,208	2.0	4,728	1.8	4,983	1.8	4,218	1.6	4,331	1.5
Italy	155,164	59.2	150,683	57.0	150,693	54.5	145,670	53.5	149,444	51.2
Portugal	2,881	1.1	2,192	0.8	1,558	0.6	2,061	0.8	1,890	0.6
Spain	46,363	17.7	57,369	21.7	60,673	21.9	67,363	24.8	66,285	22.7
Others EU	110	0.0	135	0.1	69	0.0	94	0.0	263	0.1
Argentina	7,523	2.9	8,566	3.2	7,915	2.9	5,438	2.0	8,197	2.8
Australia	1,623	0.6	2,065	0.8	2,574	0.9	2,050	0.8	1,904	0.7
Canada	23	0.0	63	0.0	173	0.1	96	0.0	225	0.1
Egypt	401	0.2	433	0.2	102	0.0	26	0.0	4	0.0
Morocco	2,002	0.8	3,269	1.2	1,589	0.6	8,487	3.1	28,156	9.6
Tunisia	21,967	8.4	27,269	10.3	36,389	13.2	25,592	9.4	25,630	8.8
Turkey	14,315	5.5	3,585	1.4	6,570	2.4	7,963	2.9	1,059	0.4
Others	3,976	1.5	3,414	1.3	3,059	1.1	2,923	1.1	4,562	1.6
Total	262,167	100.0	264,471	100.0	276,584	100.0	272,089	100.0	292,049	100.0
EU	210,337	80.2	215,807	81.6	218,213	78.9	219,514	80.7	222,312	76.1
Extra EU	51,830	19.8	48,664	18.4	58,371	21.1	52,575	19.3	69,737	23.9

[a]Metric tons. Source: International Olive Council, *Market Newsletter No. 58*, February 2012.

The next-largest source is Spain, according to the IOC's February 2012 *Market Newsletter*. Spain accounts for 23% (up 5% from 2006/07) of US imports, whereas Morocco has overtaken Tunisia in third place. Bulk sales account for more than half of Spain's and almost all of Morocco's exports to the United States.

In related news, Brazil issued its first trade standards for olive oil on January 30, 2012. They largely mirror those of the IOC; see tinyurl.com/BrazilStandard for more information. Previously, minus a standard, Brazil was "a feast for olive oil adulteration," according to an industry insider.

Rabobank looks at the "soybean dilemma" in China

Agribank cooperative Rabobank finds that a "massive increase in soy crush capacity" in China "is creating clusters of excessive soymeal supply along certain pockets on the coast, causing a deterioration in crush margins as well as a shift in soymeal supply routes."

Rabobank's *Industry Note #301*, which was released in February 2012, suggests that grain traders and crushers in China will find it increasingly important to focus on investment in distribution and storage.

The profitability in China of corn relative to soybeans has decreased domestic soybean production, which has "struck a severe blow to the local soybean crush," the report notes. Almost 40% of total national production and crushing occurs in the Northeast provinces, Rabobank says.

China's soybean crush capacity increased from a mere 25,000 metric tons (MT)/day in 1995 to more than 315,000 MT/day in 2010. "By some estimates," the report indicates, "there will be over 125 million metric tons (MMT) of annual soybean crush by the end of 2012."

Rabobank expects an eventual permanent closure of 45,000 MT of daily crush capacity over the next two years in the Northeast region. The report also notes that "much of the integration by grain traders, crushers, and feed companies that has already occurred curiously has not been among multinational players but instead among domestic firms. Rabobank believes these multinationals are at the greatest risk of being excluded from the growing market."

Bunge and Senwes partner in South Africa

South African agribusiness firm Senwes and Bunge EMEA (Europe, Middle East, and Africa) are exploring the feasibility of building a new oilseed crushing facility in South Africa. The companies have already cooperated via a joint venture in the wheat and yellow corn (maize) commodity trading markets, according to the online news site BusinessDay.com.

The new crushing plant "would change the face of the oilseed industry," the report noted, adding that it would create an alternative market for cooking oil, animal feed, fertilizer, and biopesticides. Bunge EMEA Chief Executive Jean-Louis Gourbin told

BusinessDay.com that the facility is expected to crush 2,000 metric tons (MT) of oilseeds per day or 660,000 MT per year, with the ability to expand to 3,000 MT a day.

Canola is Canada's top revenue crop in 2011

Farm gate receipts for canola deliveries in 2011 reached $7.3 billion in Canada, up 30.6% from 2010, according to Statistics Canada's report from February 23, 2012.

"Canola provided Canadian growers a strong revenue outlook for 2011, which is why we saw over 18 million canola acres last year," says Pat Van Osch, chair of the Canola Council of Canada (CCC) Board of Directors. "Record canola acres combined with strong prices and good average yields led to the 30% increase in farm gate receipts."

On average, canola prices were 26.8% higher in 2011 than in 2010, Statistics Canada reports.

Revenue results from 2011 should bolster canola's overall contribution to the Canadian economy. A report released by the CCC in July 2011 put canola's contribution to the Canadian economy at $15.4 billion annually. The trade group also noted that the canola industry is responsible for 228,000 jobs in Canada, including 43,000 canola growers, as well as jobs in research, grain handling, transportation, marketing, and processing.

Farm gate receipts for wheat, the next biggest crop by revenue, were $5.1 billion, up 31.5% from 2010.

ADM and Wilmar to partner

Archer Daniels Midland Co. (ADM; Decatur, Illinois, USA) and Wilmar International Ltd. (Singapore) announced in late February 2012 the signing of a memorandum of understanding indicating their intent to work together in a strategic partnership in global fertilizer purchasing and distribution, global ocean freight operations, and tropical oils refining in Europe.

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

In the global fertilizer business, the companies will collaborate on purchasing and distribution; in ocean freight, they will partner to

CONTINUED ON PAGE 313

Sustainability watch

"The global demand for vegetable oils is increasing at an unsustainable rate—more than 5% annually over the past decade—contributing to massive deforestation in tropical regions," according to a news release from the Union of Concerned Scientists (UCS). UCS is an activist group based in Cambridge, Massachusetts, USA.

The news release accompanied UCS's report, "Recipes for Success: Solutions for Deforestation-Free Vegetable Oils," which was co-authored with Climate Advisers, a consultancy based in Washington, DC, USA. The report offers solutions for businesses, governments, and consumers on producing and using vegetable oil "without causing deforestation." The report is available online at tinyurl.com/UCSReport.

UCS lauded Switzerland's Nestlé, the world's largest food company, for its 2010 pledge to eradicate the "deforestation footprint" from its products. The company is now able to trace its oils' supply chain to ensure that growers and producers adhere to guidelines that protect the forest, UCS said.

■■■

Scientists in France have developed a computer program called COSMO-RS to find green alternatives to hazardous solvents. The program (COnductor-like Screening MOdel for Real Solvents) compares the physicochemical properties of the green alternatives to the solvents they are supposed to replace. Using the program, the team classified common organic solvents into 10 families in which the green solvents had been positioned. The method searches for alternatives to a solvent that is hazardous to health or to the environment. It also shows when there is a lack of replacement green solvents, highlighting the need to develop new green alternatives for particular solvent families. The article appeared in *Green Chemistry* (doi: 10.1039/c2gc16515e, 2012). ■

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Biofuels News

Fish oil into biodiesel

Canada's Centre for Aquaculture and Seafood Development has received C$89,100 in funding to establish a demonstration biorefinery that will convert fish oils into biodiesel. The Centre is housed in the Fisheries and Marine Institute of Memorial University of Newfoundland, St. Johns. The biorefinery is an extension of earlier work undertaken by the Marine Institute, in which salmon oil and cod oil were processed into usable biodiesel. Previous work used oil acquired outside the province of Newfoundland because effective extraction equipment had not been available. The next stage of this research is to develop processing methodologies to use marine waste oils from the salmonid aquaculture, pelagic fish, and the sealing industries as biodiesel feed stocks.

Darin King, minister of fisheries and aquaculture, said, "The Provincial Government recognizes the need to make the Newfoundland and Labrador fishery as environmentally friendly as possible. This new demonstration biorefinery will provide for positive advancements in a more environmentally sound industry, with the research undoubtedly benefitting Newfoundland and Labrador in the future."

Crude glycerin proposed for cattle feed

James MacDonald, of the Texas AgriLife Research and Extension Service in Amarillo, Texas, USA, is investigating the possibility of taking by-product glycerin from the manufacture of biodiesel and incorporating it into livestock feed. In a report released by AgriLife (tinyurl.com/GlycerinCattle), MacDonald said, "Crude glycerin is usually priced at a discount relative to corn, so we wanted to look at replacing corn to evaluate the energy value of the glycerin."

Traits making the possibility of using glycerin attractive are (i) its good flowability at low temperatures, unlike molasses or other similar products, and (ii) its noncorrosivity to feeding equipment. Glycerin is also low in phosphorus, sulfur, and protein, which can be concentrated in other dietary ingredients.

MacDonald and Michael Brown (West Texas A&M University, Canyon) have conducted four experiments over the past two years to determine the feeding value, optimal concentration, and which dietary components were most optimally displaced by crude

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Briefs

On March 7, 2012, LAN Airlines Chile and Air BP Copec made the fi st commercial flight in South America using second-generation biofuels. The fligh , operated between Santiago and Concepción, was made with an Airbus from the A320 family with CFM 56-5B motors. The fuel, processed by Netherlands-based SkyNRG, came from used cooking oil. (Air BP Copec markets fuels for the aviation industry.) SkyNRG's Managing Director Dirk Kronemeijer commented, "We are convinced this launch will help accelerate commercial volumes [of aviation biofuel] in this part of the world." At the time of the flight no indication was given when biofuel would be used on a regular basis.

■■■

In related news, Qingdao Fresh Bio-Energy Technology Development Co., Ltd. fill d an order in March 2012 for 20 metric tons of oil refined from leftover cooking oil for export to the Netherlands, where it will be processed into aviation fuel by SkyNRG. According to Xinhua News, the Qingdao-based company combined waste oil and fat, including "gutter oil" (discarded cooking oil), pretreated it, and then carried out a distillation to clean the product for exportation.

■■■

The Association of Global Automakers has developed a new website dealing with increased fuel economy and greenhouse gas emissions (GHG) standards. DrivingFuelEconomy.com is aimed at educating policymakers about the necessity of maintaining a comprehensive and harmonized national approach to fuel economy and GHG standards. It also provides visitors with a tutorial on the fuel economy and GHG standards rulemaking process and makes available videos that explain the functionality and benefits of the latest green technologies that will help automakers meet those standards. According to the website, consumer acceptance is critical to achieving environmental goals.

■■■

In March 2012, the American Petroleum Institute (API) fil d a lawsuit with the Washington, DC, Circuit Court challeng-

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ing the Environmental Protection Agency's (EPA) "unachievable" requirements for use of cellulosic biofuels in the 2012 Renewable Fuel Standard. According to Bob Greco, director of downstream and industry operations for API, "EPA's standard is divorced from reality and forces refi ers to purchase credits for cellulosic fuels that do not exist." The API represents more than 500 oil and natural gas companies.

■■■

The Times of India newspaper reported on March 4, 2012, that the Prime Minister's Office (PMO) will be the agency to decide whether the country will have fuel efficiency standards for cars. A policy to have progressive standards for car fuel mileage and labeling has been in preparation for almost four years. A final draft policy had been prepared, but the decision has now been left to the PMO because of the "sensitivities" involved after car manufacturers opposed the draft and demanded severe dilution of the proposed norms even as government experts said the policy was too lenient on car makers.

■■■

Neste Oil (Espoo, Finland) and Lufthansa Airlines announced their satisfaction with results of using renewable diesel in a lengthy trial encompassing a total of 1,187 fligh s between Frankfurt and Hamburg (*inform 22*:497–499, 2011) and a single trans-Atlantic flight between Frankfurt and Washington, DC, USA, on January 12, 2012 (*inform 23*:149, 2012). No signs of damage or corrosion were detected in the aircrafts' fuel tanks, and longer-term storage had no negative impact on fuel quality. Use of Neste's NExBTL fuel resulted in 1% lower fuel consumption compared with regular fossil jet fuel. ■

glycerin in diets designed for growth. Within the studies, they evaluated two strategies: (i) replace corn or (ii) replace some of the forage.

In replacing corn, the researchers found that optimal inclusion rates were 2.5–7.5% glycerin; feed efficiency was reduced at 10% glycerin. In replacing forage, the inclusion of glycerin produced no change in average daily weight gain, but the cattle consumed less feed and so feed efficiency was improved at either 5% or 10% inclusion. Replacing some of the forage with glycerin also made the ration less bulky.

MacDonald observed, "We also saw an increase in microbial protein and a reduction in rumen ammonia." Further studies could explore the implications of these observations. For example, in high-forage diets, excess nitrogen is often formed in the rumen. Excreted as urea, this nitrogen volatilizes into the atmosphere as ammonia. Thus, feeding crude glycerin as a partial replacement for forage may lower the amount of ammonia excreted by the animals.

Construction starts in Spain to use algae grown in wastewater

Aqualia, a water management company located in Avila, Spain, has started construction of algae culture ponds at a wastewater treatment plant in Chiclana in southern Spain. The project will cultivate fast-growing microalgae by using the nutrients in wastewater and converting them into biofuels. In its initial efforts, Aqualia is scaling its construction to produce 500 liters of biodiesel and 1,500 cubic meters of biomethane annually (tinyurl.com/Aqualia-algae).

One goal will be to develop the technology to be able to produce 3,000 kilograms of dry algae per day having an oil content of 20%. If this can be achieved, the company will move to commercial-scale production on 10 hectares of land. At this scale, projected yields are 200,000 liters of biodiesel and 600,000 cubic meters of methane annually. Together, these could fuel 400 cars a years, according to Aqualia.

The European Commission is funding more than half of the €12 million ($15.9 million) project as part of its effort to have 10% of energy used in transport in the European Union be derived from renewable sources by 2020.

Production of algae for biofuel increasing

The Algal Biomass Organization, headquartered in Preston, Minnesota, USA, conducted an industry survey in January 2012 to assess the present development of technologies and commercial markets for algae, to identify barriers to and opportunities for growth, and to make predictions about future growth. Three hundred eighty-four people from all parts of the industry value chain responded to the survey, including people with a company that produces or researches algae products, with an academic institution, with service suppliers to the industry, and end-users of algae products (buyers of fuels, oils, etc.).

Respondents were asked to make projections about algae's near- and longer-term future. Eighty-seven percent believed it is at least somewhat likely that algae-based fuels will be cost-competitive with fossil fuels in 2020, and 66% said it is moderately to extremely likely. Nearly 20% believe fuel will be $1.50/gallon ($0.40/liter) or lower by 2020, and almost 50% believe it will be less than $3/gallon by then.

Of the approximately one-third of the respondents who identified themselves as producers of algal fuels, oils, or biomass, 65% said they plan to expand capacity at new or existing facilities in 2012. In response to the question "How likely is it that your company would accelerate hiring with better federal policy support of the algae industry?" only about 18% responded that it was not at all likely. A summary of the survey is available at tinyurl.com/SummaryABOsurvey.

Jatropha on trial in eastern Asia

JOil Pte. Ltd., a bioenergy crop developer headquartered in Singapore, announced results in March from first-year field trials of its jatropha varietals S1 and S2 in its fields in India. Calculations showed a yield exceeding 2 metric tons per hectare (MT/ha). The company indicated that these results, from marginal land plots in the Indian state of Tamil Nadu, are a significant advancement compared with wild-type jatropha plants that typically do not flower within the first year.

Hong Yan, chief scientific officer for JOil, said, "Given that jatropha matures and reaches peak yield in three to four years, this shows that the JOil open-pollinated varieties have the potential to reach mature yields of more than 5 MT of seeds per hectare, at which point the production of jatropha seed reaches a level that allows it to be a sustainable feedstock for large-scale commercial production of biodiesel for airlines and motor transport fleet operations" (tinyurl.com/jatropha-trials-India).

JOil is presently conducting tests in two states of India and in West Java. JOil's partner Toyota Tsusho is carrying out trials of jatropha in the Philippines and Cambodia. Srinivasan Ramachandran, chief technology officer of JOil, said, "We are embarking on an expanded field trial program that will see our elite jatropha grown in Kenya, Tanzania, Egypt, China, Malaysia, and Vietnam." The purpose of these multi-location trials is to help JOil evaluate the performance of its elite varieties and help identify which ones work best in different agro-climatic environments, Ramachandran said.

US military tests biofuels in drones

In mid-March 2012, *The Guardian* newspaper reported that the US Navy has been testing unmanned drones powered by a 50:50 mix of biofuel and regular jet fuel. Thomas Hicks, the deputy assistant secretary of the Navy for energy, told *The Guardian* that no negative issues had been identified in relation to biofuel use in the drones. He said, "In fact, because the fuel is cleaner, we have seen some positive impacts, as per the engine performance" (tinyurl.com/NavyDrones).

Hicks pointed out that the Navy plans to get a third of all its fuels from biofuels by 2020 because doing so "increases our mission effectiveness and is better for the US economically."

The Navy has finished testing 50:50 biofuel blends in almost all its ships and aircraft, from boats that shuttle visitors around Pearl Harbor (Honolulu, Hawaii) to amphibious transport vehicles to destroyers to the F/A-18 Super Hornet aircraft (*inform* *23*:22,85,191, 2012).

In his *Guardian* interview, Hicks likened the $500 million the Navy is putting into its biofuels program to the Navy's steel program in the 19th century. He said, "Then we needed steel for our vessels, but were getting all of the steel from the UK and Germany." He added, "So the US Navy created the US steel industry."

Sapphire Energy adds *Spirulina* to its inventory

Sapphire Energy, Inc. (San Diego, California, USA) announced on February 29, 2012, that it has entered into a licensing agreement with Earthrise Nutritionals LLC (Irvine, California), which produces the algae *Spirulina* and *Spirulina*-based products. Sapphire will add Earthrise Nutritionals' *Spirulina* strain into its inventory of cyanobacteria (also known as blue-green algae) and algae strains for production of energy from algae. This move improves Sapphire Energy's operational efficiency by expanding the range of strain choices available for producing Sapphire Energy's Green Crude—a drop-in replacement for petroleum-based crude oil—that can be refined into diesel, jet fuel, and gasoline.

Until now, *Spirulina* has been used primarily for making nutraceuticals, such as dietary supplements, and food products.

Growing algae in Florida

In southwest Florida (USA), Algenol Biofuels is facing the prospect of having to obtain a special permit before it can grow algae on any area larger than 2 acres (0.8 hectares)—unless the Florida Department of Agriculture and Consumer Services (DACS) gives it an exemption. The concern is that the algae, if they were to escape, could hurt the environment. The Division of Plant Industry (DPI) of the DACS is asking for proof that there are ways to contain the genetically altered algae if there were a hurricane or other catastrophe.

The company's research has shown that its algae will not survive if they spill out of the plastic bladders in which they are to be grown. Company Chief Executive Officer Paul Woods has informed the DPI that the algae are dependent on the nutrients they are being fed and would not live without them. Richard Gaskalla, director of the DPI, told the *Naples Daily News* newspaper, "What they basically say . . . is they have to baby this organism to get it to perform and to produce . . . ." Taking away the babying is equivalent to "unplugging someone from life support" (tinyurl.com/Florida-algae).

Algenol has more than 30 acres (12 hectares) at its headquarters in Bonita Springs, Florida, and plans to expand its activities in other parts of the state. At its current location, it plans to produce 100,000 gallons (380,000 liters) of fuel-grade ethanol a year.

The legislative change is presently with the governor of Florida for a decision. The bill will take effect July 1 unless the governor vetoes it.

POET-DSM breaks ground for cellulosic ethanol

After years of developing its techniques in the laboratory, with pilot plants, and with demonstration-scale efforts, POET-DSM Advanced Biofuels broke ground on March 13, 2012, on a $250 million commercial cellulosic plant in Emmetsburg, Iowa, USA, next door to POET's corn ethanol plant. This plant, which has been called Project Liberty throughout its development, will be among the first of about a half-dozen commercial cellulosic ethanol plants that will come onstream in the United States in the next 18–24 months. Project Liberty anticipates consuming 600 metric tons per day of corn cobs, leaves, husks, and other crop residues from area farms; producing 20 million gallons (76 million liters) of ethanol a year; and generating $15 million–$20 million annually for these farmers.

POET and Royal DSM entered into a joint-venture agreement in January to form POET-DSM Advanced Biofuels, which is headquartered in Sioux Falls, South Dakota, USA. The two companies each hold a 50% share in the joint venture.

How many renewable energy projects are there?

In a review of the federal government, the US Government Accountability Office determined that 23 agencies and their 130 subagencies implemented nearly 700 renewable energy initiatives in fiscal year 2010. The Departments of Defense, Agriculture, Energy, and Interior were collectively responsible for almost 60% of all initiatives, which supported a range of renewable energy sources. The most commonly supported sources were bioenergy, solar, and wind. Also, the initiatives supported a range of public and private sector recipients, but the large majority provided support to the private sector. Many initiatives supported multiple renewable energy sources and types of recipients, while many others targeted support to one source or recipient. ■

Health & Nutrition News

Briefs

For the fi st time, the US Environmental Protection Agency (EPA) set a maximum human-exposure level for dioxins in a reassessment report released in February 2012. "Today's findings show that generally, over a person's lifetime, current exposure to dioxins does not pose a signifi ant health risk," the agency said. The main source of dioxin exposure for most persons is food, and the EPA report confi ms a preliminary study that people should not consume more than 0.7 picogram of dioxin per kilogram of body weight per day, which is less than one trillionth of one gram. For more information, see tinyurl.com/EPADioxin.

■■■

A table spread containing both milk peptides and plant sterols reduced cholesterol and lowered blood pressure, say scientists in Finland. This is the fi st time that milk peptides have been shown to have a beneficial effect in a spread, the researchers maintain. Previously, the peptides had been used only in fermented milk products. The work was published in *Food & Function* (doi:10.1039/c2fo10286b, 2012) and was led by Anu M. Turpeinen of Valio Ltd. in Helsinki.

■■■

Omnivorous diets are high in arachidonic acid (AA) compared to vegetarian diets, the authors of a recent study acknowledge, adding that high intakes of AA can negatively aff ct mood. In a cross-sectional study led by Bonnie Beezhold of Arizona State University in Mesa (USA), omnivores initially reported signifi antly worse mood than vegetarians did. Restricting meat, fish, and poultry improved some domains of short-term mood state in the 39 subjects studied. The work appears in *Nutrition Journal* (doi:10.1186/1475-2891-11-9, 2012). "To our knowledge, this is the fi st trial to examine the impact of restricting meat, fish, and poultry on mood state in omnivores," the authors said. ■

Linking fat perception with obesity

Beverly Tepper is working to answer the following questions about specialized fat receptors on taste buds: "Why are some people more sensitive and others less sensitive to fat?" "Is this a personal trait?" "Do genes contribute to these differences?"

Tepper is a professor in the Department of Food Science at Rutgers University School of Environmental and Biological Sciences in New Brunswick, New Jersey, USA. She has been studying consumer preferences for high-fat vs. low-fat foods.

Fats are perceived on the tongue as a taste sensation by binding to specialized receptors on taste buds. More specifically, Tepper notes, "Fats are broken down in the mouth to fatty acids, and it is the fatty acids that bind to these receptors."

One oral fat receptor that has attracted a great deal of recent attention is *CD36*, a carrier protein that helps fatty acids traverse cell membranes in many tissues of the body (see *inform 23*:155, 2012). This is necessary for fats to participate in many different metabolic functions. Recent studies show that *CD36* is also located on the surface of taste buds and may send signals to the brain about the presence of fat in the mouth.

But how is *CD36* related to consumer fat preferences and the possible genetic differences that Tepper and colleagues are so keen on understanding?

The answer lies in a new study published in the journal *Obesity* (doi:10.1038/oby.2011.374, 2012) by Tepper, in conjunction with her former student Kathleen Keller. Keller, now an assistant professor of nutritional sciences at The Pennsylvania State University and lead author on the article, studied an overweight population of African-American adults and found those who had a specific change or variation in the *CD36* gene perceived the creaminess and fattiness of salad dressings quite well, but they were less able to differentiate the high-fat from the low-fat versions.

Despite this insensitivity, these same individuals reported by questionnaire that they liked added fats such as salad dressings, spreads, butter, and margarine more than those who did not have this variation in their *CD36* gene. "This is the first time that a gene involved in fat taste has been linked to fat preference in humans," said Tepper.

A GENETIC MARKER FOR FAT TEXTURE

This latest finding came out of years of research on PROP-tasting, a different genetic trait that seems to be an index of general food preferences, including liking of fat. PROP (short for propylthiouracil) is a bitter-tasting compound that is strong-tasting to some people and tasteless to others. The ability to taste PROP is controlled by a gene called *TAS2R38*. People who are taste-blind to PROP are called " nontasters" and those who perceive PROP to be strongly bitter are called "super-tasters." Those in the middle of the pack, not surprisingly, are called "medium tasters."

"Several things became very clear from our studies and those from other labs," says Tepper. "Nontasters were insensitive to a wide range of oral sensations such as bitterness, sweetness, chili pepper heat, and the texture of fats, and they avidly consumed foods with these characteristics." At the other end of the spectrum were "super-tasters, who disliked strong-tasting foods because they were too intense for them."

One area Tepper began focusing on was the perception of and preference for fat, since this has obvious implications for obesity development. In a series of studies, she asked participants to use their own words to describe dairy products that varied in fat content, such as ice cream, sour cream, whole milk, and skim milk. Super-tasters used a rich and varied vocabulary to describe these foods, whereas nontasters used very few, simple words.

However, said Tepper, "Even though the nontasters had difficulty describing the foods, they knew what they liked, and they preferred the higher-fat products."

Until recently, it was unclear why a genetic trait that controls the ability to taste bitterness plays a role in fat perception. Why should these two behaviors be related at all?

According to Tepper, "The key linking these two factors together is differences in tongue anatomy." Super-tasters have more taste buds and more nerve fibers that carry signals to the brain about oral texture; nontasters have fewer taste buds and nerve fibers. Since the perception of fat is due mostly to its texture—flavor being the second component—differences in the ability to sense the texture of fats seem to distinguish nontasters from super-tasters.

DESIGNER FATS AND PERSONALIZED DIETS

The ability to taste fatty acids provides important signals about the type of fat being consumed, and the implications of this could be far reaching, suggested Tepper. "We could use this information to design more healthful fats that also give foods the high sensory appeal that consumers want.

"Using these two genetic markers, *CD36* and PROP, we could identify those who are insensitive to oral fat and who may be more susceptible to high-fat diets and obesity," said Tepper. "We could devise more personalized diet strategies to address this specific dietary issue," she added.

"*CD36* is only the beginning," added Tepper. "There is at least one additional fatty acid receptor that is known to exist in humans, and probably others that have yet to be identified."

Faulty fat sensor in obesity and liver disease

Defects in a protein that functions as a dietary fat sensor may be a cause of obesity and liver disease, according to a study published in the journal *Nature* (doi:10.1038/nature10798, 2012), led by researchers at Imperial College London. The findings highlight a promising target for new drugs to treat obesity and metabolic disorders.

The protein *GPR120* is found on the surface of cells in the gut, liver, and fat tissue and allows cells to detect and respond to unsaturated fatty acids from the diet, especially the long-chain polyunsaturated omega-3 fatty acids that are believed to have a beneficial impact on health. Scientists found that mice deficient in *GPR120* were more prone to developing obesity and liver disease when fed a high-fat diet. They also found that people with a certain mutation in the gene encoding *GPR120*, which stops the protein from responding to omega-3 fatty acids, were significantly more likely to be obese.

In the gut, the binding of unsaturated fatty acids from food to GPR120 stimulates the release of hormones that suppress appetite and stimulate the pancreas to secrete insulin. When fat cells sense high levels of fat in the blood through *GPR120*, they are stimulated to divide to produce more adipose fat cells to store all the excess fat, reducing the risk of fatty liver and furring of the arteries. This mechanism could be an important pathway for bringing about some of the healthful effects of omega-3s.

When they were fed a high-fat diet, mice that lacked *GPR120* not only became obese but also had fatty livers, lower numbers of fat cells, and poor control of blood glucose. The researchers believe that mice that are deficient in *GPR120* have difficulty storing excess fat in fat tissue. Instead, their bodies store fat in areas where it can cause health problems, such as the liver, the muscles, and in the walls of arteries. In humans, this pattern of obesity is associated with type 2 diabetes and heart disease.

The study involved scientists in the UK, France, and Japan. It was led by Philippe Froguel from the School of Public Health at Imperial College London.

"Being overweight is not always unhealthy if you can make more fat cells to store fat," said Froguel. "Some people seem to be unable to do this, and instead they deposit fat around their internal organs, which is very unhealthy. Our study suggests that in both mice and humans, defects in *GPR120* combined with a high-fat diet greatly increase the risk of this unhealthy pattern of obesity. We think *GPR120* could be a useful target for new drugs to treat obesity and liver diseases."

The researchers analyzed the gene for GPR120 in 6,942 obese people and 7,654 controls to test whether differences in the code that carries instructions for making the protein contribute to obesity in humans. They found that one mutation that renders the protein dysfunctional increases a person's risk of obesity by 60%. The researchers think this mutation mimics the effect of a bad diet lacking in unsaturated omega-3 fat.

EFSA sets reference intakes for protein

The European Food Safety Agency (EFSA) has published population reference intakes (PRI) for protein.

A PRI indicates the amount of an individual nutrient that the majority of people in a population need for good health, depending on their age and sex. EFSA's Panel on Dietetic Products, Nutrition and Allergies set PRI for protein for adults, infants and children, and pregnant and breast-feeding women, as follows:

- Adults (including older adults)—0.83 g/kg of body weight/day.
- Infants, children, and adolescents—between 0.83 g and 1.31 g/kg of body weight/day depending on age.
- Pregnant women—additional intake of 1 g, 9 g, and 28 g/day for the first, second and third trimesters, respectively.

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Briefs

Five activist organizations announced on March 15, 2012, that they had collected 463,681 petition signatures asking Wal-Mart Stores, Inc.(Walmart; Bensonville, Arkansas, USA) to refuse to sell Monsanto's genetically engineered (GE) sweet corn. Wenonah Hauter, who is executive director of Food & Water Watch—one of the fi e organizations—said, "[Walmart is] . . . releasing public statements and telling customers they have no current plans to carry the biotech corn." She continued, "But until the retail giant sends a clear message to its supply chain that it will not buy this GE sweet corn, consumers have no way of knowing whether or not Walmart's corn is GE free."

■■■

On March 2, 2012, Japan signed an international pact that establishes redress rules for damage caused to ecosystems by international movements of genetically modified (GM) crops. Forty-six countries and regions have already signed the pact, and two of them have ratifi d it.

The Nagoya-Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety was adopted at an international conference on biodiversity held in Nagoya, Japan, in 2010. The protocol takes effect 90 days after 40 signatories have ratified it. The pact holds business operators liable for bringing in GM living organisms across national borders in case such organisms cause damage to ecosystems and human health (tinyurl.com/JapanGM-pact).

■■■

The Australian Centre for Plant Functional Genomics (ACPFG), located in Adelaide, and DuPont Pioneer Hi-Bred (Des Moines, Iowa, USA) announced at the end of February 2012 the expansion of their long-standing research collaboration. They will increase the scale of their work on improving the overall productivity of wheat. The expanded program will conduct breeding using molecular markers, look for new agronomic traits, and develop hybrid wheat. They will also continue their work to increase drought tolerance

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Biotechnology News

Plants "remember" drought, adapt

Research carried out at the University of Nebraska-Lincoln (UNL; USA) shows that plants subjected to a previous period of drought learn to deal with the stress owing to their "memories" of the experience. The research also confirms for the first time the scientific basis for what home gardeners and nursery professionals have often observed: Transplants do better when water is withheld for a few days to drought-harden them before the move.

According to Michael Fromm, a plant scientist with UNL and one of the coauthors of the research, "This phenomenon of drought hardening is in the common literature but not really in the academic literature. The mechanisms involved in this process seem to be what we found" (newsroom.unl.edu/blog/?p=1034).

Working with *Arabidopsis*, a member of the mustard family, Fromm, plant molecular biologist Zoya Avramova, and post-doctoral fellow Yong Ding compared the reaction of plants that had been previously stressed by withholding water to those not previously stressed (see "Multiple exposures to drought 'train' transcriptional responses in *Arabidopsis*," *Nature Communications*, doi:10.1038/ncomms1732, 2012).

The prestressed plants bounced back more quickly the next time they were dehydrated. That is, the nontrained plants wilted faster than trained plants, and their leaves lost water at a faster rate than trained plants. Fromm said, "The plants 'remember' dehydration stress. It will condition them to survive future drought stress and transplanting."

The team found that the trained plants responded to subsequent dehydration by increasing transcription of a certain subset of genes. During recovery periods when water is available, transcription of these genes returns to normal levels, but following subsequent drought periods the plants remember their transcriptional stress response and induce these genes to higher levels in this subsequent drought stress."

Arabidopsis forgets this previous stress after five days of watering, although other plants may differ in that memory time. This is the first instance of transcriptional memory found in any life form above yeasts.

This discovery may lead to breeding or engineering of crops that would better withstand drought, although practical applications of these findings in agriculture are years away, Fromm said.

Home gardeners, though, can make immediate use of these findings. "If I was transplanting something, I would deprive it of water for a couple of days, then water overnight, then transplant," Fromm said.

Australians develop salt-tolerant wheat

Scientists from CSIRO Plant Industry (Canberra, Australia) and six other Australian research organizations have used crop breeding techniques that did not involve genetic modification to introduce a salt-tolerant gene into a commercial durum wheat. The research is the first of its kind to fully describe the improvement in salt tolerance of an agricultural crop—from understanding the function of the salt-tolerant genes in the laboratory to demonstrating increased grain yields in the field.

The research was published in *Nature Biotechnology* on March 11, 2012 (Munns, R., *et al.,* Wheat grain yield on saline soils is improved by an ancestral Na^+ transporter gene, doi:10.1038/nbt.2120). In a statement released by the University of Adelaide, lead author Rana Munns said, "This work is significant as salinity already affects over 20% of the world's agricultural soils and salinity poses an increasing threat to food production due to climate change" (tinyurl.com/salt-tolerant-wheat).

Domestication and breeding have narrowed the gene pool of modern wheat, leaving it susceptible to environmental stress. Durum wheat, used for making food products such as pasta and couscous, is particularly susceptible to soil salinity.

The authors of the study looked at wild relatives of modern-day wheat as possible sources of salt-tolerance genes. They found a useful candidate in an ancestral cousin of modern-day wheat, *Triticum monococcum.*

Matthew Gilliham, senior author of the paper, who is with the University of Adelaide's Waite Research Institute, said, "Salty soils are a major problem because, if sodium starts to build up in the leaves, it will affect important processes such as photosynthesis, which is critical to the plant's success. . . . The salt-tolerant gene (known as *TmHKT1;5-A*) works by excluding sodium from the leaves. It produces a protein that removes the sodium from the cells lining the xylem, which are the 'pipes' plants use to move water from their roots to their leaves."

Field trials have been conducted at a variety of sites across Australia, including a commercial farm in northern New South Wales. Richard James, of CSIRO Plant Industry, who led the field trials, said, "This is the first study to confirm that the salt-tolerant gene increases yields on a farm with saline soil. . . . Importantly there was no yield penalty with this gene."

James continued, "Under standard conditions, the wheat containing the salt-tolerance gene performed the same in the field as durum that did not have the gene. But under salty conditions, it outperformed its durum wheat parent, with increased yields of up to 25%."

Thus, another advantage of this salt-tolerant wheat would be that a farmer would need to plant only one type of seed in a field that has discontinuous patches of saline soil.

The researchers have also crossed the salt-tolerance gene into bread wheat and are currently assessing its production under field conditions.

Drought-tolerant corn to be field-tested

Monsanto Co. will conduct large-scale tests in 2012 of its MON 87460 corn, the first US government-approved biotech crop developed to deal with drought. The company says that this corn variety, being marketed under the name DroughtGard, is not intended to eliminate or reduce the need for irrigation and decrease the need for soil-applied nitrogen fertilizer in corn, soybeans, canola, rice, and sorghum.

ACPFG and Pioneer Hi-Bred have been collaborating since 2005 to discover and develop traits for yield enhancement and stability in a number of major crops.

■■■

The Food & Fiber Letter reported in February 2012 that Han Gengchen, chairman of the biotechnology and seed company Origin Agritech (Beijing, China), expects that the Chinese government will approve genetically engineered (GE) corn for commercial production in 2013 (informaecon.com). Once GE corn is accepted, he predicts that plantings of his company's phytase corn will account for 10% of China's total corn area within 10 years of approval. Consumption of phytase corn by cattle signifi antly reduces their excretion of phosphorus and lowers the potential for their manure to contribute to environmental pollution.

■■■

Bioceres, an Argentine agricultural investment and development company owned by more than 230 of South America's largest soybean growers, announced its formation in late February 2012 of a 50:50 joint venture, to be called Verdeca, with Arcadia Biosciences, Inc., an agricultural technology company based in Davis, California, USA. The purpose of Verdeca is to use next-generation agricultural technologies to develop and deregulate soybean varieties. Verdeca has the distinction of being a soybean technology company that is co-owned by growers. Verdeca's initial focus will be on drought tolerance technology developed by Bioceres and nutrient efficiency technology developed by Arcadia. Verdeca plans to deploy its traits fi st in South and North America, then expand into China. ■

over the cultivation period of corn. Rather, it is intended to provide a buffer against yield loss during periods of drought stress. As such, it could help in areas such as the western Great Plains of the United States, where corn production without irrigation can be half of the national average.

Trials will take place from South Dakota to Texas in 2012, and will involve as many as 250 growers in six states. Commercial release of the corn is planned for 2013.

Whether Monsanto's DroughtGard corn will boost production is uncertain. The analysis of the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS), the agency charged with permitting the planting of biotech crops, found that the field trial results showing more corn grown per acre under dry conditions with this variety are not statistically significant. However, the corn will probably do well in drought.

The APHIS analysis pointed out that there are some conventionally bred corn varieties that have drought tolerance, and all US corn varieties have been becoming more drought resistant over time (tinyurl.com/APHIS-DroughtGard, page 11).

DuPont's Pioneer Hi-Bred (Des Moines, Iowa, USA) also has introduced drought-tolerant corn, but its product has been developed through conventional and molecular breeding, not genetic engineering.

Britons' concern over GM food lessens?

Based on the results of a survey commissioned by the British Science Association that was released March 9, 2012, *The Guardian* newspaper reported that the concern of Britons over genetically modified (GM) food has lessened since 2003 (tinyurl.com/Guardian-2012-GM).

The 2003 survey arose out of 650 public meetings held around the country, and responses from about 37,000 people to questionnaires. At that time 54% of respondents said they never wanted to see GM crops grown in the United Kingdom (tinyurl.com/Guardian-2003-GM) .

The present survey, based on 2,058 respondents, shows about 25% of Britons are now fairly unconcerned or very unconcerned by GM food, compared with 17% in 2003 (Table 1). The percentage of those who reported themselves very concerned fell from 24% in 2003 to 17% in 2012. Complete survey results are available at tinyurl.com/GMfood-poll-BSA.

An interesting series of comments accompanying the *Guardian* report pointed out possible errors in interpreting these data and provided additional information on the whole question of GM safety (tinyurl.com/Guardian-GM-2012-blog).

TABLE 1. Responses[a] to "How concerned are you about GM food?"

	2003	2012
Very concerned	23.8%	17.2%
Fairly concerned	26.7%	29.3%
Neither concerned nor unconcerned	30.7%	26.3%
Fairly unconcerned	5.9%	15.2%
Very unconcerned	10.9%	10.1%
No opinion	2.0%	1.9%

[a]Adapted from tinyurl.com/Guardian-2012-GM.

Are there similarities between biotech and nanotech?

A report prepared by Guillaume P. Gruère of the Food Policy Research Institute (Washington, DC, USA) points out that public acceptance of nanotechnology in the service of the food and agriculture sector could have the same difficult path to travel that genetically modified (GM) food has experienced if precautions are not taken.

The report (Implications of nantechnology growth in food and agriculture of OECD countries, *Food Policy* 37:191–196, 2012) identifies three main policy challenges for nanotech:

- Funding and investment
- Risk governance
- Public acceptance

Without public acceptance, the prospects for nanotechnology are uncertain. Gruère points out, "The GM food rejection in OECD countries provides an illustration of what needs to be avoided. At the same time, despite all warning, there are signs that nano food products may face the exact same consumer rejection as GM food." He adds that industry needs to "proactively communicate transparently on the use of nanotechnology in food."

According to FoodNavigator.com (tinyurl.com/FoodNav-Nanotech), nanotechnology-enabled products are derived from or issued from materials at scales of less than 100 nm in at least one dimension. They are being developed and commercialized to improve processing and nutrition. In 2010, more than 400 food companies were involved globally in nanotech research and development, up from 200 in 2006, and total investment was estimated as several billion dollars.

Gruère claims, though, the companies will not want to continue to invest in nanotech unless there is a wider acceptance of nano food products, simply because they will not be profitable.

At present, only the European Union has adopted a mandatory "nano" labeling regulation for food ingredients that fit the EU definition of engineered nanomaterials. Gruère warns that blanket mandatory labeling for all nano products "would be difficult and run the risk for mimicking the stigma effect found in the case of GM food labeling policies."

He also suggests the governments should "explicitly include food and agricultural products within their existing communication plans, conduct communication audits, and ensure that risk communication is handled properly by letting the right (trusted and competent) messenger deliver the needed message." ■

People News/ Inside AOCS

AOCS member featured in *Time* magazine


Hartel

In a series of articles on "10 Ideas That Are Changing Your Life" in the March 12 issue of *Time* magazine, **Richard Hartel** was one of four food scientists invited to comment on Idea #5, "Food That Lasts Forever." He was interviewed for his knowledge of food preservation technologies, and many of his comments stemmed from his work with desserts.

The three challenges that must be met to increase the storage life of food are controlling moisture, controlling atmosphere, and controlling microorganisms. As a specific example, Hartel pointed out that—in desserts—chocolate is often used as a moisture barrier to separate moisture-absorbing flour-based dough from moist fillings.

Ingredient changes and new packaging materials are being brought to bear on the question of controlling atmosphere, and new technologies such as high-pressure processing (*inform 18*:650–653, 2007) can effectively kill any bacteria while preserving a freshly prepared taste.

New officers at NBAC

Scott Fenwick, biofuels technical business manager for Inspectorate America Corp. (Jefferson City, Missouri, USA), and **Dave Slade**, director, technical services for Renewable Energy Group (Des Moines, Iowa, USA), were recently elected chairman and vice chairman, respectively, of the National Biodiesel Accreditation Commission (NBAC; Jefferson City, Missouri).

The NBAC is a 12-member commission that oversees the voluntary biodiesel quality assurance program known as BQ-9000. The program is a unique combination of the ASTM standard for biodiesel (D6751) and a quality systems program that includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices.

The outgoing NBAC chairman was **George Kopittke** of Griffin Industries (Cincinnati, Ohio, USA). Fenwick previously served as vice chairman.

ADM announces several management appointments

In early March 2012, ADM announced several management appointments:

Mark Kolkhorst is now president of ADM Milling. He will also be responsible for ADM Alliance Nutrition, replacing **Terry Myers**, who is retiring as president of ADM Alliance Nutrition after 42 years of service. Kolkhorst joined ADM in 1986.

Kris Lutt is the new president of Golden Peanut Co. He will work the next several months with **Jimmy Dorsett**, the chief executive officer of Golden Peanut, who will be retiring in 2013 after 35 years with the company. Lutt has been with ADM since 2002.

Scott Walker is now president of ADM Cocoa. Walker joined ADM in 1993 and served as a merchandiser at numerous locations in the Oilseed Processing business before becoming a commodity merchandiser for ADM Cocoa in 1998.

Agri-Marketing Association names 2012 leader

John Becherer, chief executive officer of the United Soybean Board (Chesterfield, Missouri, USA) and the national soy checkoff, was named 2012 Agribusiness Leader of the Year by the National Agri-Marketing Association. The award was presented to him on April 19 at the 2012 Agri-Marketing Conference in recognition of his contributions to the industry.

Becherer has led a board of more than 60 volunteer US soybean farmer-directors for nearly 18 years. The soy checkoff organization was founded in 1991, and has seen global demand for soybeans increase more than 150% in that time.

NOPA elects new officers

At its annual meeting held in February 2012, the National Oilseed Processors Association (NOPA, Washington, DC, USA) elected the following officers:

- **Mark Stonacek, chairman**: president and business unit leader, grain and oilseeds supply chain North America of Cargill, Inc. (Minnetonka, Minnesota, USA)
- **Chris Nikkel, chairman-elect**: vice president, risk management—oilseeds, Bunge North America, Inc., St. Louis, Missouri, USA
- **John Campbell, secretary-treasurer**: senior vice president, renewable fuels and government relations, Ag Processing Inc., a cooperative with offices in Omaha, Nebraska, USA, and Mankato, Minnesota, USA
- **Tom Malecha, immediate past chairman**: vice president, food & food ingredients, CHS Inc., Mankato, Minnesota

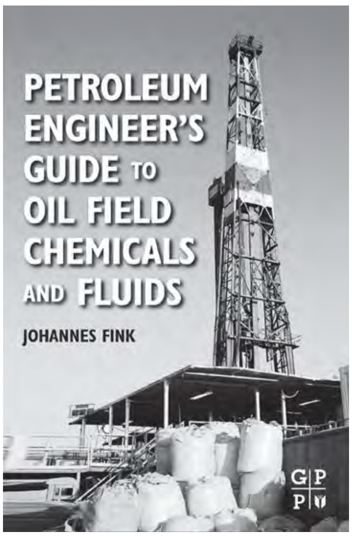
NOPA is a trade association representing member firms that either process or use vegetable oil or meal. ■

What's new with you?

Retiring? Moving? Celebrating an anniversary? Recent promotion? New child? Won an award? AOCS wants to help you spread the good news. Let us know what's going on. Email us and we'll share your news in the next AOCS member newsletter. Contact Nicole Philyaw at nicolep@aocs.org

Book Review

Petroleum Engineer's Guide to Oil Field Chemicals and Fluids
Johannes Fink, Gulf Professional Publishing, 2011, 785 pages,
$139.95, ISBN: 978-0-1238384-4-5



Charles Hammond

As oil man Mike Malone says, "Git 'er done." And *Petroleum Engineer's Guide to Oil Field Chemicals and Fluids* does just that.

If you are new to oil field chemicals or just not technically inclined, this book is a good first reference that introduces the what, where, how, and why of the chemicals that are used in the oil field. The book is designed for engineers; however, it would be useful for anyone not familiar with the topic in order to frame the chemistry that is applied in oil recovery.

The book is organized around the workflow of the oil field and so covers drilling muds, fluid loss additives, clay stabilizers, lubricants, bacterial control, corrosion inhibitors, scale inhibitors, gelling agents, filter cake removal, cementing additives, transportation, drag reducers, gas hydrate control, antifreeze agents, odorization, enhanced oil recovery, fracturing fluids, water shutoff, oil spill-treating agents, waste disposal, dispersions, emulsions, foams, defoamers, and demulsifiers.

The preface clearly outlines how best to use the guide. The volume has a detailed table of contents, lists of trade names and acronyms, and two indexes—chemical and subject—to aid the reader in finding material quickly. The chapters are broken into bite-sized paragraphs that are labeled for easy reference. The information that is presented is succinct and to the point.

The guide spans 785 pages, containing over 700 tables and 150 figures. It is based on over 20,000 references, so the reader can quickly source more detailed information.

What the book does not go into is detailed chemical molecular interactions. However, it does give chemical structures for many of the base chemicals. The list of trade names at the end of each chapter is not complete because it was derived from the references. The index also did not list "squeeze"; however, the text explained "squeeze." Because the author focused on the technical aspects of the oil field, the focus of the book did not include global regulatory considerations.

In short: the book delivers as advertised.

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The AOCS member magazine, *inform*, is looking for book reviewers. We provide a general review guideline, you have three to four months to prepare the review, and—best of all—the book remains in your library. Interested? Please email William Artz, the book review editor, at wartz@illinois.edu and indicate your subject areas of interest. You do not need to be a member to participate.

Extracts & Distillates

Thinking outside the classical chain reaction box of lipid oxidation

Schaich, K.M., *Lipid Technol. 24*:55–58, 2012.

For the past few decades, research on lipid oxidation mechanisms has been rather stagnant due to a pervasive attitude that reactions of lipid oxidation were well understood, so only tailoring applications of basic knowledge to stabilize individual systems was needed. This simplistic approach worked during the low fat/no fat era because there was little lipid substrate to oxidize. However, with current reformulation of foods with polyunsaturated fatty acids (PUFA) for health, preventing oxidation of these essential fatty acids presents major challenges that cannot always be solved with traditional thinking. Because critical gaps in our understanding prevent moving forward with improved processing, formulations, and packaging to provide high-PUFA lipid foods that remain shelf stable beyond a few months, details about oxidation mechanisms that were previously considered irrelevant have now become critically important. Considered here are alternate reaction pathways that compete with classical hydrogen abstraction and must be integrated into the overall free radical chain to more accurately account for kinetics and products of lipid oxidation.

Composition of transgenic soybean seeds with higher γ-linolenic acid content is equivalent to that of conventional control

Qin, F., L. Kang, L. Guo, J. Lin, J. Song, and Y. Zhao, *J. Agric. Food Chem. 60*:2200–2204, 2012.

γ-Linolenic acid (GLA) has been used as a general nutraceutical for pharmacologic applications, particularly in the treatment of skin conditions such as eczema. Four transgenic soybean lines that produce GLA at high yields (4.21% of total fatty acids, up to 1002-fold) were generated through the stable insertion of the Delta-6-fatty acid desaturase gene isolated from *Borago officinalis* into the genome of a conventional soybean cultivar. As part of the safety assessment of genetically engineered crops, the transgenic soybean seeds were compared with their parental soybean seeds (nontransgenic) by applying the principle of substantial equivalence. Compositional analyses were conducted by measuring the fatty acids, proximate analysis (moisture, crude protein, crude fat, carbohydrates, total dietary fiber, and ash contents), amino acids, lectins, and trypsin inhibitor activity. The present results showed that the specific transgenic cultivar studied was similar to the conventional control.

A novel process for extraction of tea oil from *Camellia oleifera* seed kernels by combination of microwave puffing and aqueous enzymatic oil extraction

Zhang, W., D. Zhang, and X. Chen, *Eur. J. Lipid Sci. Technol. 114*:352–356, 2012.

The objective of this study was to extract the oil from *Camellia oleifera* seed kernels by aqueous enzymatic oil extraction (AEOE). We describe a novel process for extraction of tea oil preceded by tea saponin extraction from *C. oleifera* seed kernels. The extraction efficiency obtained with microwave-assisted extraction (MAE) is very high, which the recovery yield is up to 83% in 30 s and the saponins in camellia seed kernels can be completely removed by the second MAE. Moreover, an important step in the process development has been the pretreatment by microwave puffing of camellia seed kernel residues followed by AEOE increased oil extraction yield from 53% to 95%, which is comparable to hexane oil extraction yields from plant materials.

Effects of frying on the *trans*-fatty acid formation in soybean oils

Hou, J.-C., L.-Z. Jiang, and C.-W. Zhang, *Eur. J. Lipid Sci. Technol. 114*:287–293, 2012.

To evaluate the effects of repeated deep-frying on the *trans*-fatty acid (TFA) formation in soybean oils, simultaneous frying experiments were carried out. French fries were prepared using three different types of soybean oil (pressed soybean oil, PSBO; first-grade solvent extracted soybean oil, FG-SESBO; and third-grade solvent extracted soybean oil, TG-SESBO). French fries were fried intermittently at 180–185°C for a total frying time of 32 h and at an interval time of 30 min. It was found that the initial amount of total TFA was 0.29 g/100 g, 0.31 g/100 g, and 0.90 g/100 g in PSBO, TG-SESBO, and FG-SESBO, respectively. Before the frying started, the C18:1,*t*-9, *trans*-linoleic acid (TLA), *trans*-linolenic acid (TLNA), and total TFA content of the PSBO and TG-SESBO were significantly lower than in the FG-SESBO ($p < 0.05$). However, in the frying oil samples, the final concentration of total TFA in the PSBO, TG-SESBO, and FG-SESBO were 1.79 ± 0.17 g/100 g, 1.12 ± 0.10 g/100 g, and 1.70 ± 0.07 g/100 g, which was 6.17-, 3.61-, and 1.89-fold higher than in fresh oil, respectively. The highest increasing slopes of C18:1,*t*-9, TLA, TLNA, and total TFA were observed in the PSBO.

Solvent-free acid-catalyzed ring-opening of epoxidized oleochemicals using stearates/stearic acid, and its applications

Ahn, B.K., S. Kraft, and X.S. Sun, *J. Agric. Food Chem. 60*:2179–2189, 2012.

Toxic solvent and strong acid catalysts causing environmental issues have been mainly used for ring-opening of epoxidized oleochemicals. Here, we demonstrated that magnesium stearate (Mg-stearate) was a highly efficient catalyst for solvent-free ring-opening of epoxidized methyl oleate, a model compound of mid-chain epoxide. Mg-stearate resulted in the highest yield (95%) and conversion rate (99%) toward mid-chain alkoxyesters under the same conditions (160°C, 12 h) superior to other fatty acid derivatives such as a Lewis acid (lithium and sodium stearate) and Brønsted acid (stearic acid). Based on this chemical study, we synthesized biogrease and thermoplastic using epoxidized soybean oil (ESO) and Mg-stearate via one-pot, solvent-free, and purification-free process. Mg-stearate played a significant role as a reactant for epoxide ring-opening and as a thickener when excess loading rate was used; viscosity increased from 1800 to 4500 Pa·s at 25°C when ESO/Mg-stearate increased from

CONTINUED ON NEXT PAGE

1:1 equiv to 1:2 equiv, then behaved like thermoplastics (T_g = glass transition temperature = −27°C, T_m = 90°C) with 1:4 equiv.

Physical ageing of the contact line on colloidal particles at liquid interfaces

Kaz, D.M., R. McGorty, M. Mani, M.P. Brenner, and V.N. Manoharan, *Nat. Mater. 11*:138–142, 2012.

Young's law predicts that a colloidal sphere in equilibrium with a liquid interface will straddle the two fluids, its height above the interface defined by an equilibrium contact angle. This has been used to explain why colloids often bind to liquid interfaces, and has been exploited in emulsification, water purification, mineral recovery, encapsulation, and the making of nanostructured materials. However, little is known about the dynamics of binding. Here we show that the adsorption of polystyrene microspheres to a water/oil interface is characterized by a sudden breach and an unexpectedly slow relaxation. The relaxation appears logarithmic in time, indicating that complete equilibration may take months. Surprisingly, viscous dissipation appears to play little role. Instead, the observed dynamics, which bear strong resemblance to ageing in glassy systems, agree well with a model describing activated hopping of the contact line over nanoscale surface heterogeneities. These results may provide clues to longstanding questions on colloidal interactions at an interface.

Metabolite profiling based on lipophilic compounds for quality assessment of perilla (*Perilla frutescens*) cultivars

Kim, J.K., S. Park, J. Na, E.S. Seong, and C.Y. Yu, *J. Agric. Food Chem. 60*:2257–2263, 2012.

Lipophilic compounds from Korean perilla (*Perilla frutescens*) seeds were characterized to determine the diversity among their phytochemicals and to analyze relationships between their contents. Twenty-four metabolites consisting of policosanol, phytosterol, tocopherol, and fatty acids were identified. The metabolite profiles were subjected to data-mining processes, including principal component analysis (PCA), partial least-squares discriminate analysis

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AOCS Journals

Journal of the American Oil Chemists' Society (April)

- Antioxidant activities and oxidative stabilities of some unconventional oilseeds, Uluata, S., and N. Özdemir
- Purifi ation of extracted fatty acids from the microalgae *Spirulina,* Zheng, G., C. Li, L. Guo, W. Ruo, and S. Wang
- Estimation of oil content and fatty acid composition in cottonseed kernel powder using near infrared reflectance spectroscopy, Quampah, A., Z.R. Huang, J.G. Wu, H.Y. Liu, J.R. Li, S.J. Zhu, and C.H. Shi
- Accelerated shelf life testing (ASLT) of oils by light and temperature exploitation, Manzocco, L., A. Panozzo, and S. Calligaris
- Composition analysis of free fatty acids from *Swertia* species by a novel pre-column fluores ence labeling method using HPLC-FLD, Li, G., C. Song, J. You, X. Zhang, and G. Chen
- Chromatographic separation of synthesized phenolic lipids from krill oil and dihydroxyphenyl acetic acid, Aziz, S., R. St-Louis, V. Yaylayan, and S. Kermasha
- Stability of solid lipid nanoparticles in the presence of liquid oil emulsions, Samtlebe, M., U. Yucel, J. Weiss, and J.N. Coupland
- Assessment of different measurement methods using ^{1}H-NMR data for the analysis of the transesterifi ation of vegetable oils, Andrade, D.F., J.L. Mazzei, C.R. Kaiser, and L.A. d'Avila
- Development and validation of a method for the determination of fatty acid methyl ester contents in tung biodiesel and blends, Pardo, V.L., C.A.M. Fagundes, S.S. Caldas, M.H. Kurz, R.M. Clementin, M.G.M. D'Oca, and E.G. Primel
- Organogel formation of soybean oil with waxes, Hwang, H.-S., S. Kim, M. Singh, J.K. Winkler-Moser, and S.X. Liu
- Immobilization of phospholipase A1 and its application in soybean oil degumming, Yu, D., L. Jiang, Z. Li, J. Shi, J. Xue, and Y. Kakuda
- Optimization of enzymatic synthesis of phytosteryl caprylates using response surface methodology, Tan, Z., and F. Shahidi
- Multivariate data analysis of fatty acid content in the classifi ation of olive oils developed through controlled cross-breeding, Dabbou, S., I. Chaieb, I. Rjiba, M. Issaoui, A. Echbili, A. Nakbi, N. Gazzah, and M. Hammami
- Formation of hydroperoxy-, keto- and hydroxy-dienes in FAME from oils: infl -ence of temperature and addition of α-tocopherol, Morales, A., S. Marmesat, M.C. Dobarganes, G. Márquez-Ruiz, and J. Velasco
- Oxidative stability of conjugated linoleic acid rich soy oil, Yettella, R.R., C. Castrodale, and A. Proctor
- Nanoencapsulation of alpha-linolenic acid with modifi d emulsion diff sion method, Habib, S.M., A.S. Amr, and I.M. Hamadneh
- Synthesis of trimethylolpropane esters of oleic acid using a multi-SO_3H-functionalized ionic liquid as an efficient catalyst, Li, R.-J., L. Chen, and Z.-C Yan
- The acrylation of glycerol: a precursor to functionalized lipids, Jackson, M.A., M. Appell, M.A. Berhow, J.A. Blackburn, and S.N. Rheiner
- Synthesis and characterization of new biodiesels derived from oils of plants growing in Northern Wisconsin and Minnesota, Lane, J.W., K. Hukriede, A. Jersett, D. Koirala, D. Levings, A. Stewart, and M.A. Waxman
- Physicochemical properties of red salmon oil (*Oncorhynchus nerka*) and microen-

capsulated red salmon oil added to baby food, Wan, Y., J. Li, K.M. Solval, J.J. Stine, P.J. Bechtel, and S. Sathivel
- Improvement may be possible, Dijkstra, A.J.
- Rebuttal to the arguments in the Letter to the Editor: Improvement may be possible, Boey, P.-L., S. Ganesan, and G.P. Maniam
- Triacylglycerol polymorphism: What can we learn from space groups and crystalline tendency? Craven, R.J., and R.W. Lencki
- Erratum to: Triacylglycerol polymorphism: What can we learn from space groups and crystalline tendency? Craven, R.J., and R.W. Lencki
- Erratum to: Quality characteristics and antioxidants of Mavroliac v. virgin olive oil, Anastasopoulos, E., N. Kalogeropoulos, A.C. Kaliora, A. Falirea, V.N. Kamvissis, and N.K. Andrikopoulos

Lipids (April)

- New 2-methyl-13-icosenoic acid from the temperate calcisponge *Leuconia johnstoni*, Quévrain, E., G. Barnathan, T. Meziane, I. Domart-Coulon, V. Rabesaotra, and M.-L. Bourguet-Kondracki
- *N*-Acyl taurines are anti-proliferative in prostate cancer cells, Chatzakos, V., K. Slätis, T. Djureinovic, T. Helleday, and M.C. Hunt
- Aberrations in plasma phospholipid fatty acids in lung cancer patients, Murphy, R.A., T.F. Bureyko, M. Mourtzakis, Q.S. Chu, M.T. Clandinin, T. Reiman, and V.C. Mazurak
- Multifunctional acyltransferases from *Tetrahymena thermophile*, Biester, E.-M., J. Hellenbrand, and M. Frentzen
- Fish oil supplementation improves neutrophil function during cancer chemotherapy, Bonatto, S.J.R., H.H.P. Oliveira, E.A. Nunes, D. Pequito, F. Iagher, I. Coelho, K. Naliwaiko, M. Kryczyk, G.A.P. Brito, J. Repka, L.V. Sabóia, G. Fukujima, P.C. Calder, and L.C. Fernandes
- Expression of enzymes and transcription factors involved in n-3 long-chain PUFA biosynthesis in Limousin bull tissues, Cherfaoui, M., D. Durand, M. Bonnet, I. Cassar-Malek, D. Bauchart, A. Thomas, and D. Gruffat
- The "HER2–PI3K/Akt–FASN axis" regulated malignant phenotype of colorectal cancer cells, Li, N., X. Bu, P. Wu, and P. Huang
- Maintenance of arachidonic acid and evidence of Δ5 desaturation in cats fed γ-linolenic and linoleic acid enriched diets, Trevizan, L., A. de Mello Kessler, J.T. Brenna, P. Lawrence, M.K. Waldron, and J.E. Bauer
- Plasma phospholipid fatty acid and ex vivo neutrophil responses are differe -tially altered in dogs fed fish- and linseed-oil containing diets at the same n-6:n-3 fatty acid ratio, Waldron, M.K., S.S. Hannah, and J.E. Bauer
- Absorption and metabolism of *cis*-9,*trans*-11-CLA and of its oxidation product 9,11-furan fatty acid by Caco-2 cells, Buhrke, T., R. Merkel, I. Lengler, and A. Lampen

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(PLS-DA), and Pearson's correlation analysis. PLS-DA could distinguish between all cultivars except between Daesil and Daeyeup cultivars. Linolenic acid contents were positively correlated with β-sitosterol ($r = 0.8367$, $P < 0.0001$) and γ-tocopherol contents ($r = 0.7201$, $P < 0.001$) among all perilla grains. The Daesil and Daeyeup cultivars appear to be good candidates for future breeding programs because they have simultaneously high linolenic acid, phytosterol, and tocopherol levels. These results demonstrate the use of metabolite profiling as a tool for assessing the quality of food.

Serum lipids, plant sterols, and cholesterol kinetic responses to plant sterol supplementation in phytosterolemia heterozygotes and control individuals

Myrie, S.B., D. Mymin, B. Triggs-Raine, and P.J.H. Jones, *Am. J. Clin. Nutr. 95*:837–844, 2012.

Plant sterol (PS) supplementation is increasingly accepted as a dietary strategy to lower plasma cholesterol concentrations. However, information is scarce about the effect of increased PS intake in potentially vulnerable groups, such as phytosterolemia heterozygotes (HET). This study assessed the responsiveness of circulating PS and lipid concentrations and cholesterol kinetics (absorption and synthesis) to daily PS supplementation in HET (*ABCG8* S107X mutation) compared with a healthy control cohort. A double-blind, randomized, crossover, placebo-controlled study was conducted in 10 HET and 15 control subjects. The participants had a mean (±SEM, standard error of the mean) age of 34 ± 2 y and a body mass index (in kg/m^2) of 29.9 ± 1.1 and consumed ~1.6 g PS or placebo capsules daily with supper for 4 wk. Cholesterol absorption and synthesis were assessed by using [^{13}C]cholesterol and deuterium oxide, respectively. Plasma low-density lipoprotein cholesterol concentrations decreased ($P = 0.006$) in both groups after PS supplementation (HET: 2.73 ± 0.19 mmol/L; control: 3.11 ± 0.19 mmol/L) compared with placebo (HET: 3.12 ± 0.20 mmol/L; control: 3.50 ± 0.21 mmol/L), whereas PS concentrations (campesterol + β-sitosterol) increased ($P = 0.03$) in both groups after PS supplementation (HET: 39.72 ± 6.05 μmol/L; control: 24.03 ± 1.65 μmol/L) compared with placebo (HET: 27.32 ± 3.80 μmol/L; control: 21.12 ± 2.05 μmol/L). Cholesterol absorption efficiency decreased ($P = 0.010$) by ×22% and ×17% and synthesis rates increased ($P = 0.040$) by ×20% and ×24% in the HET and control groups, respectively, in response to PS consumption compared with placebo. These data suggest that heterozygosity for the *ABCG8* S107X mutation does not influence the action of dietary PS on circulating cholesterol concentrations but may affect sterol absorption. This trial was registered at clinicaltrials.gov as NCT01102647.

Dietary intake of plant sterols stably increases plant sterol levels in the murine brain

Vanmierlo, T., O. Weingärtner, S. van der Pol, C. Husche, A. Kerksiek, *et al., J. Lipid Res. 53*:726–735, 2012.

Plant sterols such as sitosterol and campesterol are frequently administered as cholesterol-lowering supplements in food. Recently, it has been shown in mice that, in contrast to the structurally related cholesterol, circulating plant sterols can enter the brain. We questioned whether the accumulation of plant sterols in murine brain is reversible. After being fed a plant sterol ester-enriched diet for 6 weeks, C57BL/6NCrl mice displayed significantly increased concentrations of plant sterols in serum, liver, and brain by two- to threefold. Blocking intestinal sterol uptake for the next six months while feeding the mice with a plant stanol ester-enriched diet resulted in strongly decreased plant sterol levels in serum and liver, without affecting brain plant sterol levels. Relative to plasma concentrations, brain levels of campesterol were higher than sitosterol, suggesting that campesterol traverses the blood-brain barrier more efficiently. *In vitro* experiments with brain endothelial cell cultures showed that campesterol crossed the blood-brain barrier more efficiently than sitosterol. We conclude that, over a 6-month period, plant sterol accumulation in murine brain is virtually irreversible.

Carica papaya latex: a low-cost biocatalyst for human milk fat substitutes production

Tecelão, C., I. Rivera, G. Sandoval, and S. Ferreira-Dias, *Eur. J. Lipid Sci. Technol. 114*:266–276, 2012.

This work aims at evaluating the potential of *Carica papaya* lipase (CPL) self-immobilized in papaya latex as a biocatalyst for the synthesis of human milk fat substitutes (HMFS), to be used as a low-cost alternative to commercial lipases. Two different CPL preparations, one extracted from the papaya fruit (CPL I) and the other from petiole leaves (CPL II) of papaya tree, were tested as catalysts for the acidolysis between tripalmitin and (i) oleic acid or (ii) omega-3 polyunsaturated fatty acids, batchwise, at 60°C, in solvent-free media. After 24 h, molar incorporation was higher for oleic acid (22.1 mol%) when CPL I was used. This biocatalyst was selected for further studies. Response surface methodology was used to model reaction conditions: medium formulation [molar ratio oleic acid/tripalmitin (MR), 1.2:1–6.8:1] and temperature (58–72°C). Acyl migration decreased with MR increase. In batch operational stability assays at 60°C, using MR of 2:1 and 6:1, the highest stability was observed for a MR of 2:1.

Fibre intake in relation to serum total cholesterol levels and CHD risk: a comparison of dietary assessment methods

Ward, H.A., R. Keogh, M. Lentjes, R.N. Luben, N.J. Wareham, *et al., Eur. J. Clin. Nutr. 66*:296–304, 2012.

Prospective diet diaries may be more accurate than retrospective food frequency questionnaires (FFQ). The objective of this study was to compare FFQ and 7-day diet diary (7DD) measurements of fiber intake with the incidence of coronary heart disease (CHD). We compared 7DD and FFQ fiber intake in a nested case-control study in a population of 25,639 men and women aged 40–79 years, surveyed in 1993–1997 and followed up until 2007. Among 21,51 CHD cases and 5,354 controls, FFQ and 7DD fiber intake (6 g/day) was examined in relation to serum total cholesterol and CHD using linear and logistic regression adjusted for age and additionally for body mass index, physical activity, smoking status, family history of CHD, social class, diabetes, alcohol, energy, saturated fat and use of lipid lowering medication, antihypertensive medication or aspirin. Age-adjusted serum total cholesterol was inversely associated with 7DD fiber among men and women, but with FFQ fiber among men only. In the multivariate analysis, associations with 7DD fiber were attenuated among men [regression coefficient = −0.036 mmol/L, ,standard error (se) = 0.021, *P*-value = 0.087) and women (regression coefficient −0.069 mmol/L, se= 0.036, *P*-value = 0.053], and were nonsignificant for FFQ fiber. Among men, age-adjusted CHD risk was inversely associated with 7DD fiber [odds ratio (OR) = 0.84, 95% confidence interval (CI) = 0.79–0.90], but not with FFQ fiber (OR = 0.96, 95% CI = 0.90–1.12). Among women, age-adjusted CHD risk was inversely associated with 7DD fiber (OR 0.83, 95% CI 0.75–0.93), and had a weaker inverse borderline-significant association with FFQ fiber (OR 0.93, 95% CI 0.87–1.01). Multivariate models yielded similar results. Inconsistencies in diet-CHD relationships in population studies may be associated with the use of different dietary assessment methods.

Validation of a method for the analysis of phytosterols in sunflower seeds

Fernández-Cuesta, Á., M.R. Aguirre-González, M.V. Ruiz-Méndez, and L. Velasco, *Eur. J. Lipid Sci. Technol. 114*:325–331, 2012.

Phytosterols are natural compounds that contribute to lower serum cholesterol in humans. Sunflower seeds and oils are rich sources of phytosterols. Breeding for phytosterol content in sunflower has been scarce thus far, mainly because of the lack of analytical methods suitable for use in plant breeding. The objective of this research was to validate a method for the analysis of phytosterols in small seed samples of sunflower. Samples consisting of six seeds were analyzed for phytosterol content in a set of 87 inbred lines using a method adapted to small samples. The accuracy of the method was evaluated through the standard error of the analysis of replicates of ground samples, which was 72.12 mg/kg compared to average values of 1665.3 and 1887.2 mg/kg seed in the samples. Sunflower inbred lines showed ranges of variation from 1426.0 to 4710.0 mg/kg seed and from 2855.2 to 9752.0 mg/kg oil. The method correlated strongly with the conventional method based on the analysis of extracted oils ($r = 0.85$). The results indicated that analysis of phytosterols on samples consisting of sunflower seeds is an accurate approach for breeding and genetic studies, in which extraction of the seed oil is not feasible.

Lipase-catalyzed incorporation of different fatty acids into tripalmitin-enriched triacylglycerols: effect of reaction parameters

Qin, X.-L., B. Yang, H.-H. Huang, and Y.-H. Wang, *J. Agric. Food Chem. 60*:2377–2384, 2012.

Tripalmitin-enriched triacylglycerols were concentrated from palm stearin by acetone fractionation and as the substrate reacted with a mixture of equimolar quantities of fatty acids (C8:0–C18:3). The incorporation degree and acyl migration level of the fatty acids and acylglycerols composition were investigated, providing helpful information for the production of human milk fat substitutes. Higher incorporation degrees of the fatty acids were obtained with lipase PS IM, Lipozyme TL IM, and Lipozyme RM IM followed by porcine pancreatic lipase and Novozym 435-catalyzed acidolysis. During reactions catalyzed by Lipozyme TL IM, Lipozyme RM IM, and lipase PS IM, incorporation degrees of C12:0, C14:0, C18:1, and C18:2 were higher than those of other fatty acids at operated variables (molar ratio, temperature, and time), and the triacylglycerols content reached the highest (82.09%) via Lipozyme RM IM-catalyzed acidolysis. On the basis of significantly different levels of acyl migration to the *sn*-2 position, lipases were in the order of lipase PS IM < Lipozyme TL IM < Lipozyme RM IM. ■

Patents

Published Patents

Nutritional food oil compositions and methods of making same

Greither, T., US8062688, November 22, 2011

Nutritional food oil compositions containing all of the essential fatty acids and the highly recommended omega-3 fatty acid DHA [docosahexaenoic acid] in correct proportions making it convenient and easy for consumers to supplement their diets with these fatty acids in the proper amounts thereby deriving the health benefits of these fatty acids. A nutritional food oil composition is provided comprising α-linolenic acid (ALA) and linoleic acid (LA) wherein the ratio of the amount of ALA to LA in the composition by weight is in the range of 1.5:1 to 6:1 and together the ALA and LA comprise at least 65% by weight of the composition and DHA from an algal source in an amount greater than 0.5% by weight of the composition.

Carbohydrates

Medoff, M., Xyleco, Inc., US8063201, November 22, 2011

Carbohydrates having functional groups such as carboxylic acid groups and methods of making such carbohydrates.

C[h]romatography process for recovering a substance or a group of substances from a mixture

Krumbholz, R., *et al.*, K.D. Pharma Bexbach GmhH, US8063235, November 22, 2011

Method for improving the performance of a preparative batchwise supercritical fluid chromatographic separation for the recovery of a target fatty acid or derivative thereof, or of a group of target fatty acids or of derivatives thereof, from a mixture. The separation employs a chromatographic column charged with a stationary phase chosen from the group consisting of aluminum oxide or aluminum oxides, titanium oxide or titanium oxides, silica gel or silica gels, amino propyl modified silica gels, diol modified silica gels, phenyl modified silica gels, and "reversed phase" phases, the former in turn chosen from the group consisting of RP18, RP8, and RP3. The separation employs a mobile phase chosen from the group consisting of ethylene, propane, ammonia, dinitrogen dioxide, and CO_2. During the run of the mixture on the chromatographic column, a pressure and/or temperature gradient is applied to the chromatographic column during the elution of the target fatty acid or derivative thereof.

Process for milling cocoa shells

Kopp, G.M., *et al.*, Kraft Foods R&D Inc., US8067051, November 29, 2011

A process for preparation of milled cocoa shell including grinding cocoa shell in a single unit operation in a short-duration manner without the need for moving mechanical parts. The milled cocoa shell product obtained from the grinding treatment has reduced heat degradation and avoids equipment maintenance concerns otherwise associated with mechanical milling of the cocoa shells while providing an edible granular product useful for food manufacture such as chocolate food production.

Polyurethane foam

Cameron, P., and E. Appelman, Croda International Plc; Uniqema B.V., US8067479, November 29, 2011

A microcellular polyurethane obtainable by reacting a polyisocyanate, a polyester formed from a dimer fatty acid and/or dimer fatty diol, and a chain extender. The foam is particularly suitable for use as a component of shoe soles.

Method of preparing carboxylic acid functionalized polymers

Harris, J.M., *et al.*, Nektar Therapeutics, US8067505, November 29, 2011

Methods for preparing water-soluble non-peptidic polymers carrying carboxyl functional groups, particularly carboxylic acid functionalized poly(ethylene glycol) (PEG) polymers are disclosed, as are the products of these methods. In general, an ester reagent R(C=O)OR′, wherein R′ is a tertiary group and R comprises a functional group X, is reacted with a water-soluble, non-peptidic polymer POLY-Y, where Y is a functional group which reacts with X to form a covalent bond, to form a tertiary ester of the polymer, which is then treated with a strong base in aqueous solution, to form a carboxylate salt of the polymer. Typically, this carboxylate salt is then treated with an inorganic acid in aqueous solution, to convert the carboxylate salt to a carboxylic acid, thereby forming a carboxylic acid functionalized polymer.

Desaturase genes, enzymes encoded thereby, and uses thereof

Mukerji, P., *et al.*, Abbott Laboratories, US8067674, November 29, 2011

Disclosed are isolated polynucleotides encoding an ω-3 desaturase and a Δ-12 desaturase, the enzymes encoded by the isolated polynucleotides, vectors containing the isolated polynucleotides, transgenic hosts that contain the isolated polynucleotides that express the enzymes encoded thereby, methods for producing the desaturase enzymes, and method of using the enzymes to make polyunsaturated fatty acids. The isolated polynucleotides are derived from a fungus, *Saprolegnia diclina* (ATCC 56851). In particular ω-3-desaturase may be utilized, for example, in the conversion of arachidonic acid (AA) to eicosapentaenoic acid (EPA). Δ-12 Desaturase may be used, for example, in the conversion of oleic acid (OA) to linoleic (LA) acid. EPA [eicosapentaenoic acid] or polyunsaturated fatty acids produced therefrom may be added to pharmaceutical compositions, nutritional compositions, animal feeds, as well as other products such as cosmetics.

Methods for producing fuels and solvents

Bressler, D., Governors of the University of Alberta, US8067653, November 29, 2011

Described herein are methods for producing fuels and solvents from fatty acid resources. In general, the pyrolysis products of fatty acids are extracted in order to remove residual fatty acids and produce very pure hydrocarbon compositions composed of alkanes and alkenes. The fatty acids removed from the extraction step can be further pyrolyzed to produce additional hydrocarbons or, in the alternative, the fatty acids can be isolated and used in other applications. Also disclosed herein are fuels and solvents produced by the methods described herein.

Triacyglycerol-based candle wax

Murphy, T.A., Elevance Renewable Sciences, Inc., US8070833, December 6, 2011

A triacylglycerol-based wax includes a triacylglycerol component and a polyol fatty acid partial ester component. The triacylglycerol-based wax may have a melting point of about 54–63°C, may have an Iodine Value of about 20 to 40, and may have a fatty acid profile including about 50–70 wt% saturated fatty acids. The wax may be suitable for use as a candle.

Composition with a fungal (yeast) lipase and method for treating lipid malabsorption in cystic fibrosis as well as people suffering from pancreatic lipase insufficiency

Schuler, C., and E. Schuler, BIO-Cat, Inc., US8071089, December 6, 2011

The invention provides compositions and methods for treating pancreatic enzyme insufficiency, such as the pancreatic enzyme insufficiency associated with cystic fibrosis. The invention also provides compositions comprising lipase from *Candida cylindracea*, alone or in combination with amylase or amyloglucosidase protease and/or lactase. Furthermore, the invention discloses methods for treating pancreatic enzyme insufficiency comprising administering compositions to patients in need thereof.

Whey protein-containing granules and method of producing the same

Kodama, T., *et al.*, Meiji Seika Kaisha, Ltd., US8071153, December 6, 2011

Disclosed are whey protein-containing granules that can dissolve a whey protein into water without forming insoluble lumps, thereby making a solution containing the dissolved whey protein clear without turbidity, and a method for producing the same. The whey protein-containing granules are composed of a polyglycerin fatty acid ester having a HLB [hydrophilic lipophilic balance] of 13 to 18 and containing lauric acid as a constituent fatty acid. As the polyglycerin fatty acid ester, monolauric acid decaglycerin ester or monolauric acid pentaglycerin ester may be used.

Self-adhesive film

Kato, J., *et al.*, Panac Co., Ltd., US8071212, December 6, 2011

A self-adhesive film comprises a substrate layer and an adhesive layer on the substrate layer, which comprises a carboxylic acid-modified thermoplastic elastomer, a carboxylic acid-unmodified thermoplastic elastomer, a crosslinking agent, and a plasticizer. A self-adhesive functional film comprises a substrate layer, an adhesive layer formed on one side of the substrate layer, and a functional layer on the other side of the substrate layer, which has at least one of antireflective, electromagnetic wave-blocking, heat ray cutting off, antistatic, anticlauding, antibacterial, deodorizing, easy-adhering, antifouling functions and hard coat layer.

Biodegradable wipe utilizing bio-based lubricant comprising refined soybean oil

Horton, C., Hoover Inc., Techtronic Floor Care Technology Ltd. Royal Appliance Mfg. Co., US8071524, December 6, 2011

The present invention generally relates to a biodegradable lubricating wipe, such as wet wipes. The wet wipes are typically fibrous sheet materials, pre-moistened with a solution for improved lubrication and/or protection of an area. In one embodiment the solution is comprised of a bio-based lubricant, a bio-based solvent, and water. In one embodiment, the solution is comprised of mineral spirits and refined soybean oil. In another embodiment, the solution is comprised of soy methyl ester and refined soybean oil. In yet another embodiment, the fibrous sheet material of the invention is biodegradable and the solution portion breaks down into a vaporizing component and a biodegradable carrier portion.

Orlistat compositions

Barbier, P., *et al.*, Hoffmann-La Roche Inc., US8071571, December 6, 2011

A pharmaceutical combination or composition containing a lipase inhibitor, preferably orlistat, and a bile acid sequestrant is useful for treating obesity.

Omega 3 fatty acid formulations

Feuerstein, S.D., *et al.*, Cenestra LLC, US8071646, December 6, 2011

The present invention provides highly purified omega-3 fatty acid formulations. Certain formulations provided herein contain greater than 85% omega-3 fatty acids by weight. Certain other formulations

CONTINUED ON NEXT PAGE

provided herein contain eicosapentaenoic acid and docosahexaenoic acid and in a ratio of from about 4.01:1 to about 5:1. The invention also provides methods of using the dosage forms to treat a variety of cardiovascular, autoimmune, inflammatory, and central nervous system disorders by administering a formulation of the invention to a patient in need thereof.

Maleated and oxidized fatty acids

Hurd, P.W., *et al.*, Georgia Pacific Chemicals LLC, US8071715, December 6, 2011

An oxidized and maleated fatty acid composition, especially an oxidized and maleated tall oil fatty acid-containing product useful in formulating corrosion inhibitors and for use as an emulsifier especially for petroleum-related applications is disclosed.

Chain-selective synthesis of fuel components and chemical feedstocks

Olson, E.S., Energy & Environmental Research Center Foundation, US8071799, December 6, 2011

A method comprising: (i) providing a starting composition comprising a polyunsaturated fatty acid, a polyunsaturated fatty ester, a carboxylate salt of a polyunsaturated fatty acid, a polyunsaturated triglyceride, or a mixture thereof; (ii) self-metathesizing the starting composition or cross-metathesizing the starting composition with at least one short-chain olefin in the presence of a metathesis catalyst to form self-/cross-metathesis products comprising: cyclohexadiene; at least one olefin; and one or more acid-, ester-, or salt-functionalized alkene; and (iii) reacting cyclohexadiene to produce at least one cycloalkane or cycloalkane derivatives. A method for producing cycloalkanes for jet fuel by providing a starting composition comprising at least one selected from the group consisting of algal and polyunsaturated vegetable oils, subjecting the starting composition to metathesis to produce metathesis product comprising at least one olefin, cyclohexadiene, and at least one acid-, ester-, or salt-functionalized alkene, and reacting the at least one olefin and cyclohexadiene to form cycloalkane(s).

Composition for oxidation dyeing of human keratin fibres at a pH of less than 8, comprising a fatty alcohol, a fatty ester and a cationic surfactant, method using same and device

Debain, J.-D., *et al.*, L'Oreal SA, US8075639, December 13, 2011

Provided is a dyeing composition for coloring human keratin fibers, comprising, at a pH less than 8, in a cosmetically acceptable medium, at least one oxidative dye precursor, at least one cationic surfactant, at least one fatty acid ester, and at least one fatty alcohol. The fatty alcohol is chosen from non-(poly)oxyalkylenated and non-(poly)glycerolated, saturated and unsaturated fatty alcohols. The weight ratio of the fatty alcohol to fatty acid ester is greater than 2:1 and less than 10:1. Also provided are methods and devices for coloring the keratin fibers.

Antioxidant compositions useful in biodiesel and other fatty acid and acid ester compositions

Carter, T.E., *et al.*, Eastman Chemical Co., US8075804, December 13, 2011

Compositions containing phenolic antioxidant solutions are provided. The invention further provides methods of making and using such compositions as well as compositions that contain both biodiesel and at least one antioxidant concentrate solutions and blended fuel compositions containing biodiesel blended with other fuels.

Triglyceride compositions useful for preparing composite panels and applications thereof

Wantling, S.J., Momentive Specialty Chemicals Inc., US8076006, December 13, 2011

Composite panels may be prepared using a moisture resistance additive having a formulation that includes a triglyceride having a saponification value of at least 150 and an iodine value of at least 35. The additive may be used in the form of a water emulsion. The water emulsion may be prepared by dispersing the components of the additive formulation under conditions sufficient to at least partially saponify the triglyceride. The moisture resistance additive can impart resistance to moisture absorption and thickness swelling to composite panels prepared therewith.

Methods for producing alkyl esters

Chou, C.-C., Sunho Biodiesel Corp., US8076110, December 13, 2011

This invention relates to a method for producing an alkyl ester via a transesterification or esterification reaction. The method includes (i) mixing an oil source containing a triglyceride or a carboxylic acid and a primary or secondary alcohol in an organic solvent to form a solution in which each molecule of the organic solvent contains 4–8 carbon atoms and a heteroatom; (ii) reacting the triglyceride or the carboxylic acid with the primary or secondary alcohol in the presence of a lipase to produce an alkyl ester in which the solution does not undergo phase separation throughout the reaction; and (iii) separating the alkyl ester from the solution.

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.

CALENDAR (CONTINUED FROM PAGE 275)

June 18–20, 2012. 16th Annual Green Chemistry & Engineering, Washington, DC, USA. Information: acswebcontent.acs.org/gcande.

June 18–21, 2012. BIO (Biotechnology Industry Organization) International Convention, Boston, Massachusetts, USA. Information: convention.bio.org.

June 18–22, 2012. 20th European Biomass Conference and Exhibition, Milan, Italy. Information: conference-biomass.com.

June 18–22, 2012. ACHEMA, Frankfurt am Main, Germany. Information: achema.de/index.php?selectedArea=1&selectedItem=1&spkz=E.

June 19–22, 2012. 15th Workshop on Vitamin D, Houston, Texas, USA. Information: vitaminD.UCR.edu.

June 21–22, 2012. Science and Technology of Food Emulsions, London, UK. Information: soci.org/General-Pages/Display-Event?EventCode=OF114.

June 25–29, 2012. Institute of Food Technologists' Annual Meeting and Expo, Las Vegas, Nevada, USA. Information: ift.org.

June 27–28, 2012. Separation Science 2012, Kuala Lumpur, Malaysia. Information: tinyurl.com/SepScience.

June 27–29, 2012. Heart UK 26th Annual Conference 2012: Metabolic Syndrome, Obesity and Pre-Diabetes, Newcastle upon Tyne, UK. Information: heartuk.org.uk/index.php?/events/heart_uk_26th_annual_conference_2012.

June 28–29, 2012. 1st European Conference on the Replacement, Reduction and Refinement of Animal Experiments in Ecotoxicology, Dübendorf, Switzerland. Information: euroecotox.eu.

July

July 8–13, 2012. 20th International Symposium on Plant Lipids, Seville, Spain. Information: ispl2012.org.

July 9–12, 2012. 8th Asia-Pacific Conference on Algal Biotechnology, Adelaide, Australia. Information: sapmea.asn.au/conventions/apcab2012/index.html.

July 12–15, 2012. Kern Lipid Conference, Vail, Colorado, USA. Information: kernconference.org.

July 15–20, 2012. FASEB Conference: Phospholipid Metabolism—Disease, Signal Transduction, and Membrane Dynamics, Saxtons River, Vermont, USA. Information: https://secure.faseb.org/faseb/meetings/Summrconf/Programs/11524.pdf.

July 22–27, 2012. FASEB Conference: Lipid Droplets—Metabolic Consequences of the Storage of Neutral Lipids, Snowmass Village, Colorado, USA. Information: https://secure.faseb.org/faseb/meetings/Summrconf/Programs/11697.pdf.

July 22–27, 2012. FASEB Conference: Lipid Signaling Pathways in Cancer, Steamboat Springs, Colorado, USA. Information: https://secure.faseb.org/faseb/meetings/Summrconf/Programs/11724.pdf.

July 30–August 1, 2012. Australian Grains Industry Conference, Melbourne, Australia. Information: australianoilseeds.com.

August

August 19–23, 2012. 244th American Chemical Society National Meeting & Exposition, Philadelphia, Pennsylvania, USA. Information: acs.org.

August 19–23, 2012. 16th World Congress of Food Science and Technology, Salvador, Brazil. Information: iufost2012.org.br/ingles.

August 23–25, 2012. Regulation of Protein Traffi ing and Function by Palmitoylation, Oxford, UK. Information: biochemistry.org/Conferences/AllConferences/tabid/379/View/Conference/MeetingNo/SA139/Default.aspx.

September

September 4–9, 2012. 53rd International Conference on the Bioscience of Lipids, Banff, Canada. Information: icbl.unibe.ch/index.php?id=81.

September 5–9, 2012. 5th Global Jatropha World 2012, Jaipur, India. Information: biodieselacademy.com.

September 27–28, 2012. US Regulatory Network Meeting, Bethesda, Maryland, USA. Information: leatherheadfood.com/training-and-conferences.

September 30–October 4, 2012. World Congress on Oleo Science & 29th ISF Conference (JOCS/AOCS/KOCS/ISF Joint Conference), Arkas Sasebo, Nagasaki Prefecture, Japan. Information: www2.convention.co.jp/wcos2011.

September 30–October 5, 2012. SCIX2012 (national meeting of the Society for Applied Spectroscopy), Kansas City, Missouri, USA. Information: scixconference.org.

October

October 29–31, 2012. Singapore 2012: World Conference on Fabric and Home Care, Shangri-La Hotel, Singapore. Information: email: meetings@aocs.org; phone: +1 217-693-4821; fax: +1 217-693-4865; email: meetings@aocs.org; singapore.aocs.org. ■

BELGIAN CHOCOLATE (CONTINUED FROM PAGE 287)

chocolate, and retemper it. Then, they form it into pralines or other chocolates in a variety of shapes, from simple squares to hearts, seashells, and birds.

Chocolatiers continue to refine the art of making pralines, the Belgian specialty. The two classic methods for praline production are molding and enrobing. In molding, chocolatiers use a mold to create a hollow chocolate shell, insert a soft filling through an opening in the shell, and then cover the opening with a layer of chocolate. Although some chocolate makers continue to produce their molded pralines by hand, modern "one-shot processing" machines enable the simultaneous extrusion of the chocolate mass and filling into the mold. However, the filling must be viscous enough that it won't mix with the chocolate shell during cooling. Praline manufacturers can temporarily increase the filling viscosity during processing by adding pregelatinized starch and malt extract to the filling. The starch thickens the filling during molding, whereas the malt extract contains starch-cleaving enzymes that make the filling more liquid during storage.

FIG. 2. *Researchers at the University of Ghent Cacaolab experiment with chocolate to improve its quality and shelf life.*

Enrobing is typically used for firmer fillings. In this method, a slab of filling is dipped in melted chocolate, coating the filling. Enrobing machines exist, but some artisan chocolate makers still prefer to enrobe their chocolates by hand. Because they are time-consuming, handmade Belgian chocolates fetch a premium price. Also contributing to a high-quality praline is the use of couverature chocolate for molding and enrobing. Couverture chocolate contains a higher percentage of cocoa butter (32–39%) than regular chocolate and is thus shinier, snaps more firmly when broken, and has a mellow, creamy flavor.

Praline fillings have evolved considerably since Neuhaus' first simple creams, nougats, and ganaches. Traditional favorites such as caramels and hazelnut creams remain popular, but they have been joined by a dazzling array of flavors ranging from the expected (fruit, coffee, and flower essences) to the exotic (chili peppers, tomato-basil, and wasabi). Indeed, as a counterpoint to the traditionally sweet praline fillings, savory fillings with flavors of cheese, tomato, wine, even goose liver and seafood, are gaining popularity among praline-savvy Belgians.

Yet for many Belgian praline makers, the flavor of the chocolate itself remains the paramount consideration. Such is the case for Geert Decoster, artisan chocolatier and owner of Centho Chocolates in the village of Duisburg, near Brussels (Fig. 1 on page 286).

Twelve years ago, Decoster was among the first to embrace an up-and-coming trend in the chocolate world: making chocolates with cacao beans from one region, or sometimes even one plantation. Such "single-origin" chocolate has subtle flavors that reflect the unique cacao tree variety and growing conditions of that particular region. In contrast, most industrial chocolate contains a mixture of beans, typically from countries in West Africa. Blending beans from different geographical regions ensures taste consistency and compensates for a bad growing season in any one region.

However, Decoster believes that blending sacrifices the unique character of cacao beans from different regions. For example, Ecuadorian beans produce a fruitier-tasting chocolate, whereas beans from Papua New Guinea confer hints of mushroom and tobacco flavors. Decoster enjoys concocting praline fillings that perfectly complement the flavor of each origin chocolate. "The chocolate from Vanuatu, with hints of licorice and cinnamon, pairs well with a filling of good Scotch whiskey and pear jam," he explains. Other tempting pralines from Centho's large assortment include spicy Peruvian chocolate paired with a violet and raspberry filling, and earthy Ugandan chocolate harmonized with wild Tuscan fennel flowers and blood oranges.

For Decoster, chocolate making is a family affair. His business name, "Centho," comes from the first three letters of his children's names: daughter Centa and son Thomas. His small factory has only two employees, in addition to him and his wife, Els, who manages the retail shop. Nevertheless, Centho pralines have made their way into some of the finest restaurants and hotels in Europe, including London's Ritz and Savoy hotels. "The reason we supply all the beautiful restaurants is because after dinner, there's nothing as nice as a good praline," says Decoster. "And when you have a small praline like ours, you can taste more than one." At 8 g, Centho's square-shaped pralines are diminutive compared with many of their competitors. "Here in Europe, the time of eating one big chocolate and then having enough is going away," he says. "I see the young people loving a large assortment of smaller pralines."

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In 2009, Decoster brought a sampling of his chocolates to the Summer Fancy Food Show in New York City. "Everybody was crazy about our chocolates," recalls Decoster. "Our chocolates were completely new for them because in the States, people are used to a bigger chocolate that is very sweet." But even in Belgium, Centho chocolates are unique. "Everyone has two or three single-origin chocolates in his assortment, but we're the only ones to have 40 different types of single-origin chocolates," he notes.

Decoster's innovative approach is typical for a country not prepared to rest on its chocolate-covered laurels. New technology now allows researchers to probe the science of chocolate making, with the potential to dramatically improve quality and shelf life. In 2009, the University of Ghent inaugurated the UGent Cacaolab, a small-scale experimental chocolate and fillings production facility (Fig. 2).

According to AOCS member Koen Dewettinck, food scientist and director of the facility, UGent Cacaolab researchers partner with industry to create innovative chocolate products, improve chocolate-making processes, and stimulate the export potential of Belgian chocolate. Current projects at UGent Cacaolab include efforts to improve the microbial resistance of water-based praline fillings, adjust the flow behavior of chocolate, and develop sugar-free dark chocolate. Another important focus of UGent Cacaolab is extending the shelf life of Belgian pralines, which are susceptible to a phenomenon known as fat bloom. This is a whitish-gray coating that forms on the surface of chocolate, typically after several months' storage. Fat bloom is unattractive and gives chocolate a waxy texture.

According to AOCS member Dérick Rousseau, food chemist at Ryerson University in Toronto, Canada, fat bloom in chocolate occurs for three main reasons: improper tempering, temperature fluctuations during storage or in the hands of the consumer, and the migration of fats from a praline's filling through its chocolate shell. At the microstructural level, fat bloom is associated with the transformation of form V crystals of cocoa butter into the undesirable, but more stable, form VI crystals.

"Regardless of how well you temper your chocolate, eventually the chocolate will transform to form VI because it's the most stable," says Rousseau. However, the consumer can hasten this process by subjecting the chocolate to temperature fluctuations, for example, storing chocolate in the freezer or moving it from an air-conditioned store to a hot car.

Rousseau has used scanning electron microscopy to show that the needle-like fat bloom crystals can grow from imperfections on the surface of the chocolate (*Soft Matter*, doi:10.1039/b718066g, 2008). This observation led Rousseau to hypothesize that channels in the chocolate serve as conduits for lower-melting triglycerides to rise to the surface of the chocolate and recrystallize, primarily into form VI. Therefore, minimizing surface imperfections on chocolate may help control fat bloom, he says.

Pralines are more susceptible to fat bloom than unfilled chocolates because their fillings often contain higher concentrations of specific triglycerides than their chocolate shell. As a result, these fats diffuse to the chocolate surface, transforming into form VI crystals. Because fat bloom is a major impediment to long-term storage, and thus export, of Belgian pralines, the UGent Cacaolab is working to produce fat bloom-resistant chocolates.

The early results are promising. Dewettinck's group found that storing pralines at a cold temperature (4°C or –20°C) immediately after production decreased oil migration and fat bloom during later storage at a higher temperature (*European Journal of Lipid Science Technology,* doi:10.1002/ejlt.200800179, 2009). Cold storage therefore may cause favorable fat crystallization that leads to permanent microstructural changes.

Thus, the secrets of Belgian chocolate lie in a mix of quality ingredients, expert processing, centuries-old tradition, and a willingness to embrace new technology. But the importance of Belgians' passion for chocolate cannot be underestimated. "Ever since I was a kid, I knew I wanted to make chocolate," says Decoster. "I'm always thinking of chocolate. My brains are chocolate," he jokes. Such dedication gives chocolate lovers the world over cause to celebrate—and what better way than with a fine Belgian chocolate? ■

NEWS & NOTEWORTHY (CONTINUED FROM PAGE 291)

improve the utilization and management of their shipping fleets, with each company initially contributing two ships to the effort; and in tropical oil refining in Europe, they will work together to optimize refining capacity utilization. ADM and Wilmar hope to make the definitive agreements final over the next few months.

Aflatoxins and ochratoxin A in chocolate

Researchers in Brazil are calling for "constant monitoring" of chocolate for the presence of potentially lethal ochratoxin A and aflatoxins, according to a report by FoodProductionDaily.com.

In a study led by Marina V. Copetti of the Federal University of Santa Maria in Rio Grande do Sul, researchers evaluated 125 samples of powdered, bitter, milk, and white chocolate from supermarkets in Brazil. They found aflatoxins in 80% of all chocolate examined. Ochratoxin A was found in 98% of the samples.

Aflatoxin B is a Group One carcinogen with mutagenic and teratogenic properties, according to the International Agency for Research on Cancer (IARC). IARC found that ochratoxin A is possibly carcinogenic to humans (Group 2B).

The research appeared in *Food Control* *26*:36–41, 2012.

DuPont introduces alternative to EDTA

DuPont Nutrition & Health (Wilmington, Delaware, USA) has introduced an alternative to the food industry's go-to synthetic chelator, EDTA, or ethylene diamine tetraacetic acid.

The ingredient, named Guardian Chelox L, is composed of a blend of natural plant extracts that protect against oxidation in high-lipid foods. The solution is available in the United States, Canada, and Mexico; availability will be expanded soon.

Metal-chelating and radical-scavenging activities of plant extracts were identified using electron spin resonance spectroscopy, according to FoodNavigator-USA.com. "Once identified and blended, Guardian Chelox L was tested in samples of 40% fat ranch dressing stored at 77°F (25°C)," DuPont was quoted as saying.

Compared with the ranch dressing formulated with EDTA, the Guardian Chelox L blend exhibited similar levels of antioxidant protection over a 12-month period, the report noted. ■

HEALTH & NUTRITION NEWS (CONTINUED FROM PAGE 297)

- Breast-feeding women—additional intake of 19 g/day during the first six months of lactation and 13 g/day thereafter.

The Panel also looked at several health outcomes that may be associated with protein intake—such as bone health, body weight, muscle mass, and kidney function—but concluded that the available data were insufficient to derive PRI based on these health outcomes. See tinyurl.com/PRI-Protein for more information. To compare the EFSA recommendations with the dietary reference intakes set by the US Institute of Medicine's, see tinyurl.com/IOMProtein.

Salmon produce DHA from plant-based materials

Salmon fed diets low in the marine omega-3 fatty acids contain more DHA (docosahexaenoic acid) than that which is provided by the diet, according to Norway's National Institute of Nutrition and Seafood Research (NIFES). DHA is an important marine [long-chain] omega-3 fatty acid.

"When there are plenty of marine omega-3 fatty acids in their feed, salmon use them as a source of energy, but when the levels are low, they store them and may even produce more. And in this study, we found that salmon produced their own marine omega-3 fatty acids based on omega-3 from plants," NIFES research scientist Monica Sanden told fis.com, an online information service.

"We found that the fish body contained more DHA than what was provided by the diet, meaning that the fish had a net production of DHA. The level of marine omega-3 fatty acids in salmon flesh is lower when the fish are fed plant-based raw materials. But our study has shown that it will still be sufficient to satisfy consumer requirements based on the EFSA (European Food Safety Authority) recommendations. A 150 g serving of salmon from this experiment would give us 1400 mg EPA [eicosapentaenoic acid] and DHA, which is almost six times the recommended daily intake of these fatty acids," says Sanden.

Social media redefine relationship with food

Social media have changed how North Americans learn to cook, select recipes, plan their meals, purchase their food, and share their culinary secrets with others, according to a new study entitled *Clicks & Cravings: The Impact of Social Technology on Food Culture*.

The study suggests that almost half of consumers learn about food via social networking sites, such as Twitter and Facebook, and 40% learn about food via websites, apps, or blogs. "Consumers used to rely on mom and family traditions for meal planning but now search online for what to cook, without ever tasting or smelling," said Laurie Demeritt, president and chief operating officer at The Hartman Group, which conducted the study in tandem with Publicis Consultants USA, a food and nutrition marketing agency. "Digital food selection is less of a sensory experience and more of a visual and rational process: What is on the label? What is in the recipe? Show me the picture!"

In the past, consumers listened to the opinions of a few trusted resources—generally family members—in deciding what to buy, cook, or eat; modern consumers "crowdsource" the opinions of many before deciding what to buy. What's more, the infiltration of social media into the food experience goes far beyond purchasing and preparing food; it now includes the meal experience as well. While eating or drinking at home, nearly one-third of North Americans use social networking sites. Among Millennials (18–32 years old), this figure jumps to 47%. "The 'table for one' rarely exists anymore, even among single people eating alone at home," said Demeritt. "If you are eating alone, chances are you are also texting friends who live miles away or posting food photos to a review site."

For an executive summary of the survey, visit tinyurl.com/HartmanReport. ■

A prescription for chocolate

Laura Cassiday

In 1520, Spanish explorer Hernán Cortés remarked that the Aztec Indians of central Mexico consumed ground cacao beans in "a drink which makes the body stronger and fends off fatigue." Growing evidence in this century indicates that cocoa and the chief product made with it, chocolate, contain a host of phytochemicals—chemical compounds derived from plants—that may help stave off disease and enhance mood.

Epicatechin

Epicatechin belongs to a group of plant compounds called flavanols that have potent antioxidant properties *in vitro*. Antioxidants may prevent cell damage and death by controlling cellular levels of reactive oxygen species and other harmful oxidized molecules. Cacao beans are one of the richest known sources of epicatechin. Other dietary sources include tea, grapes, red wine, and some fruits and berries. According to the US Department of Agriculture (USDA) Database for the Flavonoid Content of Selected Foods (2011), dark chocolate has eight times more epicatechin per 100 g than milk chocolate, about 10 times more epicatechin than black grapes or brewed green tea, and 20 times more than red table wine.

Like several other antioxidants found in cocoa, epicatechin has a polyphenolic structure. Epicatechin can prevent the oxidation of low-density lipoprotein (LDL) -cholesterol, a key lipoprotein sometimes associated with heart disease. The oxidized form of LDL-cholesterol may promote atherosclerotic plaque formation. Epicatechin has been shown to boost levels of nitric oxide, a compound that causes blood vessels to relax and widen (a process known as vasodilation), improving blood flow. Nitric oxide also inhibits blood platelet aggregation and leukocyte adhesion to the inside of blood vessels, thereby reducing the risk of clots, strokes, high blood pressure, and atherosclerosis. Epicatechin also has been shown to increase insulin sensitivity, guarding against type 2 diabetes.

During cocoa processing, the oxidation of epicatechin forms a series of epicatechin polymers known as **procyanidins**. Evidence suggests that polymers containing two to five epicatechin moieties are better antioxidants than either the epicatechin monomer or the higher-order polymers, possibly owing to better absorption and bioavailability in the human body. In addition to the effects of monomeric epicatechin, procyanidins inhibit cancer cell proliferation *in vitro* and can prevent chemically induced carcinogenesis in experimental animals.

Caffeine and theobromine

Contrary to popular belief, chocolate does not contain high amounts of caffeine: A 40-g serving of dark chocolate contains less than half the caffeine of a cup of coffee, with milk chocolate containing even less caffeine. However, cacao beans are nature's most concentrated source of theobromine, a compound with a similar structure to caffeine. Theobromine stimulates the nervous system less robustly than caffeine; therefore, chocolate is unlikely to induce hyperactivity or sleeplessness. Dark chocolate contains about three times more theobromine than milk chocolate.

Theobromine is also an antioxidant, but because of the small amount of theobromine in cocoa relative to the procyanidins, its contribution to the overall antioxidant effect is relatively small. Theobromine further acts as a vasodilator and also reduces inflammation, a hallmark of many diseases including cancer, atherosclerosis, and diabetes.

Anandamide

Chocolate contains a small amount of the neurotransmitter anandamide, which is also produced naturally in the brain of all vertebrates.

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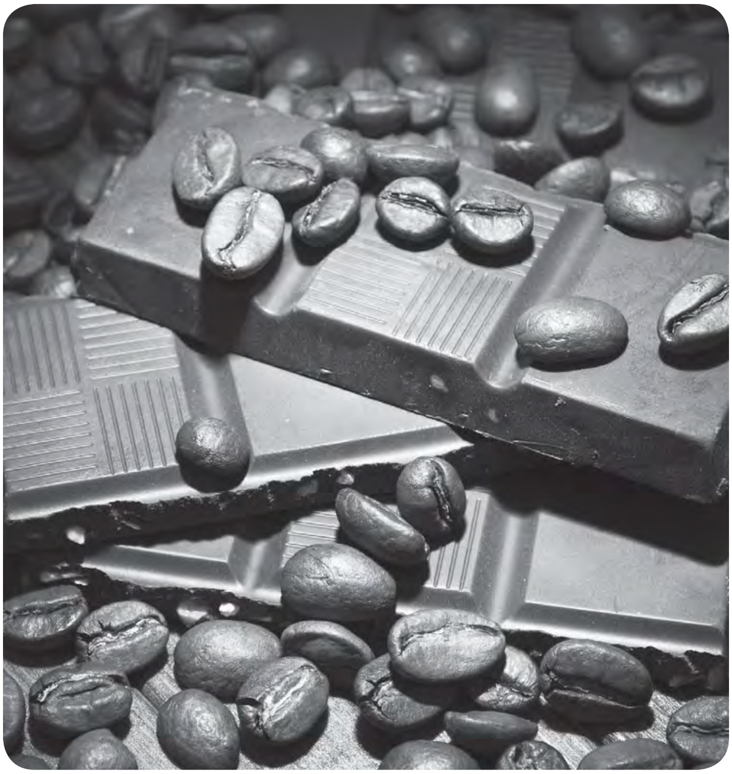

This lipid compound activates the same receptors in the brain (the cannabinoid receptors) as tetrahydrocannabinol, the principal active chemical in marijuana. Although anandamide at higher concentrations can produce a feeling of relaxation, the low levels present in chocolate likely have little or no effect on mood. A 130-pound (59 kg) person would have to eat 25 pounds (11 kg) of chocolate all at once to attain a feeling similar to marijuana-induced euphoria, according to Christian Felder at the US National Institute of Mental Health. However, chocolate also contains two inhibitors of cannabinoid breakdown, N-oleoylethanolamine and N-linolenoylethanolamine, that may enhance anandamide's modest effects in the brain.

Phenethylamine

Chocolate contains phenethylamine, a compound that causes the brain to release mood-elevating and pain-relieving endorphins. Moreover, phenethylamine triggers the release of dopamine, a neurotransmitter that stimulates creativity, sociability, and reward-seeking behavior. Phenethylamine is released in the brain when people fall in love or become infatuated, which could explain the addictive properties of chocolate. However, scientists think that most phenethylamine ingested orally is quickly metabolized, preventing significant concentrations from reaching the brain.

Magnesium

Magnesium is an essential mineral required for numerous biochemical reactions in the body. One of the many important functions of magnesium is vasodilation. Magnesium may also prevent or slow the progression of osteoporosis in postmenopausal women. Surprisingly, dark chocolate is one of the richest magnesium sources of any food. According to the USDA Nutrient Database for Standard Reference, a 40-g serving of 70% dark chocolate contains about 91.2 mg of magnesium, or 23% of the recommended daily allowance. Scientists have postulated that intense chocolate cravings may actually be a sign of magnesium deficiency.

Stearic triglycerides

Cocoa butter contains stearic acid, a saturated fat. Saturated fats have long been associated with a higher risk of atherosclerosis and heart disease, although recent studies have not validated that association. Stearic acid has been associated with lowered LDL-cholesterol and is considered neutral with respect to high-density lipoprotein-cholesterol. In fact, some evidence suggests that a diet rich in stearic acid actually lowers the risk of atherosclerosis by decreasing platelet activity.

These are just a few of the many compounds in chocolate thought to have beneficial health effects. Although a chocolate bar a day may not keep the doctor away, every year researchers discover new reasons to indulge (with moderation) in the Aztecs' "food of the gods." Yet in terms of health benefits, not all chocolates are created equal.

Because of its higher cocoa content, dark chocolate contains more health-promoting chemicals than either milk chocolate or white chocolate. It also contains less sugar and fat, thus providing more health benefits with fewer calories. The health benefits of any given chocolate depend not only on its cacao content, but also on its origin, as cacao beans from different origins may contain different amounts of phytochemicals. Moreover, cacao bean processing destroys some polyphenols, which prompted US candy maker Mars, Inc., to develop a proprietary method for processing cacao beans. The method, called Cocoapro, preserves polyphenols at each step in the chain of production, from cacao bean selection to chocolate formulation.

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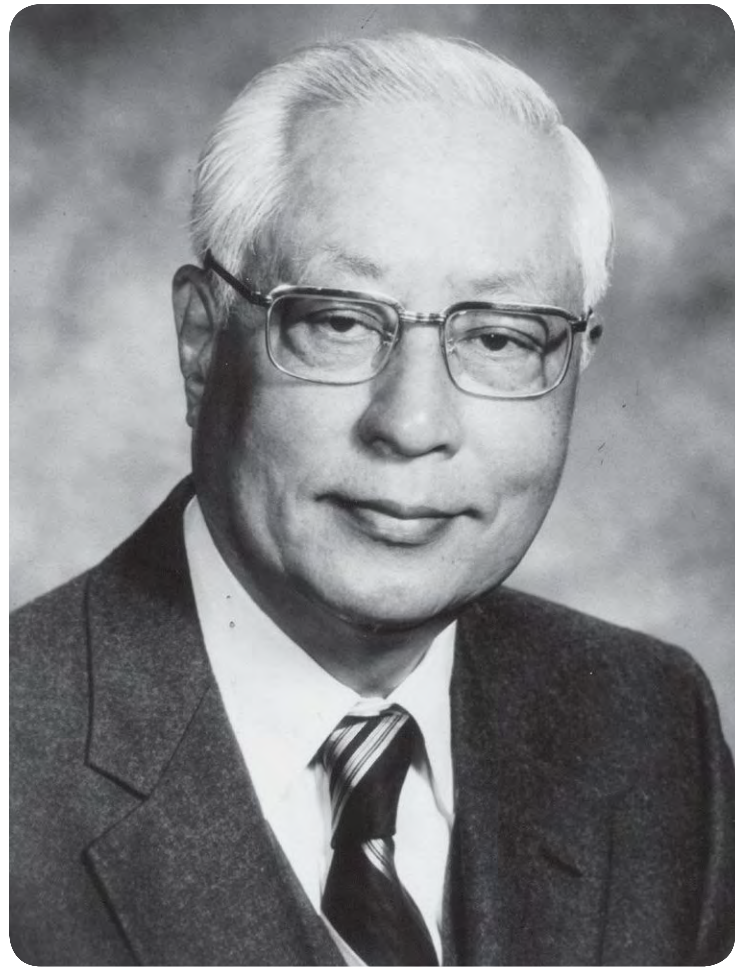
Giants of the past: Stephen S. Chang (1918–1996)

Gary R. List

Stephen S. Chang was born in China in 1918. He received his bachelor of science degree in 1941 from the National Jinan University of Shanghai, worked for six years at a factory that converted tung oil into automotive fuel, and came to the United States in 1947 for graduate studies. He received his master's degree in organic chemistry from the Kansas State University (KSU; Manhattan) in 1949 under the supervision of Fred Kummerow. Shortly thereafter, Kummerow left KSU for the University of Illinois (Urbana-Champaign), and Chang followed, receiving his doctorate in food science under Kummerow from the University of Illinois in 1952. Chang's doctoral work led to publications on the relationships of polymers to the flavor stability of soybean oil in the *Journal of the American Oil Chemists' Society (JAOCS)*.



After three years in a post-doctoral appointment at the University of Illinois, Chang joined the research group at Swift & Co. From 1957–1960, Chang conducted research at A.E. Staley Co. in Decatur, Illinois. Here his interest grew in using gas chromatography and infrared techniques to study flavor chemistry. Chang published the seminal study on compounds contributing to soybean oil flavor reversion.

On his voyage to the United States, Steve Chang met Lucy Ding, who also was traveling to the United States for graduate work. Chang was headed to the University of Wisconsin and Ding to the University of Missouri-Kansas City (UMKC). When Chang transferred to KSU after his major professor at Wisconsin retired, he and Ding began dating. They were married in 1952. Lucy, who had received her bachelor of science in chemistry in China, earned a DDS degree from the UMKC. However, Lucy never practiced dentistry. Instead, she served in the chemistry department of the University of Illinois and later joined the American Meat Institute Foundation. When Chang returned to academia, she devoted her time and energy to supporting his career.

An influen ial teacher

Chang's major interests were always research and teaching. Thus, in 1960, Chang took a position as associate professor in the food science department at Rutgers University in New Brunswick, New Jersey. When Rutgers' food science department was established in 1946, it was housed in one building and consisted of one professor (the chair) and two support staff. Department head Walter Mclinn chose "Food Science" as the department name to emphasize food-related basic science, research, and education. Moreover, he emphasized harmonious relationships among faculty, support staff, and students.

In 1948 the department moved to a remodeled building and a number of new faculty members joined the staff. The early research areas in the department included thermal process engineering and food packaging. Chang's task was to build a program around fats and oils chemistry and flavor chemistry. He began by recruiting promising young graduate students and seeking funding from the National Soybean Processors Association to study the flavor reversion phenomena.

A legacy of top scientists

His early graduate students included R.G. Krishnamurthy and Thomas Smouse, who were among the first AOCS honored students. After obtaining his Ph.D., "Krish," as he was known by his friends and colleagues, took a position at Kraft Foods, where he spent his entire career. He received the Alton E. Bailey (1992) Award, and he was inducted as an AOCS Fellow in 1999. He served two terms on the

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AOCS Governing Board. Krish not only was a top researcher but was also an accomplished author and contributor to three revisions of *Bailey's Industrial Oil and Fat Products.*

After finishing at Rutgers, Smouse took a position at Anderson, Clayton and Co.'s Foods Division to work with Robert R. Allen, who encouraged him to join and become active in AOCS. Smouse responded by volunteering to be the technical chair of an annual AOCS meeting, was elected to the AOCS Governing Board in 1978, and served as treasurer, vice president, and as AOCS president in 1983. In 1995, Smouse became ill, and he passed away in August that year. To honor his contributions to AOCS and the science of fats and oils, AOCS presented its Alton E. Bailey and Steven S. Chang Awards to Smouse posthumously in 1996. To further honor Smouse's memory, the AOCS Foundation and his family established the Thomas H. Smouse Memorial Fellowship Fund to aid promising graduate students working in the area of fats, oils, and lipids.

In 1974, Chi-Tang Ho joined Rutgers' food science department to become a colleague of Steve Chang. Ho, who is still active in research, has distinguished himself as a prolific author with over 600 technical publications and numerous books and chapters. He received the Stephen S. Chang Award for lipid/flavor science from the Institute of Food Technology (IFT) and is an IFT Fellow. He has been recognized as a Fellow in the American Chemical Society (ACS), a Fellow in the Agricultural and Food Chemistry Division (AGFD) of ACS, and he received the AGFD Achievement Award for Food and Agricultural Chemistry.

In 1972, Chang supervised the move of the food science department to a new facility, and by the late 1970s, he was promoted to department head and assumed increased administrative duties. With 18 faculty members conducting a diverse program in fats and oils, flavor chemistry, biochemistry, nutrition, and food engineering, Chi-Tang Ho assumed the supervision of much of the day-to-day research.

During the early 1970s, Michael Blumenthal and David Min began their studies under Chang's supervision. Blumenthal focused on deep-fat frying and went on to start his own company, Libra Technologies (Metuchen, New Jersey). A basic problem in frying is determining at what point frying oils should be discarded. Although a number of tests had been proposed (color, free fatty acids, smoke point, polar materials), the need for a rapid, simple test easily performed by fast-food restaurant staff existed. Based on his extensive research of the chemistry of frying, Blumenthal developed test kits for measuring oil deterioration and discard point. Blumenthal has the distinction of having been awarded both the IFT and AOCS Stephen Chang Awards in the same year—2001.

David Min (1942–2011) had a long and distinguished career at The Ohio State University (Columbus) as a professor of food science. Min maintained a long-term interest in the oxidation of soybean oil, particularly photo-oxidation and its mechanisms. He received many awards for his research, including the AOCS Alton E. Bailey Award (2007), and was elected an AOCS fellow in 2001. Min was active not only in AOCS but also in IFT. His IFT awards include the Chang (1995), the Harold Macy from the Minnesota section of IFT (2005), Fellow (2002) and Food Chemistry Division Lectureship. He was the author/editor of numerous books on lipid oxidation and flavor chemistry. Of particular note, the AOCS Press book *Food Lipids*, edited by C.C. Akoh and Min (2002,) is an excellent reference book and has served as a textbook for graduate courses in lipid chemistry.

Chang left a rich legacy of top scientists who entered the fats and oils profession. The Changs distributed an annual newsletter to keep former students and staff members aware of each others' accomplishments.

Contributions to fats and oils chemistry

Chang's career spanned 40 years, during which he published over 130 technical articles. He held 20 US patents dealing mainly with natural antioxidants from plant sources. Often, a professor's career is determined by where he or she can obtain grant money to solve a problem in industry. Although Chang's focus was primarily on flavor chemistry, fat oxidation, the chemistry of frying, and so on, he was able to solve more applied problems. He frequently stressed that research should be aimed at specific goals. An example is his work on the causes of color in commercial oleic acid.

Chang was heavily involved in both AOCS and IFT. His AOCS involvement included working as an associate editor and an abstractor for *JAOCS*. He served on numerous committees, was elected to the AOCS Governing Board in 1966, as secretary in 1968, as vice president in 1969, and as AOCS president in 1970. Chang's AOCS awards include the Alton E. Bailey Award (1974) and the AOCS/Supelco-Pelick Award in Lipid Chemistry (1979).

Although less involved with IFT governance, Chang was well known and respected as a researcher and was recognized in 1983 with IFT's highest honor, the Nicholas-Appert Award. In addition, he was elected an IFT Fellow and received the Bohr International Award for technology transfer to underdeveloped countries.

Humanitarian and philanthropic effo ts

His research accomplishments are well documented, but his humanitarian efforts are probably less familiar to the younger AOCS generation. In the early 1970s, Chang traveled to Taiwan as an advisor to the Republic of China. After visiting 14 refineries and three laboratories and presenting four major lectures, he prepared a list of 23 suggestions to improve the nation's edible oil processing. One of these suggestions was to form a research group at one of the major Taiwanese universities and recruit a US oil chemist with both technical and academic experience to oversee the group. This bore fruit, as the American Soybean Association established a Far East group under the leadership of Lars Weidermann, who was among Chang's former colleagues at Swift in the 1950s. Much of the expansion of soybean markets into China can be traced to Chang's visit.

One of Chang's goals was to promote basic research in order to ensure adequate supplies of nutritious, safe, and tasty foods to every person on earth. He asserted that, "Freedom from hunger is a basic human right; a hearty meal is one of the enduring pleasures of human life, and the selection of safe and nutritious foods is the foundation of good health."

Chang had two dozen consulting activities both in the United States and overseas. (See the guide to the Stephen S. Chang papers, Rutgers University Library, special collections.) Major consulting clients included The American Lecithin Co. and Lever Brothers.

Philanthropic efforts of the Changs included donations to build two campus buildings in Lucy's home town of Fuzhou, People's Republic of China, where her father had served as university president. They also established an award for graduate students in food science in Chang's name at his alma mater, Jinan University. The Chinese Institute of Food Science and Technology in Taiwan established the S.S.

CONTINUED ON PAGE 336

Diabetes: a gut reaction to a defect in fatty acid synthase?

Jim Dryden

Scientists at Washington University School of Medicine in St. Louis, Missouri, USA, have made a surprising discovery about the origin of diabetes. Their research suggests that problems controlling blood sugar—the hallmark of diabetes—may begin in the intestines.

The new study, in mice, may upend long-held theories about the causes of the disease. Because insulin is produced in the pancreas and sugar is stored in the liver, many scientists have looked to those organs for the underlying causes of diabetes. The findings were published in the journal *Cell Host & Microbe* [Wei, X., Z. Yang, F.E. Rey, V.K. Ridaura, N.O. Davidson, J.I. Gordon, and C.F. Semenkovich, Fatty acid synthase modulates intestinal barrier function through palmitoylation of Mucin2, doi:10.1016/j.chom.2011].

In the new research, scientists studied mice that are unable to make fatty acid synthase (FAS) in the intestine. FAS, an enzyme crucial for the production of lipids, is regulated by insulin, and people with diabetes have defects in FAS. Mice without the enzyme in the intestines develop chronic inflammation in the gut, a powerful predictor of diabetes.

"Diabetes may indeed start in your gut," says principal investigator Clay F. Semenkovich. "When people become resistant to insulin, as happens when they gain weight, FAS doesn't work properly, which causes inflammation that, in turn, can lead to diabetes."

First author Xiaochao Wei, and Semenkovich, the Herbert S. Gasser Professor of Medicine, professor of cell biology and physiology, and director of the Division of Endocrinology, Metabolism and Lipid Research, collaborated with specialists in gastroenterology and genome sciences to determine what happens in mice that can't make FAS in their intestines

"The first striking thing we saw was that the mice began losing weight," says Wei, a research instructor in medicine. "They had diarrhea and other gastrointestinal symptoms, and when we looked closely at the tissue in the gut, we found a lot of inflammation."

Initially, the researchers thought that the mice became sick because of changes to the mix of microbes that naturally live in the gut, where they help digest food and synthesize vitamins.

In collaboration with Jeffrey I. Gordon, director of the Center for Genome Sciences and Systems Biology at the School of Medicine, they looked more closely at gut microbes in the mice.

"The mice had substantial changes in their gut microbiome," Semenkovich says. "But it wasn't the composition of microbes in the gut that caused the problems."

Instead, Wei says, the mice got sick because of a defect in FAS. The mice without fatty FAS had lost the protective lining of mucus in the intestines that separates the microbes from direct exposure to cells. This allowed bacteria to penetrate otherwise healthy cells in the gut, making the mice sick.

In a further collaboration with Nicholas O. Davidson, director of the Division of Gastroenterology, the researchers found gastrointestinal effects resembling some features of inflammatory bowel disease. Other investigators studying humans with ulcerative colitis had previously made the unexplained observation that colon biopsies from these patients have low amounts of FAS.

"Fatty acid synthase is required to keep that mucosal layer intact," Wei says. "Without it, bad bacteria invade cells in the colon and the small intestine, creating inflammation, and that, in turn, contributes to insulin resistance and diabetes."

Inflammation and insulin resistance reinforce each other. Inflammatory substances can cause insulin resistance and inhibit the production of insulin, both of which interfere with the regulation of blood sugar. In turn, insulin resistance is known to promote inflammation.

Further study showed that the ability to build the thin, but important, layer of mucosal cells was hindered by faulty FAS.

That the gut is so important to the development of diabetes makes sense because many people with the condition not only have faulty FAS but also frequently develop gastrointestinal difficulties, Semenkovich says.

"Abdominal pain and diarrhea are some of the most common problems we see in people with diabetes," he says. "We could only connect these 'dots' because other experts at the university could help us link what we observed in these mice to what occurs in patients with diabetes and inflammatory bowel disease," Semenkovich says.

Semenkovich and Wei say much more study is needed, but they say that FAS and a key component of the intestinal mucosa called Muc2 may be potential targets for diabetes therapy. They now plan to study people with diabetes to see whether FAS is altered in a similar way, producing damage to the mucosal layer in the intestines.

Jim Dryden is associate director of broadcast services for medical public affairs at Washington University School of Medicine in St. Louis, Missouri, USA. He can be contacted at jdryden@wustl.edu.

The chemistry of cooking

Catherine Watkins

Just outside Boston, Massachusetts, USA, is a 2,500 square foot (about 230 square meters) test kitchen. There, more than three dozen cooks and product testers work to develop foolproof recipes. Results of the testing are available in two magazines, many cookbooks, and a television series—*America's Test Kitchen*.

Guy Crosby is a science adviser for *America's Test Kitchen* and an adjunct associate professor of nutrition at the Harvard School of Public Health. Recently, he led a webinar on the Top Five Chemistry Tips for the Kitchen as part of the American Chemical Society's Joy of Science: Food Chemistry Series.

A poll taken at the beginning of the webcast asked participants, "How important is the application of science to home cooking?" The results were: very important (55%), somewhat important (42%), not very important (2%), and not at all—cooking is an art (1%). Crosby clearly thinks science is very important to cooking, and he outlined why as he delivered five main tips.

PRESERVING FRESH PRODUCE

Most home cooks probably do not realize that preserving fresh produce illustrates Le Châtelier's Principle. (At its simplest, the principle states that any change in the status quo prompts an opposing reaction in the responding system.)

Test kitchen researchers found that simply blowing into a bag of salad greens (thereby increasing the CO_2 level) almost doubled the time the greens remained fresh, from five days to almost 10 days. Crosby was quick to say, "Don't do this at home," however, for sanitary reasons. The method worked, though, because increasing CO_2 drove down the rate of respiration.

Other ways of accomplishing the same end are to add "a little" baking soda or cream of tartar and water to a bag of greens. Baking soda and vinegar will also work, Crosby said. Don't forget to isolate the liquid from the greens in a small dish.

APPLICATIONS FOR BAKING SODA

Baking soda ($NaHCO_3$) is one of the few ingredients in a kitchen that is alkaline, with a pH of around 8. It can be used to break down pectin, the polysaccharide that holds cells together and strengthens cell walls.

Polenta (cornmeal mush) normally requires "lots of vigorous stirring" for 40–60 minutes. A pinch of baking soda in the cooking water eliminates the need for stirring and reduces cooking time to about 30 minutes. Another suggestion: Take small cubes of potato, put them in boiling water with a half-teaspoon of baking soda, remove the cubes after a few minutes, strain them, and "rough up the outsides." The baking soda breaks down the outer surfaces, making them fluffy. Put the cubes in the oven with a little oil and onion, and the potato will be "extra brown and crispy" because of the breakdown of the starch, said Crosby.

QUICKER WAY TO MAKE STOCK

Every cook knows that making stock the traditional way takes hours of simmering as the collagen in the tough meat cuts and bone used for stock slowly breaks down to gelatin. Adding store-bought gelatin directly to a broth will lead to the same "wonderful velvety-smooth viscous-textured mouthfeel" of traditionally made stock without the hours of cooking.

Another tip from the test kitchen: Do not use egg whites to hold crusts on beef tenderloin. Use gelatin instead, and the crust will stay on the meat. Crosby hypothesizes that the gelatin provides a stronger bond because it is a breakdown product of collagen and so has a certain "affinity" for the meat.

BEST WAY FOR STALING BREAD

Thinking about a "best way" to stale bread may seem trivial, Crosby said, but in some recipes, it makes a "big difference."

Many home cooks assume that letting bread go stale while sitting on the counter is perfectly fine. But an understanding of the chemical process of bread staling explains why counter-staling is not a good idea.

When moisture migrates from starch granules in the bread into the interstitial spaces, the starch is degelatinized, Crosby noted. As bread stales, the amylase and amylopectin molecules that formed crystallites through hydrogen bonding during the baking process incorporate the water into the crystalline structure. Thus, although the bread appears dry, the moisture has not actually left the bread; it just migrated into the crystallites.

So the next time a recipe calls for stale bread, do the right thing: Dry it in the oven. Or else your bread pudding will be gummy because of the excess moisture.

MAKING REALLY CHEWY BROWNIES

As AOCS members know, the crystal structure of fat plays a key role in the chewy texture of brownies and other baked treats. For best results, cooks need to force β-prime crystallization during baking by using the correct proportion of saturated to unsaturated triglycerides.

Crosby and his test chefs have found that a ratio of three parts unsaturated vegetable oil to one part saturated fat (butter or other source) will result in the proper texture. Reversing the proportion (three parts saturated to one part unsaturated) will produce tender brownies with a cake-like texture.

To listen to the webinar—which provided additional information on the Maillard reaction and caramelizing, among other science-related cooking tips—visit acswebinars.org/Crosby.

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

41 COOKING MISTAKES

Learn from the mistakes of others—or gloat over your superior knowledge—by checking out *Cooking Light* magazine's list of 41 cooking errors. Some are obvious: "You don't taste as you go," or "You don't read the entire recipe before you start cooking." Others are less obvious: "You overheat low-fat milk products," or "You overwork lower-fat dough." Find all 41 errors at tinyurl.com/41Mistakes.


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Super-high-density plantings such as this one in Lodi, California, USA, facilitate higher production per hectare and allow greater mechanization than has been used in the past. Photo by Richard Belcher. Courtesy, Corto Olive.

Super-high-density olive production: evolution or revolution?

The move to super-high-density olive orchards for olive oil production in the United States and elsewhere around the world is seen by some in the olive industry as a game changer and by others as a wrong move away from traditional olive tree culture. Horticulturist and olive industry leader Paul Miller reflects on recent developments in olive orchard design and shares his views on the implications of these developments for the future.

Paul Miller

Olive trees are planted throughout much of the world, and, as with other crops, the way olive orchards are set out reflects the local environment, farming traditions, and also changes in technology.

The distance between olive trees in cultivated conditions varies greatly. In orchards under dry-farmed desert conditions, such as in the southern Mediterranean, some olive trees are planted as far apart as 40 m by 40 m (about 6 trees/ha). In typical dry-farmed or semi-irrigated orchards in the northern Mediterranean, where most of the world's olive trees are planted, trees may be 8 m by 8 m (156 trees/ha). Under irrigated conditions, many orchards since the 1990s have been planted at spacings of 7 m by 4 m or 6 m by 5 m (330–360 trees/ha). In recent intensive developments, typical spacings are from 4 m by 2 m, often 4 m by 1.5 m, and as close as 3 m by 1.35 m (1,250 trees/ha, 1,667 trees/ha, or 2,470 trees/ha, respectively).

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TABLE 1. 2011 industry estimates of world olive tree areas and types of orchards

Category/tree density	Area planted (× 10^3 ha)			
	>10 yr old	4–10 yr old	<4 yr old	Total
Conventional: <200/ha	8,955	50	5	9,010
High-density: 200–600/ha	600	200	200	1,000
Super-high-density: >600/ha	5	15	10	30
Total	9,560	265	215	10,040

At conferences and during industry discussions, participants have developed terminology in an attempt to categorize different planting styles of olive orchards. The most common terms are "conventional," "high-density," and "super-high-density." It is difficult to obtain accurate data about how much of each category is planted in the world, but I have estimated the following indicative planted areas and tree ages of what we currently understand to represent each category based on published data and discussions with colleagues in several countries (Table 1). These data reflect the trend to higher planting densities in recent times as well as the persistent dominance of conventional olive orchards in the global olive industry.

The stark difference in tree numbers per hectare between conventional, high-density, and super-high-density reflects significant differences in the technology of the different styles of orchards. The newer, denser plantings are done in an attempt to facilitate higher production per hectare and greater mechanization than has been used in the past.

There has also been a tendency to treat the more recent categories of denser plantings as "systems" with defined technologies and processes of orchard culture—pruning, irrigation, fertilizer, varieties, and so on.

In my view, while the categorization and system-definition of new types of olive orchards may be convenient, it is misleading. From a horticultural point of view, there is a continuum of tree density from the most widely spaced to the most closely spaced. What is optimal for the tree may not be optimal for the current technology and for human access, so there are almost always compromises with regard to tree and row spacings. Technology changes rapidly. Olive varieties grow in different ways and to different tree sizes. In addition, each orchard has its own environment and soils, so suitable spacings for productive orchards will vary according to site.

All of this may seem obvious, but super-high-density in particular has become almost a brand for a system. This, in turn, creates a risk of not taking fresh points of view of how olive trees are being grown. It also leads to broad-based simplistic opinions: "Super-high-density is the only way of the future," "high-density cannot be effectively mechanized," "super-high-density won't last," "the oil is better quality from . . . system," and even the infamous "super-high-density should be globally outlawed." This last opinion was seriously discussed at an international meeting in Madrid early last decade.

Both the criticisms and the categorizations are illogical. Clearly, excellent olive oils are made from the production of every type of olive orchard, but problems can also occur with every type of olive orchard. Success and failure happen across the board. The trend to closer planting of trees has occurred in almost every other tree crop. In fact, olives lag well behind other crops such as apples and stone fruits in this regard. This trend for olive trees was an inevitable evolution.

That the trend to higher tree densities is "new" for olives means that the learning curve for producers using such plantings continues to be steep. It has become apparent that there is no simple system that applies everywhere.

Accordingly, farmers in many countries are re-evaluating techniques and styles of orchards. This step, combined with the pressure for greater efficiency, is leading to unprecedented innovation both with mechanization and with how olive trees are grown. In addition, as orchards that have been planted in new styles become older, there are some useful observations that relate to the experience with other tree crops.

Tree density, age, and competition

At densities of less than 2 m between trees, roots of neighboring trees compete with each other. This at least in part restricts the sizes of trees as they age. I have seen trees nearly 20 years old planted 1.35 m apart that are still easily manageable with regard to tree trunk size, and these trees seem tiny compared with counterparts of the same age planted at more conventional spacings. What we need to better understand is the effects of tree spacing and consequent competition for nutrients, water, and space in the soil. In particular, farmers need to know the spacings where these effects are optimal. If we plant olive trees closer than necessary, we are spending too much on trees. If the trees are too far apart, then the trees may grow stronger and bigger than we want.

Varieties

Few varieties are proven at the closer tree densities. To date, at the closest spacings only three or four varieties seem to function well. At what is called high density, many more varieties can be used. This is a significant limitation of the closest spacings and restricts the options for the resultant olive oils. There are breeding efforts to make new varieties for close spacings, but experience with other crops tells us that it is a long-term process to prove new varieties commercially.

Tree nutrition

The commercial desire for rapid tree-canopy development and also the need for fruiting early in the life of the olive trees can be at odds. Feeding for vegetative growth in the early years can restrict fruit production. Israeli research and farmer trials in other places are re-evaluating olive tree nutrition for modern irrigated orchards. There are few easy answers yet, but what is clear is that tree nutrition can have a major effect and that monitoring the nutritional status of olive trees is a good orchard practice.

Harvesting

The denser olive orchards lend themselves to mechanical harvesting and enable the adaptation of machines from other crops—coffee,

CONTINUED ON NEXT PAGE

grapes, and blueberries, for example. The densest plantings have the smallest trees, use the smallest machines, and so harvester development work is usually cheaper than for bigger machines on bigger trees. It is the case that advances in some of these smaller machines and their technology will be applicable to their larger counterparts.

The effective harvesting of trees at spacings that qualify as high-density or closer is driving a significant improvement in olive oil quality from these new orchards, because olives can be harvested faster than before, at their optimal quality, and transported quickly to the olive mills—the keys to producing extra virgin olive oil.

Pruning and trimming

I think that the most exciting recent development in olive orchards, which is being led by the denser plantings, is the mechanization of pruning and trimming of olive trees. Machines and practices are evolving quickly, particularly in new producer countries such as the United States and Australia. These range from tractor-mounted heavy-duty saws that can reduce tree size by major proportions in a single pass to cutters used to trim shoots (the latter can look like the working parts of home hedge-trimmers).

The effects on orchard efficiency of the changes in technology are dramatic. On traditional widely spaced olive trees, where hand-held saws and secateurs [small pruning shears] are used for pruning, it can take one person an hour or more to prune a tree. Using tractor-mounted machines on the densest plantings, one person can cover up to 1,000 trees per hour.

What is becoming apparent is the suitability of olive trees for mechanized approaches. Olive trees readily regrow shoots after they are cut back. The timing and severity of mechanized trimming and pruning alter the regrowth outcome, and this is becoming a management tool. What is also apparent is that we are just beginning to understand the effects and commercial implications of such practices.

Recent research on US farms has seen positive effects from trimming shoots on olive fruit set; a higher percentage of flowers become olives, and therefore there are more olives on the trimmed trees. This reaction appears to be a direct response to the removal of growing points. It is logical that the olive trees would have a natural hormonal response to such treatment, as vegetative growing points (the developing tips of shoots) are strong hormonal sinks that compete with reproductive growth for nutrients and energy. The removal of such growing points immediately changes the hormonal balance of trees. How this works has yet to be evaluated, but the effects of the degree of trimming offer numerous exciting possibilities.

The removal of the aerial parts of any tree slows its development. Pruning is a tree-dwarfing technique. As observed in the United States, the removal of parts of the tree canopy can also have direct effects on fruiting. That we can now do this effectively in densely planted olive tree orchards because the trees and machines are small enough to be economic is a breakthrough in olive tree culture. It seems likely that the management of tree size and the promotion of fruiting in these new ways will be become a highly effective management tool.

Research and tree size

It is usually easier and cheaper to evaluate new techniques on olive trees at close spacings than their larger, more widely spaced counterparts.

Olive trees at the closest spacings have fruiting canopies that are less than 2 m in height. From the ground, there is a limb-free zone of at least 0.5 m; then the canopy is developed above that to a height of 2–2.5 m from the ground. The trees may be restricted to less than 2 m in width, and the effective fruiting canopy may be 1.2 m wide.

By comparison, trees in typical, less intensive orchards reach heights of up to 6 m with fruiting canopies that can be 5 m tall and 3 or more meters wide.

The machines that may deal with the smallest trees at the closest spacings are naturally smaller than those for typical larger trees. Machines to deal with larger trees are usually more expensive to develop (even if they may be ultimately efficient) than those designed for small trees. As machines are made bigger, the engineering is usually harder, there is more steel, and development mistakes are more expensive.

Experiments at the closest tree spacings use less land than similar work at wider spacings, and smaller trees are easier to measure and to sample from.

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AOCS Press Book of the Month

Microscopic Analysis of Agricultural Products, 4th Edition

James Makowski, Neil Vary, Marjorie McCutcheon, and Pascal Veys, Editors
2011. Spiralbound. 204 pages. ISBN: 978-1-893997-71-4. Product code 226

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Recognizing the tremendous increase of interest in the area of agricultural microscopy, *Microscopic Analysis of Agricultural Products*, 4th Edition provides a more inclusive approach to the microscopy of agricultural products. The area of animal protein products and their detection in light of recent outbreaks of Bovine Spongiform Encephalopathy (BSE), or "Mad Cow Disease," as well as other Transmissible Spongiform Encephalopathies (TSEs), requires a much more detailed methodology for detecting the presence of animal protein products. We have included coverage of fertilizers and expanded the number of unusual feed ingredients. Agricultural microscopy is both an art and applied science that draws from many academic disciplines. Plant and animal anatomy, feed technology, and analytical chemistry are just a few that have contributed. This **full-color** manual is designed as a study guide for beginning microscopists and as a reference for the more experienced microscopists and others working toward common goals of agricultural product identification.

CONTENTS

- Methods of Agricultural Microscopy
- Feed Ingredients of Plant Origin
- Feed Ingredients of Animal Origin
- Feed Ingredients of Marine Origin
- Detecting Animal Products in Feeds and Feed Ingredients
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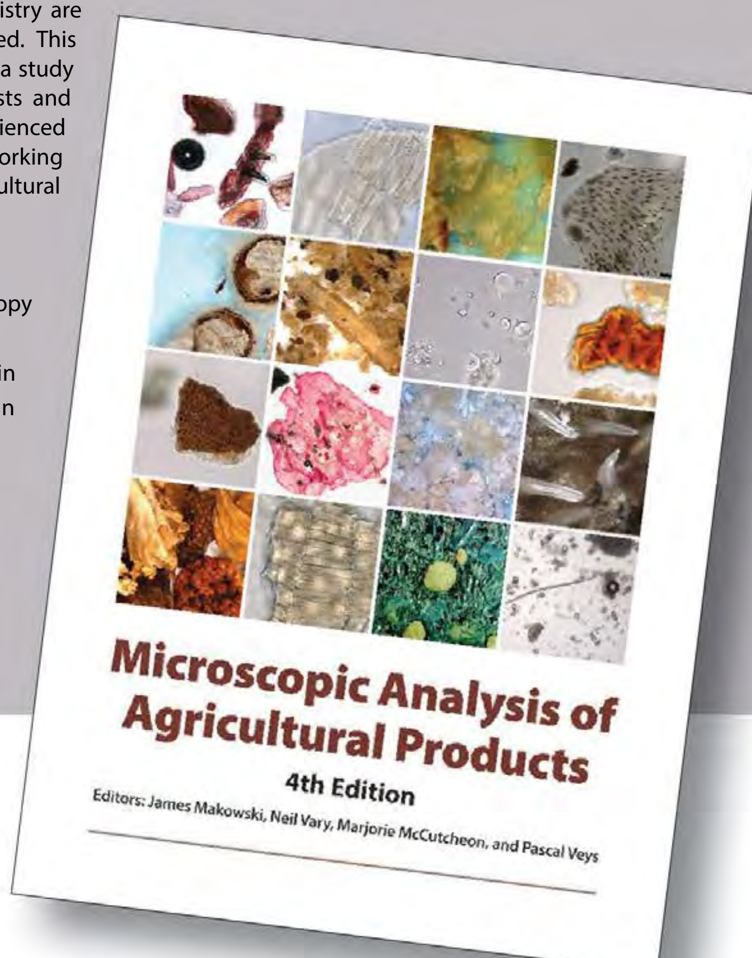

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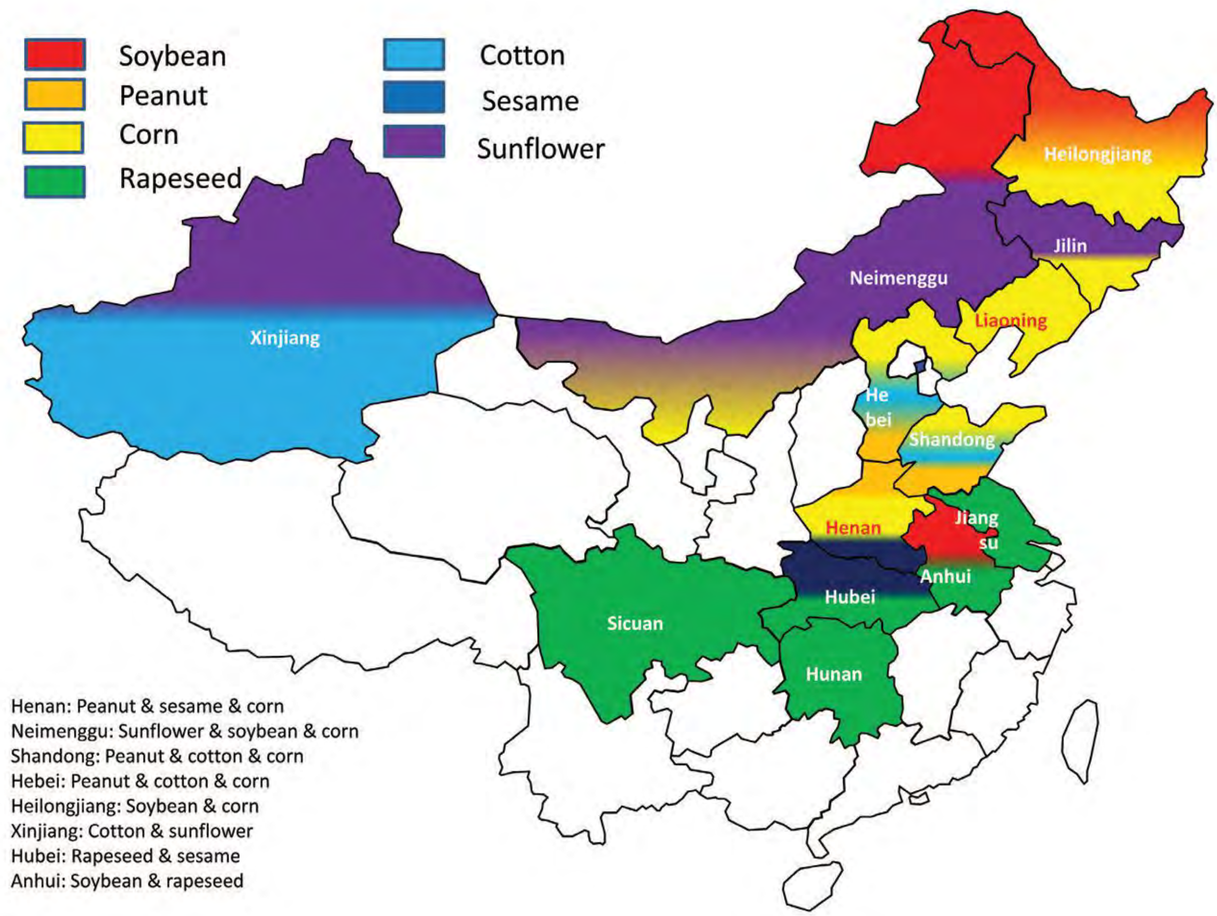

FIG. 1. *Distribution of oilseed production in China.*

Vegetable oils and fats in China: current and future trends

Not only is China a major oilseed-producing country, but it is also the largest vegetable oil-consuming country in the world. This article highlights the current situation and future trends in the Chinese vegetable oil market from both regulatory and industrial perspectives.

Ruiyuan Wang, Xuebing Xu, and Yuanrong Jiang

The most widely cultivated oilseeds in China include soybean, groundnut, rapeseed, cottonseed, sunflowerseed, and sesame. The distribution of oilseed production is illustrated in Figure 1, and production data for the top three oilseed-producing regions are presented in Table 1 (page 330). Total oilseed production for the country reached approximately 60 million metric tons (MMT) in 2009 and 2010 (Table 2 on page 330).

As the Chinese economy has grown, the growth rate for vegetable oil consumption has increased rapidly, averaging 5.22% per year during the past five years. The annual consumption of vegetable oil per capita currently is close to 18 kg (more for urban inhabitants). In 2011, the total consumption of vegetable oil in China reached 29.09 MMT.

A reliance on imported oilseeds

Not all of the oilseeds grown domestically are used for oil production. For example, although about 15 MMT of soybeans are produced each year (2005–2011), only a small portion goes to oil production

CONTINUED ON NEXT PAGE

TABLE 1. Oilseed production in top three regions[a]: 2010

Crop	Ranking 1	2	3
Soybean	Heilongjiang (5.85 MMT)	Neimenggu (1.33 MMT)	Anhui (1.20 MMT)
Peanut	Henan (4.28 MMT)	Shandong (3.39 MMT)	Hebei (1.29 MMT)
Corn	Heilongjiang (23.24 MMT)	Jilin (20.04 MMT)	Shandong (19.32 MMT)
Rapeseed	Hubei (2.32 MMT)	Sichuan (2.05 MMT)	Hunan (1.67 MMT)
Cotton	Xinjiang (2.48MMT)	Shandong (0.72 MMT)	Hebei (0.57 MMT)
Sesame	Henan (0.23 MMT)	Hubei (0.14 MMT)	Anhui (0.07 MMT)
Sunflowe	Neimenggu (0.99 MMT)	Xinjiang (0.44 MMT)	Jilin (0.29 MMT)

[a]Source: US Department of Agriculture. Abbreviation: MMT: million metric tons.

TABLE 2. Production (MMT) of main oilseeds in China[a]: 2005–2011

Year	Soybean	Groundnut	Rapeseed	Cotton-seed	Sunfl wer seed	Sesame	Others	Total
2005	16.35	14.34	13.05	9.60	1.93	0.63	1.37	57.27
2006	15.97	12.89	10.97	12.11	1.50	0.67	1.24	55.34
2007	13.40	13.03	10.57	12.60	1.25	0.56	1.22	52.63
2008	15.54	14.29	12.10	13.50	1.79	0.59	1.91	59.71
2009	14.98	14.71	13.66	12.54	1.96	0.62	1.49	59.96
2010	15.10	15.64	13.10	11.95	1.90	0.70	1.65	60.04
2011	13.50	16.20	12.50	13.13	2.00	—	—	—

[a]Source: US Department of Agriculture. Abbreviation: MMT, million metric tons.

TABLE 3. Production (MMT) of major vegetable oils in China[a]: 2009–2011

	Soybean oil[b]	Rapeseed oil	Peanut oil	Cottonseed oil
2009	8.73	5.17	2.19	1.47
2010	9.84	5.06	2.37	1.41
2011	10.76	4.95	2.54	1.48

[a]Source: US Department of Agriculture. Abbreviation: MMT, million metric tons.
[b]Soybean oil has two components: imported soybean oil, and the oil obtained by crushing beans that were imported or that were domestically produced.

(Table 3). This explains the discrepancy between oilseed production and oil output (compare Tables 2 and 3). As one can see in Table 3, soybean oil production in 2011 was 10.76 MMT. However, most of this was oil obtained by crushing imported soybeans. Only about 1 MMT was crushed from domestic soybeans.

The rapid growth of domestic demand in China and limited crush of domestic oilseeds have led to a current supply shortage and a heavy reliance on imported oilseeds. In 2010, China imported a net 20.88 MMT of edible vegetable oils and fats, almost double the amount it imported in 2005. Currently, China is the biggest importer of soybean oil (1.34 MMT of soybean oil and 54.79 MMT imported oilseed) and palm oil (5.69 MMT) (Table 4). In addition, the continual rise in oilseed imports has negatively impacted the amount of domestic acreage devoted to soybean cultivation. Overall, the total area planted with soybeans dropped from 9.127 million hectares (MHa) in 2008 to 8.5 MHa in 2011. Virtually all of the decline occurred in Heilongjiang province, the foremost soybean-producing area in China.

Major consumable oils and fats

Soybean oil, palm oil, rapeseed oil, and groundnut oil are the top four types of oil consumed in China. The consumption of these four varieties accounted for 91.1% of total domestic consumption. The specific amount consumed of each can be found in Table 5 (page 333).

Soybean oil. Historically, soybean has been the most important edible oil in China, accounting for nearly 40% of total vegetable oil

CONTINUED ON PAGE 333

TABLE 4. Main imports[a] of oil in 2005–2011 (MMT)

	2005	2006	2007	2008	2009	2010	2011 (Jan.–Sept.)
Rapeseed	0.296	0.740	0.830	1.138	3.284	1.600	0.673
Rapeseed oil	0.178	0.044	0.375	0.270	0.468	0.985	0.355
Soybean	26.590	28.270	30.800	35.610	42.546	54.797	37.705
Soybean oil	1.694	1.540	2.820	2.586	2.391	1.341	0.851
Palm oil	4.327	5.141	5.097	5.283	6.441	5.696	4.167
Palm kernel oil	0.232	0.291	0.377	0.341	0.511	0.478	0.256
Coconut oil	0.126	0.166	0.125	0.146	0.138	0.307	0.136

[a]Data obtained from Chinese Customs Statistics. Abbreviation: MMT, million metric tons.

TABLE 5. Vegetable oil consumption[a] (MMT) in China: 2005–2011

	Soybean oil	Rapeseed oil	Palm oil	Peanut oil	Sunfl wer seed oil	Others	Total
2005	7.61	4.54	4.97	2.26	0.39	1.74	21.51
2006	8.67	4.34	5.14	2.01	0.33	2.07	22.56
2007	9.69	4.14	5.22	2.02	0.13	2.14	23.34
2008	9.49	4.85	5.62	2.18	0.44	2.16	24.74
2009	10.44	5.64	5.93	2.23	0.49	2.19	26.91
2010	11.11	5.96	5.80	2.43	0.33	2.03	27.66
2011	12.06	5.69	6.19	2.56	0.48	2.11	29.09

[a]Source: US Department of Agriculture. Abbreviation: MMT, million metric tons.

consumption in the past seven years. Total consumption of soybean oil increased from 7.61 MMT in 2005 to 12.06 MMT in 2011, a jump of 158.5%. The majority of the soybean oil consumed in China was from imported soybeans. In contrast, only about 1 MMT of the soybean oil consumed was produced from locally cultivated soybeans.

Palm oil. Palm oil is China's largest vegetable oil import. The importation of palm oil increased dramatically following the 2006 termination of the tariff rate quota for vegetable oils in China. In 2011, China imported 6.30 MMT of palm oil, mainly from Malaysia and Indonesia (see Tables 6 and 7). The majority of palm oil (4.40 MMT) in China is used for catering and food production rather than household uses. Approximately 35% (2 MMT) of the imported palm oil in 2011 was used by the oleochemical industry to make products such as soap. In addition, products from the fractionation of palm oil have been widely used in China. Most of the palm oil fractionation plants are located in Guangdong, Jiangsu, Shandong, Tianjin, and other coastal cities.

Rapeseed oil. Rapeseed oil consumed in China comes largely from domestic production. Its production and consumption have remained steady for many years. The government has taken active measures to develop and expand more healthful rapeseed oil, such as low erucic acid and low glucosinolate varieties.

Groundnut oil. Production and consumption of groundnut oil have both risen gradually in recent years. In 2011, groundnut oil production was 2.54 MMT—almost half of the total global production. Aromatic roasted groundnut oil is the favorite groundnut oil in China owing to its rich flavor.

Comprehensive use and safety enhancement

Two major developments have been applied to improve domestic oil production. One is to maximize the use of current oil resources, such as corn germ oil and rice bran oil. In 2011, 0.87 MMT of corn germ oil and 0.21 MMT of rice bran oil were produced. Another is to develop uncommon oil resources, such as camellia oil, to reduce the land area needed to produce oilseeds and the reliance on imported oils (seeds).

The Chinese government has also increased its emphasis on food safety in recent years. This has had a big impact on the vegetable oil industries. To ensure the sanitation and safety of cooking oil, the sale of unpackaged oil has gradually been eliminated from the market. The use of packaged oil (18–22 liters) in catering (hotel, restaurant,

CONTINUED ON NEXT PAGE

TABLE 6. Imports of palm oil[a] (MMT): 2005–2011

	2005	2006	2007	2008	2009	2010	2011 (Jan.–Sept.)
Malaysia	2.9406	3.3693	3.6096	3.5581	3.9236	3.4338	2.7806
Indonesia	1.3807	1.6269	1.4013	1.6833	2.5052	2.2452	1.3745
Others	0.0056	0.1446	0.0864	0.0412	0.0127	0.0175	0.0115
Total	4.3269	5.1408	5.0973	5.2826	6.4415	5.6965	4.1666

[a]Data from Chinese Customs Statistics. Abbreviation: MMT, million metric tons.

TABLE 7. Types of imported palm oil[a] (MMT): 2005–2011

	2005	2006	2007	2008	2009	2010	2011 (Jan.–Sept.)
Crude palm oil	0.1042	0.6456	0.4334	0.5841	0.5904	0.2022	0.0631
Palm olein	2.6713	3.4858	3.9395	4.0361	4.5139	4.1087	3.2918
Palm stearinb	1.4924	0.8813	0.7078	0.6352	1.3273	1.3817	0.8113
Others	0.0590	0.1281	0.0166	0.0272	0.0099	0.0039	0.0003
Total	4.3269	5.1408	5.0973	5.2826	6.4415	5.6965	4.1666

[a]Data from Chinese Customs Statistics. Abbreviation: MMT, million metric tons.
[b]Melting point 44–56°C.

TABLE 8. Approved novel foods related to fats and oils

Novel foods	Year approved
Plant stanol ester	2008
Conjugated linoleic acid	2009
Conjugated linoleic acid glycerides	2009
Eucommia ulmoides Oliv. seed oil	2009
Tea camellia seed oil	2009
Fish oil (extract)	2009
Diacylglycerol oil	2009
Docosahexaenoic acid algal oil	2010
Plant sterol ester	2010
Plant sterol	2010
Arachidonic acid oil	2010
Poppy seed oil	2010
Elaeagnus mollis Diels oil	2011
Acer truncatum Bunge seed oil	2011
Peony seed oil	2011

or canteen) and, in part, in food production has therefore grown in recent years even as regulations have been tightened so that households are now purchasing packaged oils in containers of 5 liters or less.

Government and industry are also working to reduce unhealthful oil components. The national standard for nutritional labeling of prepackaged foods (GB 28050-2011) requires that "*trans* fatty acids" be indicated on the label when partially hydrogenated oil is used in a product. Because of Chinese dietary habits, the average daily consumption of *trans* fatty acids is only 1.06 grams, much smaller than the per capita consumption of *trans* fatty acids in western countries.

Moreover, transgenic seeds imported to China must be identified as genetically modified organisms (GMO) on the label. Legally, imported transgenic soybeans can only be used to produce oil and feed. All GMO feeds and GMO food products, such as oil, that go directly to the end consumer must be labeled as GMO. Other uses of genetically modified soybeans (e.g., tofu, miso) in products that would be consumed by humans are unauthorized.

In recent years, the Chinese government has taken steps to improve human nutrition by authorizing the use of novel foods. In most of the cases, "novel foods" mean foods that are not traditionally consumed in China. Table 8 lists 15 novel oil-related food components. More and more new cooking oils containing components such as phytosterol-enriched maize oil and fish oil-blend oil are beginning to appear on the market

Ruiyuan Wang is from the Chinese Cereals and Oils Association in Beijing, China. Xuebing Xu and Yuanrong Jiang are scientists at Wilmar Biotechnology R&D Center in Shanghai, China. *The authors thank Shuahua Xia, Zhang Yuquan, and Yu Jianguo for their assistance in collecting and organizing the data.* *Correspondence should be directed to Yuanrong Jiang, Wilmar (Shanghai) Biotechnology R&D Center, Gaodong Road 118, Pudong New District, 200137 Shanghai, China (jiangyuanrong@wilmar-intl.com).*


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GIANTS OF THE PAST (CONTINUED FROM PAGE 318)

Chang fund to encourage research in food science.

Shortly after Chang retired from Rutgers in 1988, the Changs endowed the AOCS Stephen S. Chang Award with a $100, 000 gift with the earnings to provide a generous honorarium and a beautiful jade horse symbolizing the award. It was first presented in 1991. His long association with IFT prompted the endowment of the Stephen S. Chang award for lipid/flavor science, which includes a generous honorarium and a beautiful Steuben crystal sculpture to commemorate the award. Several of Chang's former students have received the award, first given in 1993.

The Changs made a significant donation toward construction of a new AOCS headquarters building, completed in 1999, where the conference room/library was designated as the "Steven S. Chang Room."

Cook College, the land grant unit of Rutgers, is home to the food science department that Chang headed for many years. The Changs made a major donation to construction of a new library for the Cook College campus, which is known as the Steve and Lucy Chang Science Library. It opened in 1995.

During his later years, Chang's health failed, and he passed away in December 1996. True to form, Lucy Chang asked that memorials be made to the Stephen and Lucy Chang Science Library that they endowed.

Gary List, the 2012 Stephen S. Chang Award winner, is currently working as a consultant after retiring from the US Department of Agriculture, Agricultural Research Service, National Center for Agricultural Utilization Research, in Peoria, Illinois, USA. There, he made numerous contributions to the field of edible oils, including the preparation of margarine and shortening, the detection of trans fatty acids, and the development of alternative methods to produce fats and oils with desirable properties that lack trans fatty acids. In 2011, List received AOCS' highest service award, the A. Richard Baldwin Award, as well as an honorary doctor of science degree from the University of Illinois. He can be contacted at grlist@telestar-online.net.

SUPER-HIGH-DENSITY OLIVE PRODUCTION

(CONTINUED FROM PAGE 326)

As a consequence, we are seeing a greater degree of innovation and experimentation on the orchards with the smallest olive trees. What is being tested on the closest spacings will, however, have ramifications and generate useful knowledge for many other situations. Already the mechanized pruning of such super-high-density plantings is being adopted with greater confidence on larger trees using larger machines.

In conclusion, the evolution of olive orchards to denser tree plantings of smaller trees is just that—a logical evolution. The revolution may be in what is being learned from closer-spaced trees, because innovation and research are cheaper in these situations.

Paul Miller is president of the Australian Olive Association and a founding member of the AOCS Olive Oil Expert Panel. He can be contacted at president@australianolives.com.au.

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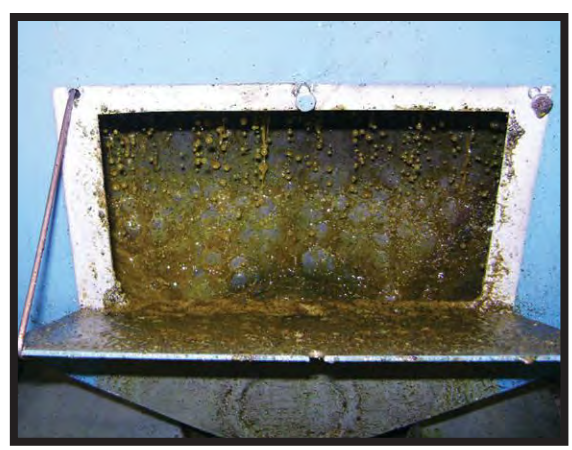

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