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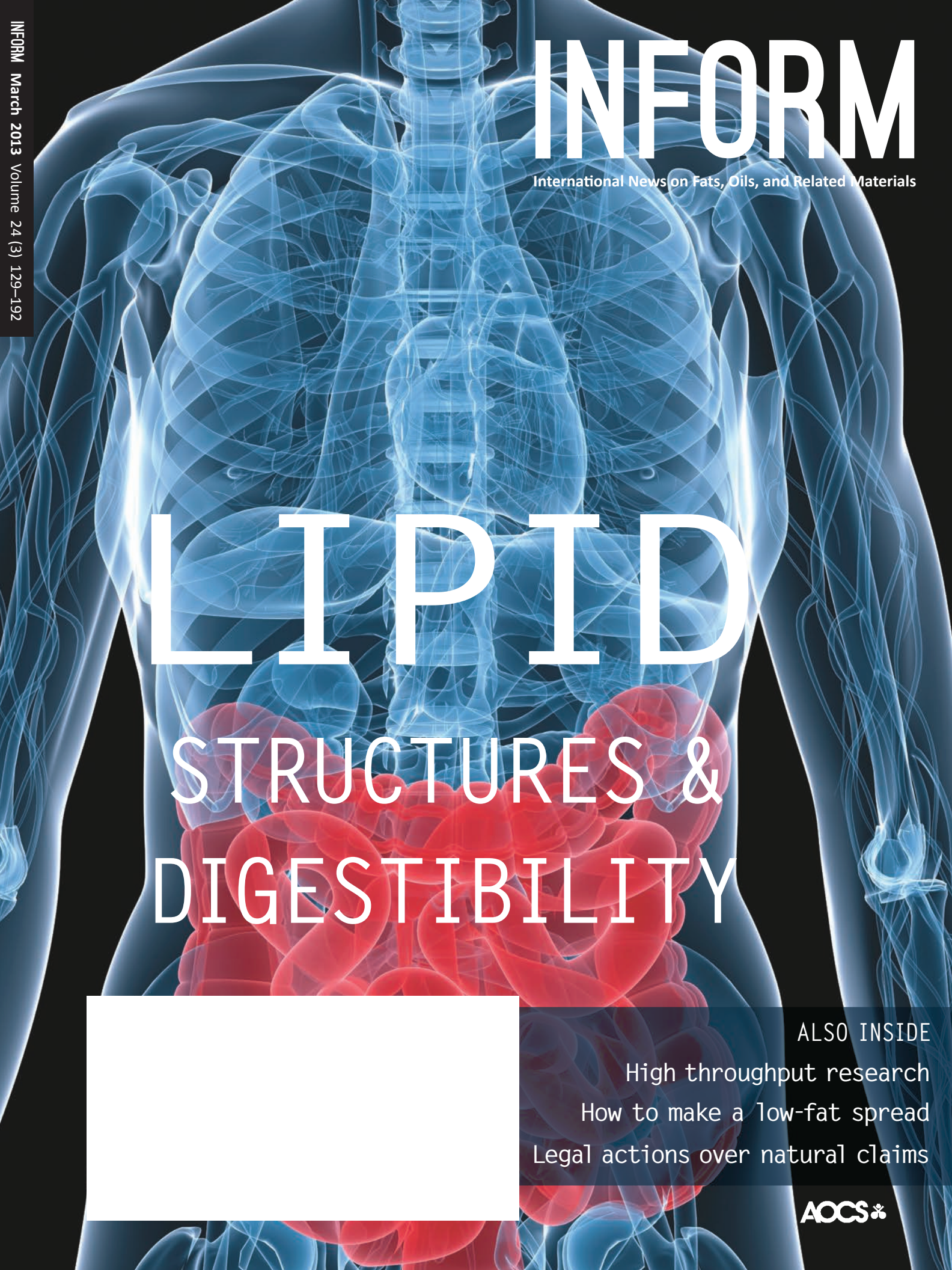

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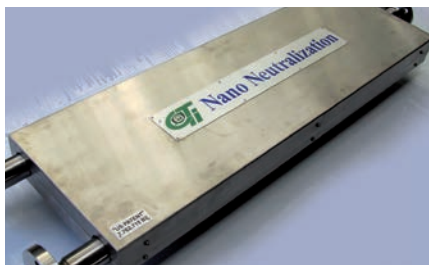

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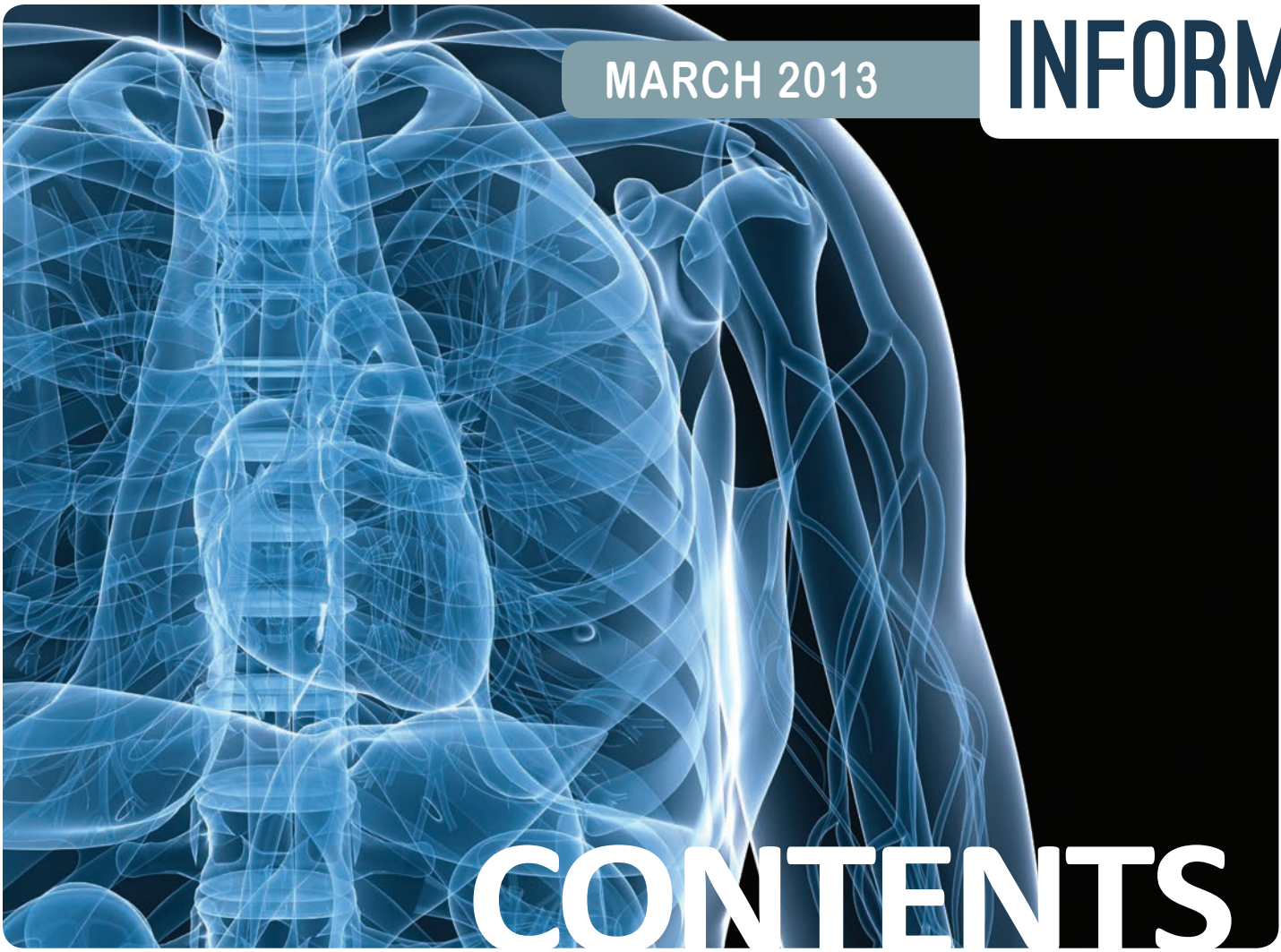

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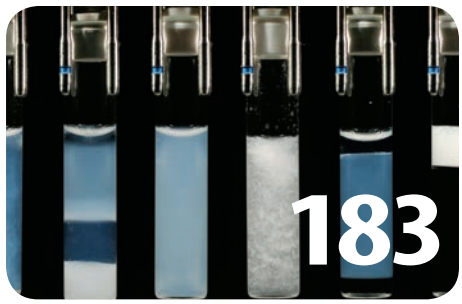

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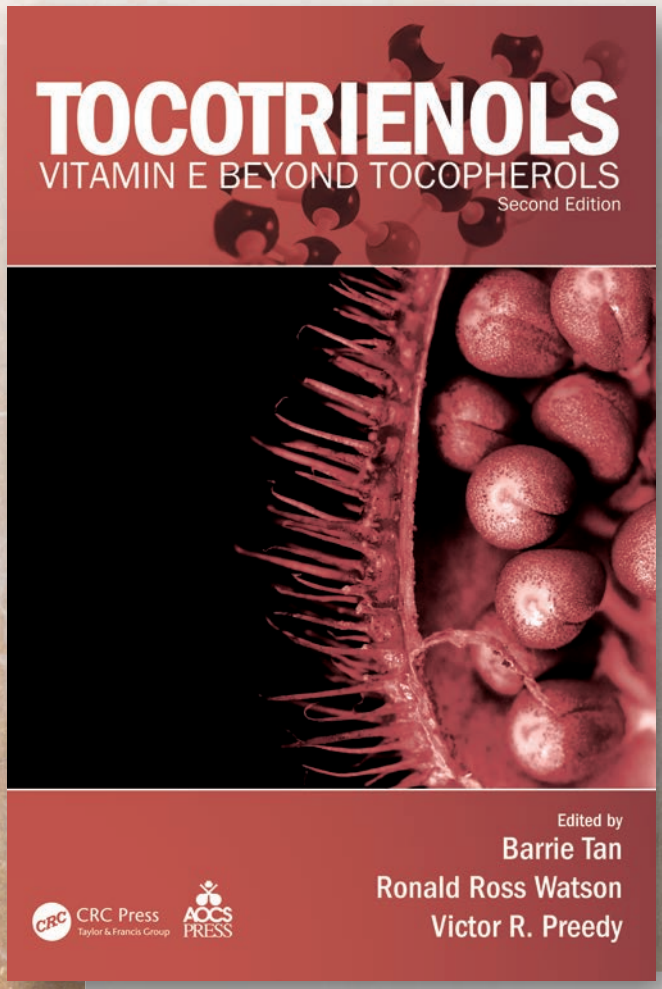

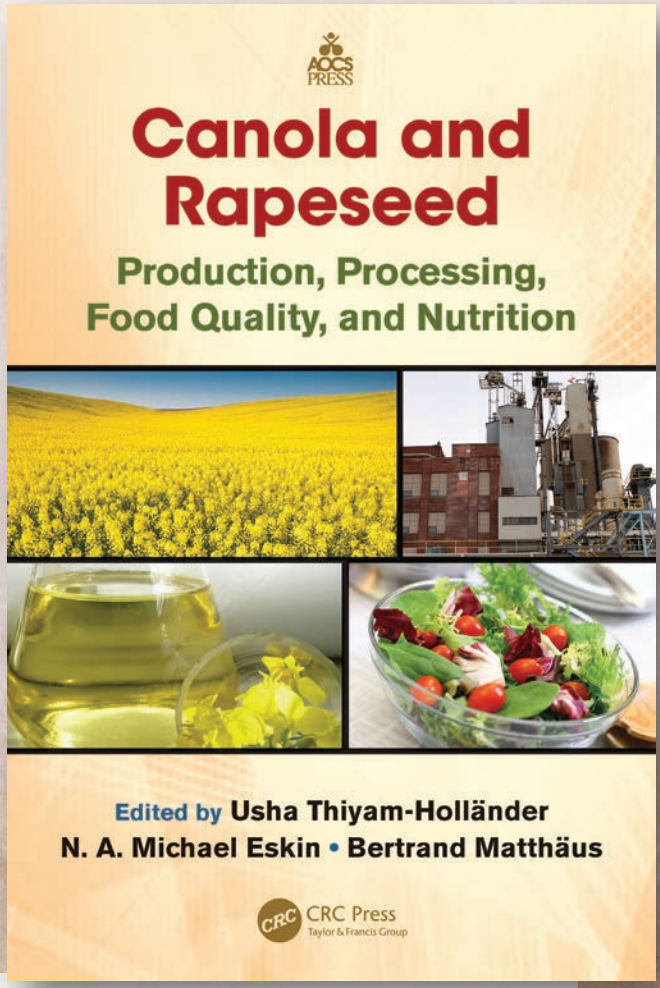

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Tocotrienols have been found to reduce cholesterol, suppress tumors, and protect the heart from oxidative stress. This edition features all new chapters written by experts in the field and addresses animal and *in vitro* studies as well as mechanistic and pre-clinical studies. Topics include tocotrienols, and their mechanisms of action; inflammation and antioxidant actions; the role of tocotrienols in the treatment and prevention of cancer and in cardiovascular health; diabetes and other hormone regulation; and neuroprotection by tocotrienols.

Search 265

With a focus on current health issues, this book presents information on the chemistry of minor constituents of canola and rapeseed. It includes research on bioactive compounds and identifies new areas of interest for industrial application of functional foods and nutraceuticals. Chapters present historical perspectives; modifying composition of oil; ways to increase crop yield; value-added processing; canola protein; and biodiesel quality. The text also covers several health aspects including heart health; obesity and insulin resistance; antioxidant behavior; and the effects of canola on the oxidation of edible oils.

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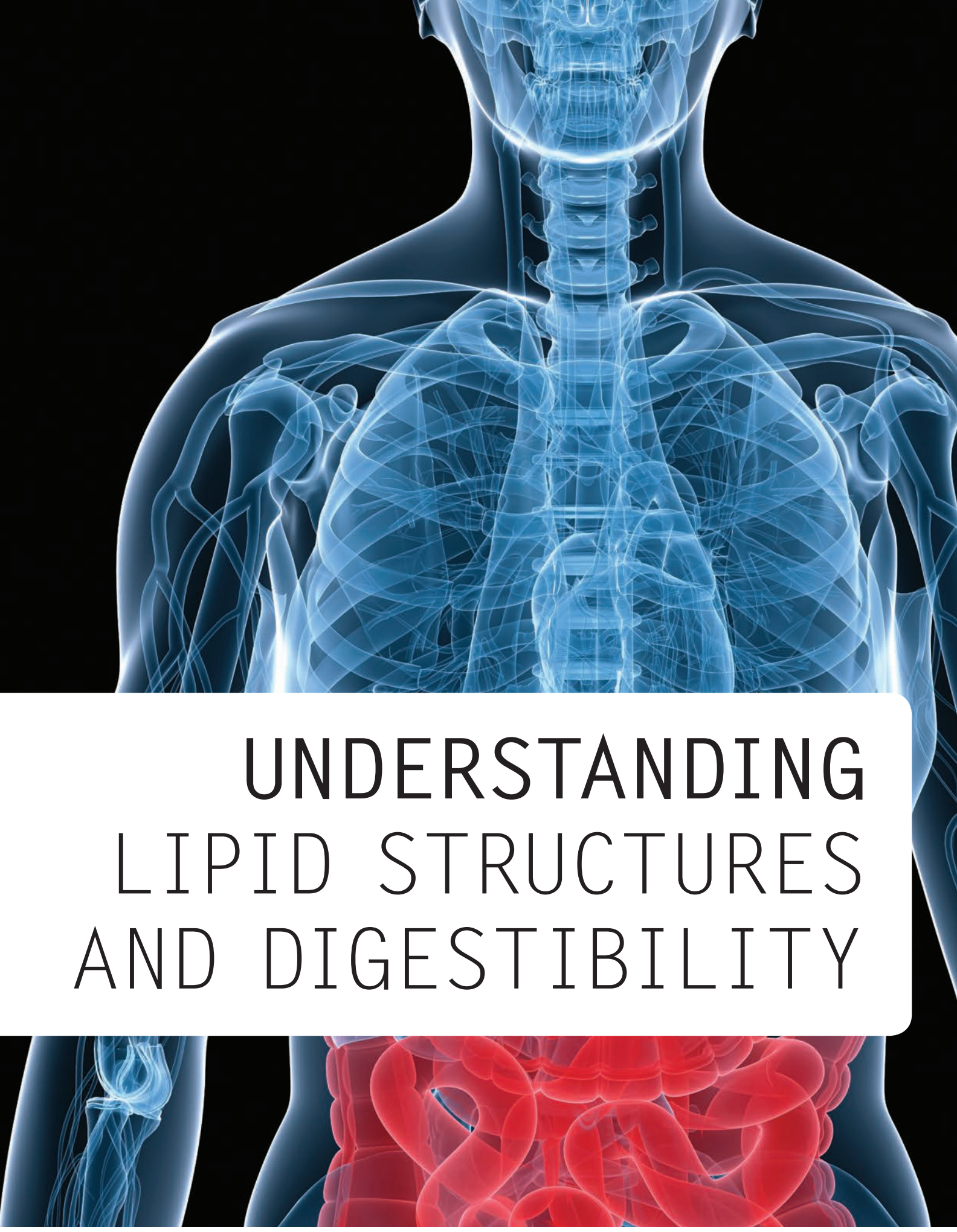

UNDERSTANDING LIPID STRUCTURES AND DIGESTIBILITY

Harjinder Singh and Sophie Gallier

Dietary lipids provide 20–40% of the total calories in the average Western diet. The lipids we eat act as carriers of fat-soluble vitamins (vitamins A, D, E, and K) and supply us with essential fatty acids, such as linoleic and α-linolenic acids, not synthesized in our bodies. They are also critical in energy storage, the structure of cell membranes, and cell signaling. However, overconsumption within a population can lead to serious health problems, such as obesity, atherosclerosis, and other food-linked diseases.

- **The key steps in lipid digestion and absorption are well known.**
- **However, these two processes can be affected by other factors, such as the physical transformation of food matrices in the mouth during mastication and the physical properties of an emulsion.**
- **The following article considers the lipids in two natural foods (milk and nuts) and how these systems are modified as they traverse the gastrointestinal tract.**

The lipids in nonprocessed foods (e.g., meat, dairy, nuts) occur in complex structures in which triacylglycerol (TAG) particles are coated with a solubilizing layer or multilayer of membrane phospholipids and proteins. In processed foods, oils or fats are extracted from animal or plant materials and then incorporated within the food matrix in the form of emulsions (such as yogurt, cheese, spreads, imitation creams, salad dressings, gravies, sauces, ice creams, confectionery products, and chocolate). A range of emulsifiers, such as phospholipids, proteins, monoacylglycerols (MAG), diacylglycerols (DAG), and polysaccharides, are commonly used. Emulsified lipids play a major role in determining the texture, flavor, and taste profile of processed foods.

KEY STEPS IN LIPID DIGESTION AND ABSORPTION

Ingested lipids, in the form of mixed TAG from meats, dairy products, vegetable oils, nuts, or structured emulsions, are digested by lipases in the lumen of the gastrointestinal tract into absorbable fatty acids and MAG. Because lipases are water soluble and TAG are not, the lipolysis occurs at the oil–water interface. Therefore, lipid must be in an emulsified state to allow the binding of lipases to the interface and consequently efficient lipolysis to take place. Five to 40% of TAG are hydrolyzed by gastric lipase in the stomach, a further 7.5 % in the duodenum, while pancreatic lipase hydrolyzes up to 70% of TAG in the intestines. Gastric lipase is more active on fatty acids on the *sn*-3 position of the TAG backbone and hydrolyzes all fatty acids with a preference for short-chain (SCFA) and medium-chain fatty acids (MCFA). Pancreatic lipase is *sn*-1 and *sn*-3 specific; as a result, one TAG will be hydrolyzed into two free fatty acids (FFA) and one 2-MAG. Pancreatic lipase is more active on MCFA than on long-chain fatty acids (LCFA). SCFA and MCFA are rapidly hydrolyzed, absorbed, and metabolized in the body. Colipase forms a stoichiometric complex with pancreatic lipase, allowing the latter to anchor firmly to the substrate (hydrophobic lipid core) at the oil-water interface. Bile salts, at low concentrations, promote pancreatic lipase activity mainly by allowing the adsorption of lipase to the oil-water interface, while at high concentrations the bile salts generally compete with lipases for the oil-water interface, retarding lipase activity.

In the final step of lipid digestion, the lipolytic products (FFA and 2-MAG) are solubilized in the lumen of the intestine into bile salt micelles and unilamellar phospholipid vesicles. These particles deliver the lipolytic products to the aqueous-enterocyte membrane interface where they are subsequently absorbed either by passive diffusion through the bilayer of the enterocyte plasma membrane or by active transport involving specific proteins in the enterocyte brush border.

As stated earlier, lipids in foods are often located in natural cellular matrices or within complex assemblies produced during processing. Breaking down the surrounding structures and releasing the lipid droplets from the cells, seed bodies, or wherever else they are stored will have a profound effect on lipid digestibility. The physical transformation of food matrices in the mouth during mastication (i.e., particle size reduction and oil droplet release) also plays a role in the digestion of lipids.

CONTINUED ON NEXT PAGE

Digestion vocabulary

- **Bile salt:** a salt of bile acid and a base. It functions as an emulsifier of lipids and fatty acids.
- **Brush border:** a layer of tightly packed minute finger-like protuberances on cells that line absorptive surfaces, such as those of the intestine and kidney.
- **Chylomicron:** a class of lipoproteins that transport exogenous (dietary) cholesterol and triglycerides after meals from the small intestine to tissues for degradation to chylomicron remnants.
- **Colipase:** a protein co-enzyme required for optimal enzyme activity of pancreatic lipase. It is secreted by the pancreas in an inactive form, procolipase, which is activated in the intestinal lumen by trypsin. Its function is to prevent the inhibitory effect of bile salts on the lipase-catalyzed intraduodenal hydrolysis of dietary long-chain triacylglycerols.
- **Domain:** a part of protein that can fold, function and exist independently of the rest of the protein chain or structure. Protein domains vary in length. Some can consist of about 25 amino acids while others may be up to 500 amino acids in length.
- **Duodenum:** the first part of the small intestine, immediately beyond the stomach.
- **Emulsifying agent:** a substance that stabilizes an emulsion.
- **Enterocyte:** intestinal absorptive cells. They are simple columnar epithelial cells found in the small intestines and colon.
- **Glycocalyx:** the glycoprotein-polysaccharide covering that surrounds many cells.
- **Lumen:** a cavity or passage in a tubular organ, for example, the lumen of the intestine.
- **Pepsin:** the chief digestive enzyme in the stomach. It breaks down proteins into polypeptides.
- **Plasma membrane:** microscopic membrane of lipids and proteins that forms the external boundary of the cytoplasm of a cell or encloses a vacuole, and that regulates the passage of molecules in and out of the cytoplasm.
- **Portal vein:** the (hepatic portal) vein leading from the internal organs, especially the small intestine, to the liver. Its main purpose is to carry blood that contains digested food such as glucose, from the small intestine to the liver, where some of the food is deposited and stored.

Recent research shows that the properties (such as the droplet size) and structures of an emulsion (as in processed foods) may have an impact on the release of fatty acids at the point of utilization in the human body. In this article, we discuss aspects of lipids in two natural foods (milk and nuts) and how these systems are modified as they traverse the gastrointestinal tract. Greater knowledge and understanding of how the digestive system treats, transports, and utilizes lipids will allow the design of foods to achieve a specific physiological response.

MILK AND NUTS

Milk and nuts are two major sources of dietary lipids. The lipids in these systems occur naturally in a complex emulsified state (Gallier *et al.*, 2012a); in both cases, the TAG core is surrounded by a membrane (Fig. 1), protecting TAG from the endogenous lipases.

However, there are major differences in composition and structure. In milk, nearly all of the lipids (>95%) exist in the form of globules ranging from 0.1 to 15 mm in diameter. Each globule is surrounded by a thin membrane, 8–10 nm thick, usually called milk fat globule membrane (MFGM). The MFGM acts as a natural emulsifying agent, enabling the lipid to remain dispersed throughout the aqueous phase of milk. MFGM is composed of a complex trilayer of phospholipids along with proteins and cholesterol. Some MFGM proteins are glycosylated and, with the MFGM glycolipids, form the glycocalyx on the outer layer of the MFGM. In nuts, the lipids are embedded in "oil bodies." These oil bodies range between 0.5 and 3 μm in diameter and are contained within a 5 nm-thick oil body membrane. The entire structure is surrounded by a monolayer of phospholipids with specific structural proteins, the oleosins and caleosins (Beisson *et al.*, 2001). These proteins have three domains, one anchored in the TAG core of the oil body, one penetrating the phospholipid monolayer, and one covering entirely the phospholipid monolayer.

Because of the differences in their interfacial compositions, size, and structures, it is likely that the rates and extents of lipid digestion from oil bodies would differ from those of milk fat globules. The interface can assist or prevent gastrointestinal lipases from accessing the TAG core, and the interfacial components can be more or less easily displaced by bile salts in the small intestine. Resistance of the interfacial components to displacement by bile salts may slow down lipolysis by pancreatic lipase.

Recently, we studied the *in vitro* digestion of almond and walnut oil bodies dispersed in an aqueous suspension (Gallier and Singh, 2012) and milk fat globules in bovine milk (Gallier *et al.*, 2012b). The milk fat globules were stable in the gastric environment whereas the oil bodies aggregated, which may affect the rate at which food leaves the stomach. In simulated intestinal conditions, lipolytic products accumulated at the

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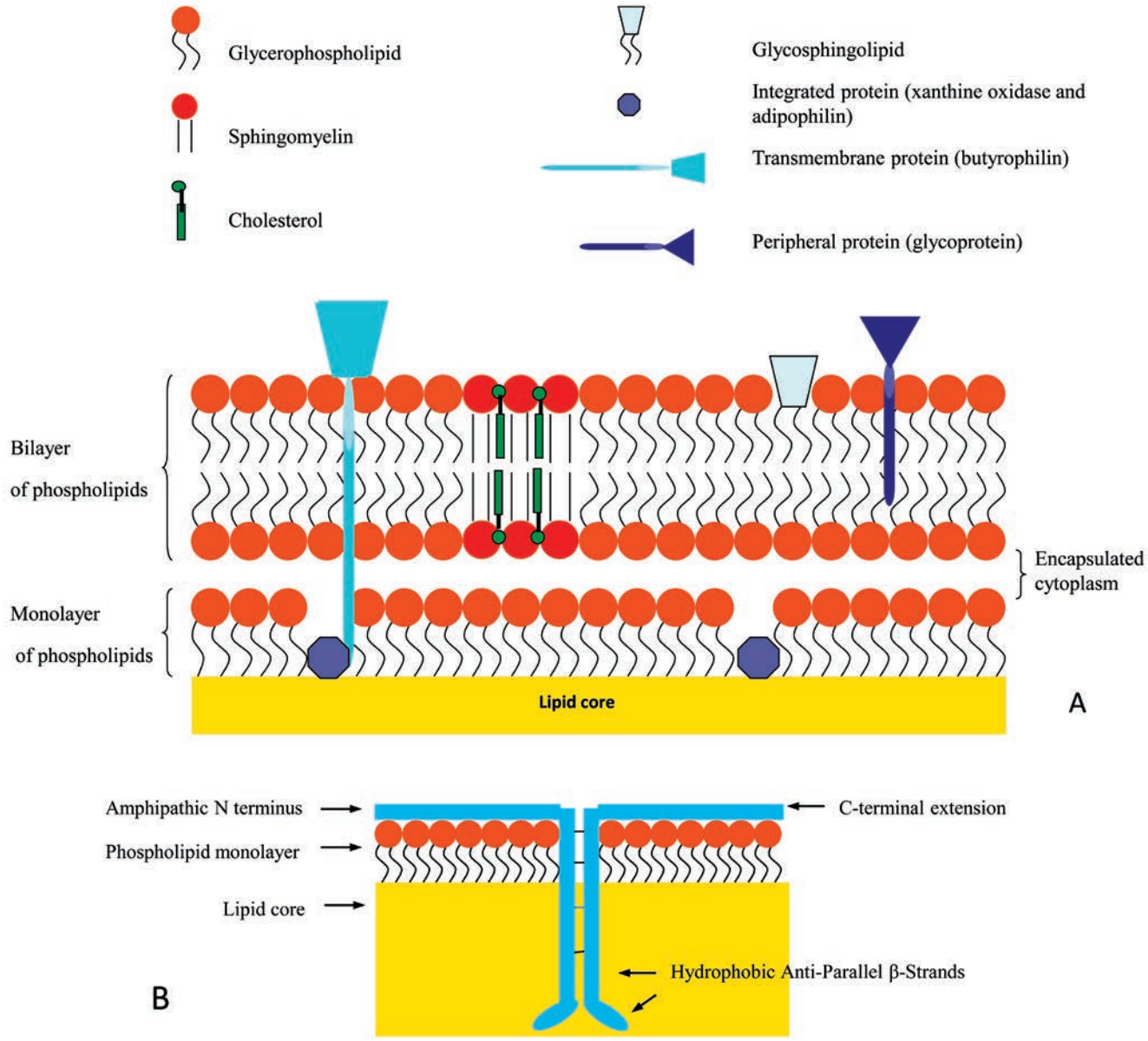

FIG. 1. Schematic representation of the trilayer structure of the milk fat globule membrane (A) and the surface layer of an oil body (B). Not to scale. Sources: (A) Gallier (2012); (B) adapted from Huang (1994).

INFORMATION

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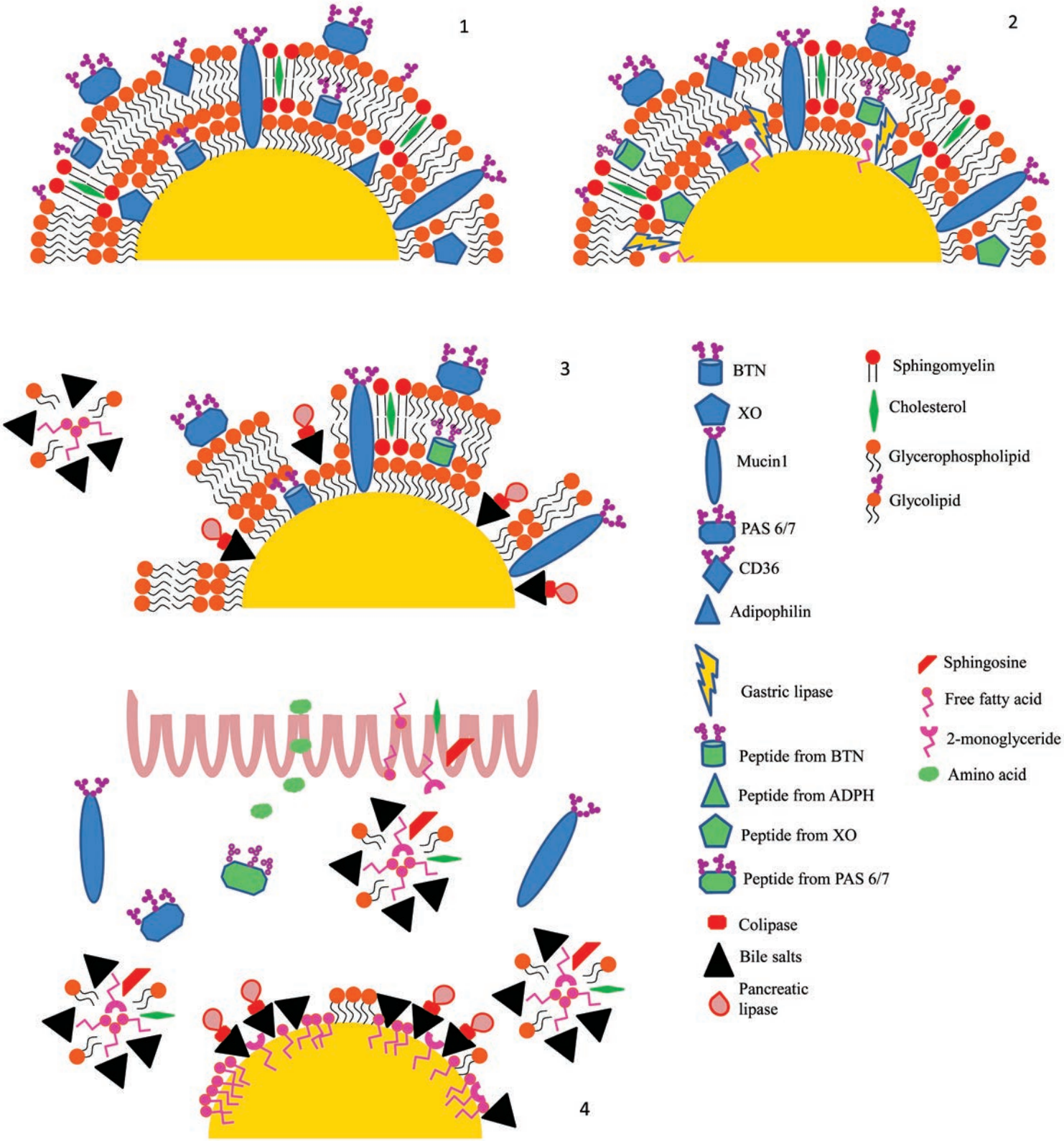

FIG. 2. Schematic illustration (not to scale) of the changes taking place at the interface of the bovine milk fat globule (MFG) during gastric and intestinal digestion. (1) Native MFG membrane structure; (2) MFG in the gastric environment; (3) the MFG reaches the duodenum; (4) MFG in the intestinal environment. Abbreviations: BTN, butyrophilin; XO, xanthine oxidase; PAS 6/7, periodic acid Schiff 6/7; CD36, cluster of differentiation 36; APDH: adipophilin. Adapted from Gallier et al. (2012b).

surfaces of the milk fat globules and oil bodies, forming a liquid-crystalline phase. These products were more noticeable at the surface of the milk fat globules (a figure illustrating this point can be found in the digital edition of this issue of *inform*. Log in to read the January 2013 issue at aocs.org/login). Multilamellar and unilamellar vesicles, transporting the lipolytic products, are formed from the liquid-crystalline phase and, in contact with an excess of bile salts, form smaller mixed micelles (Rigler *et al.*, 1986). Surprisingly, a water-in-oil-in-water emulsion formed spontaneously during the *in vitro* intestinal digestion of walnut oil bodies (a figure illustrating this point can be found in the digital edition of this issue of *inform*. Log in to read the January 2013 issue at aocs.org/login), likely due to the release of omega-9 oleic, omega-6 linoleic, and omega-3 α-linolenic acids in the form of FFA and MAG. The water-oil and oil-water interfaces were stabilized by crystalline structures, possibly composed of bile salts and lipolytic products.

In a recent publication, we proposed a model of digestion of bovine milk fat globules (Fig. 2).

Some MFGM proteins are hydrolyzed in the stomach by pepsin, and the gastric lipase is able to penetrate the MFGM but has no activity on phospholipids. Thus, despite the hydrolysis of some MFGM proteins, MFGM keeps its integrity in the stomach and stabilizes the milk fat globules. FFA from gastric lipolysis accumulate at the interface, inhibit further gastric lipolysis, and emulsify the fat globules. Once the globules reach the duodenum, the FFA are solubilized into vesicles and mixed micelles for their transport across the intestinal wall, and bile salts displace the MFGM proteins and interact with the MFGM phospholipids. Colipase adsorbs onto the bile salt-rich interfacial area, and the pancreatic lipase binds to the colipase. As the intestinal lipolysis by pancreatic lipase proceeds, the lipolytic products accumulate at the interface of the milk fat globules forming a liquid-crystalline phase. The lipolytic products are either solubilized into phospholipid vesicles or mixed bile salt micelles or precipitated as calcium-fatty acid soaps. The lipolytic products in vesicles and micelles are absorbed by enterocytes whereas calcium-fatty acid soaps are excreted in the feces. Trypsin and chymotrypsin hydrolyze the gastroresistant MFGM proteins and peptides into amino acids to be absorbed through the intestinal wall. Milk lipids contain a third of SCFA and a third of MCFA, mostly located at the *sn*-3 position, whereas almond lipids are composed of 92% LCFA. This indicates that milk lipids may be readily hydrolyzed and absorbed unlike almond lipids, which will be slowly hydrolyzed and possibly precipitated into insoluble calcium-fatty acid soaps.

Even though nuts and seeds are high in fat, clinical studies have reported little to no weight gain when they are introduced in the diet. This is mainly due to their satiety properties leading to less daily energy intake. Furthermore,

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not all ingested nut lipids are digested, as nut cell walls reduce lipid bioaccessibility and thus bioavailability. Indeed, cell walls that are not fully broken down by the chewing mechanism in the mouth as well in the stomach and prevent access of gastric and pancreatic lipases to nut lipids. The consumption of nuts, with their high amounts of monounsaturated fatty acids as well as polyunsaturated fatty acids, phytosterols and antioxidants, has been associated with a reduction of the risk of coronary heart disease, some cancers, and type 2 diabetes; an improvement in the conditions of metabolic syndrome; and a favorable plasma lipid profile. Indeed, phytosterols displace cholesterol from mixed micelles, reducing its absorption. Moreover, the body cannot absorb phytosterols. The combined consumption of nuts and bovine milk could help reduce the absorption of milk cholesterol. The rapid absorption of SCFA and MCFA by the portal vein is an advantage for milk lipids over nut lipids as it means that the former will in part be oxidized; a smaller part will be esterified in chylomicrons. The consumption of saturated fatty acids is linked to health issues. However, stearic acid, an important fatty acid of milk, has a lower absorption due to its high melting point.

Food scientists may choose to refer to the structure of "natural" lipids as models for creating new structured food emulsions for efficient nutrient delivery and reduced lipid absorption.

Harjinder Singh is the co-director of the Riddet Institute, Palmerston North, New Zealand. His current research program involves understanding the structures, interactions, and functions of food proteins and food emulsions and optimization of encapsulation, protection, and delivery of bioactive compounds in foods and food formulations.

Sophie Gallier is a postdoctoral fellow at the Riddet Institute. Her current research focuses on the* in vitro *and* in vivo *gastrointestinal digestion of naturally occurring food emulsions and the interfacial engineering of food emulsions.

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What's in a Claim?

Would a food not labeled "natural" taste as sweet?

Cathy Burgess and Scott Elder

- **US government agencies have not established clear requirements for the claim that a food or beverage is "natural."**
- **Meanwhile, consumers are becoming increasingly more educated about the ingredients contained in their foods and beverages, and there has been an increase in consumer fraud class actions aimed at food and beverage companies over natural claims.**
- **Conservative labeling is the best way to avoid such actions, and understanding the latest legal developments in this area is the best way to prepare for such actions should they occur.**

REGULATIONS AND LEGAL LIABILITY

With apologies to Shakespeare, what's in a claim? Specifically, what does a claim that a food or beverage is "natural" mean? Consumers purchase foods labeled as "natural" for a variety of reasons, assuming, for example, that these foods are less processed, have improved health benefits, or have less impact on the environment. But does a "natural" product provide all of those benefits, and what do manufacturers who use that label intend to communicate?

US federal government agencies responsible for regulation of food labeling have not established clear requirements for use of this claim, giving food manufacturers some flexibility in their use of natural food labels. Perhaps as a result of that flexibility, consumers have challenged natural claims as misleading in a number of recent lawsuits. This article describes the regulatory landscape, recent litigation, and how food producers can minimize their potential liability.

REGULATORY FRAMEWORK

The US Food and Drug Administration (FDA) is responsible for federal regulation of labeling for most food products. (The US Department of Agriculture (USDA) regulates certain egg products, meat, and poultry.) FDA is charged with ensuring that food labels are not false or misleading but has acknowledged the difficulty of defining a food as natural because most foods have been at least minimally processed.

Historically, FDA has not objected to use of a natural claim for foods that do not contain added color, artificial flavors, or synthetic substances. Seeking a more specific definition of "natural," FDA solicited comments on that term in its 1991 Notice of Proposed Rulemaking (NPR) for the Nutrition Labeling and Education Act (NLEA). In 1993, after reviewing public comments, FDA announced that it intended to maintain its policy allowing a natural label claim for products containing no artificial ingredients because the issue was too complex for resolution given FDA's limited resources and other priorities. Since that time, FDA has typically relied on its 1993 guidance in dealing with natural claims.

FDA rarely acts against companies for improper use of "natural" and has issued only a few warning letters related to natural claims. On March 11, 2011, Shemshad Food Products, Inc. (Shemshad; Los Angeles, California) received a warning letter from FDA in which the agency stated that Shemshad's Lime Juice Natural product was misbranded owing to a misleading label. FDA observed that the ingredient statement listed a synthetic chemical preservative, sodium benzoate 1%, and stated that the term "natural" is truthful and nonmisleading on a label

only when nothing artificial or synthetic has been included. Likewise, on November 16, 2011, FDA issued a warning letter to Alexia Foods, Inc. (Alexia; Eagle, Idaho) after reviewing the labels for Alexia's Roasted Red Potatoes & Baby Portabella Mushrooms products. Similar to the Shemshad warning letter, FDA stated that the declaration of disodium dihydrogen pyrophosphate, a synthetic chemical preservative, caused any natural claim on the food label to be false and misleading.

These warning letters appear to be isolated cases, and FDA has expressly and continually declined to define "natural" in any regulatory or formal policy statement. This ambiguity has prompted some groups, such as The Sugar Association, to petition FDA to define the term. FDA has not responded meaningfully to these petitions, and it is unlikely the agency will address the issue in the near future.

USDA also has been reluctant to define "natural" and has adopted a policy similar to that of FDA, prohibiting the use of a natural label for any product containing an ingredient identified as artificial by FDA. In addition, USDA prohibits a natural label for meat and poultry that is "more than minimally processed." In 2006, USDA solicited public comments in an attempt to establish a more detailed definition of "natural." USDA received over 12,000 comments regarding an appropriate definition. The agency still has not issued a regulation and, given the controversy reflected in the public comments, USDA is likely to proceed with caution in developing a definition of "natural."

The Federal Trade Commission (FTC) is charged with protecting consumers from deceptive practices and may take regulatory action for false or misleading advertising claims such as deceptive food labeling. However, FTC has decided not to address the "natural" label issue, recognizing that consumers have inconsistent perceptions of natural and that both FDA and USDA have declined to define the term. The agency has provided general guidance stating that a marketer's natural claim must capable of being substantiated to a "reasonable" consumer. This reasonableness standard is flexible and FTC defers to FDA and USDA for enforcement actions.

LITIGATION AND EMERGING TRENDS

In recent years, numerous consumer fraud class actions have been filed based on natural food and beverage claims. These lawsuits often allege that using the term "natural" is deceptive when a product contains ingredients such as high fructose corn syrup or soy that are made from natural ingredients but are alleged to be processed and therefore not natural according to

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Consumers are becoming increasingly more educated about the ingredients contained in their foods and beverages.

the plaintiff-consumer. Many of these suits are filed under plaintiff-friendly state law consumer fraud and protection acts, such as those in California and New Jersey.

In 2009, for example, plaintiffs brought suit against Snapple (Plano, Texas) under California's Unfair Competition Law, alleging that the natural label on Snapple's drink products was "deceptive, misleading, and untrue advertising" because the beverages contained high fructose corn syrup, an allegedly nonnatural ingredient. However, the judge ruled in Snapple's favor by finding that the plaintiffs suffered no injury and granted a motion for summary judgment.

Unlike in the Snapple suit, plaintiffs are now alleging injury because they would not have purchased the product had they known it was not "all-natural," and this strategy has been more successful in court. In a November 2012 decision, in a case based on a similar allegation that high fructose corn syrup is not natural, a US federal judge in California certified a class action filed against AriZona Beverage Co. (Cincinnati, Ohio). The court held that plaintiffs presented enough evidence to confer standing to seek declaratory and injunctive relief, although it refused to allow plaintiffs' claims for monetary damages or for restitution and disgorgement.

Most of these lawsuits that allege that certain foods contain non-naturally occurring substances have been either settled or dismissed at the class certification stage. However, suits filed more recently— such as those against General Mills' Nature Valley products (high fructose corn syrup), Dreyer's Grand Ice Cream (potassium carbonate in alkalization process), ConAgra's Wesson oils (genetically modified crops), and Ben & Jerry's ice cream products (alkalized cocoa)— are still pending.

In another example of these types of claims, plaintiffs filed a class action against Frito-Lay (Dallas, Texas) in 2012 under Florida's Unfair and Deceptive Practices Trade Act, alleging that the company's bean dip contained substances "known to be derived" from genetically modified organisms (GMO). Therefore, according to the plaintiffs, the bean dip's "all-natural" label was "likely to mislead the public." This case and others are undergoing consolidation into a multidistrict litigation, which is pending before the court.

The use of GMO ingredients is becoming increasingly contentious as evidenced by California's Proposition 37 (Prop. 37) ballot initiative. The ballot initiative would have mandated disclosure of GMO ingredients in food and only allowed the use of a natural label in very limited circumstances. Although it failed to pass, Prop. 37 demonstrates that use of GMO ingredients and natural claims is clearly on the public's mind.

RISK MITIGATION

As a result of ambiguous regulations and permissive consumer protection statutes in many jurisdictions, the only risk mitigation measure that is sure to prevent a consumer class action is conservative labeling. Thus, if a manufacturer wants to include a natural label, it should avoid ingredients such as high fructose corn syrup, which consumers have alleged are processed and therefore not natural. This avoidance has the added benefit of ensuring compliance with admittedly ambiguous FDA regulations.

If food manufacturers were to be sued for a natural label claim, they could mount several defenses. At the pleading stage, courts have dismissed class action lawsuits based on the failure of plaintiffs to file a complaint with "enough facts to state a claim for relief that is plausible on its face" or for a lack of specificity in the complaint, as a federal judge did with part of ConAgra's Wesson oils suit. In that suit, the plaintiff did not adequately describe how ConAgra allegedly misled consumers.

Manufacturers could also argue that consumer fraud claims made under state law are expressly preempted by federal law under NLEA. The main drawback of this defense is that FDA does not provide a legal definition of "natural," so state law that purports to regulate all-natural labels may not be expressly preempted. However, companies have had success dismissing suits using the primary jurisdiction doctrine, in which courts can conclude that the preliminary decision-making authority remains with the relevant agency, such as FDA, rather than the courts. Also, certain states, such as California, have safe harbor exceptions to consumer protection laws that may apply if the conduct is permitted by federal statutes or regulations.

Given the recent increase in consumer fraud class actions aimed at food and beverage companies, manufacturers must remain vigilant about the labeling of their products and keep up to date on the latest legal developments in this arena. Consumers are becoming increasingly more educated about the ingredients contained in their foods and beverages, and heightened consumer awareness may prompt future FDA and USDA regulations on what constitutes an all-natural product as well as continued debate about this issue in the courts.

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REGULATORY OVERVIEW

The end of 2012 and beginning of 2013 was a busy time for US regulators and standard-setters as two regulations and one consensus standard made the news. One regulation—long overdue—is final, the second regulation—also long overdue—was proposed, and the consensus standard is in the beginning stages of development. All three have implications for oilseed processing and edible oil refining.

FINAL EPA BOILER MACT RULE RELEASED

On December 20, 2012, the US Environmental Protection Agency (EPA) released final clean air standards for large industrial boilers and solid waste incinerators. The soonest the MACT (Maximum Achievable Control Technology) rules can take effect is 2016.

EPA said that of the 1.5 million boilers in the United States, less than 1% (about 2,300) will need to meet numerical emission limits under the new rules. Approximately 13% (about 197,000) will need to follow work-practice standards such as conducting annual tune-ups. The remaining 86% are "clean and not covered by these rules," the agency noted in its overview of the final regulation.

Industry sources report after reviewing the final rules that those processors who burn natural gas in their boilers will be less affected than those who use other types of fuels such as oil or biomass. The greatest effect is expected to be the ongoing reporting burden.

The US Department of Energy, through its regional Clean Energy Application Centers, will provide site-specific technical and cost information to those facilities that are currently burning coal or oil in their boilers. Likewise, the US Department of Agriculture will work with facilities with boilers that burn biomass to provide information about work-practice standards and how to conduct an energy audit, EPA said.

The effort to regulate boiler emissions began in 2004. A federal appeals court struck down EPA's original standard in 2007. After reissuing the regulation in 2011, industry groups called the emission limits "unachievable." EPA retooled the standards after consulting with industry.

An EPA analysis found that the emission reductions from the new rule will prevent up to 8,100 premature deaths; 5,100 heart attacks; and 52,000 asthma attacks per year. That analysis also found that industry will have to spend between $1.3 billion and $1.5 billion annually to meet the standards.

W. Randall Rawson, president and CEO of the American Boiler Manufacturers Association (ABMA) in Vienna, Virginia, commented on the new MACT rules in a written statement. He said:

"The over 100 small-business, domestic manufacturer, and supplier members of ABMA have been ready and able since December 2011 to assist boiler users in developing innovative and affordable boiler-room-specific solutions to Industrial Boiler MACT challenges with myriad types of

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BRIEFS

Berg + Schmidt and Sternchemie are building a deoiling plant for the production of soybean lecithin in Singapore, which they say is the first such facility in Southeast Asia. Both companies are owned by Volkmar Wywiol, an international seller of lecithin products based in Hamburg, Germany. The capacity of the first construction phase will be 4,000 metric tons per year. The plant is due to come online in the second quarter of 2013. The Singapore facility will have separate production lines for lecithins from both genetically modified (GM) and non-GM soybeans in powder and granulated forms.

■■■

Pacific Coast Canola is constructing its first canola crushing plant in Warden, Washington. With an initial capacity of 1,100 metric tons (MT) of canola per day, the Warden facility will produce expeller-pressed canola oil and canola meal.

The plant has a design output capacity of 142,500 MT of canola oil and 227,000 MT of canola meal per year. Pacific Coast Canola is 85% owned by Legumex Walker and 15% by Glencore Grain Investment LLC.

■■■

Cavitation Technologies, Inc. (CTI; Chatsworth, California, USA) announced in January 2013 that Italy's Desmet Ballestra Group, CTI's strategic partner since 2010 and the licensee of the company's vegetable oil refining technology, has entered into a sales agreement with a refinery in Ecuador. The purchased system is capable of processing 350 metric tons of soybean oil daily, CTA said in a statement.

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Cargill "plans to buy a pair of livestock feed mills from Pennfield Corp., which had filed for bankruptcy protection" during the third quarter of 2012, according to the *Minneapolis-St. Paul Business Journal*. Cargill, which is based in Wayzata, Minnesota, USA, reportedly will pay $8.5 million for two of the three mills owned by Pennfield, the *Central Penn Business Journal* reported. Pennfield is based in Lancaster, Pennsylvania, USA. ■

OSHA and combustible dust

Applicable requirements of the US Occupational Safety and Health Administration (OSHA) include:

- §1910.22 Housekeeping
- §1910.307 Hazardous Locations
- §1910.1200 Hazard Communication
- §1910.269 Electric Power Generation, Transmission and Distribution (coal handling)
- §1910.272 Grain Handling Facilities
- General Duty Clause, Section 5(a)(1) of the Occupational Safety and Health Act (Employers must keep workplaces free from recognized hazards likely to cause death or serious physical harm.)

For the complete OSHA fact sheet on combustible dust, visit http://tinyurl.com/OSHA-Dust. OSHA's Hazard Communication Guidance for Combustible Dusts is available at http://tinyurl.com/OSHA-3371. The preliminary draft of the proposed new National Fire Protection Association's standard (NFPA 652) can be found at http://tinyurl.com/NFPA-652.

clean, efficient, fuel-flexible, affordable, and technologically-advanced products and equipment."

For more information on the new standards, visit http://tinyurl.com/EPA-Boiler.

FSMA ROLL-OUT BEGINS

The other recent regulatory news of note, of course, is the long-delayed beginning of the implementation phase of the Food Safety Modernization Act (FSMA). The Act was signed into law in January 2011; the first two proposed rules were not released by the US Food and Drug Administration (FDA) until January 2013.

The first proposed rule released in January concerns the production and harvesting of produce and, thus, will not affect the vegetable oil processing and refining industries. The second proposed rule, however, will: Titled "Preventive Controls for Human Food," the proposed rule sets safety requirements for facilities that process, package, or store food for people. (The proposed rule on animal food and feed as well as rules regarding food imports and accreditation of third-party certification has yet to be issued. Those rules are in the pipeline, but as of late January 2013, FDA had not yet announced target release dates.)

At this point, it is too early to tell how the proposed rule may affect oilseed processing and edible oil refining. At press time, industry trade groups were busy analyzing all 680 pages of the proposed rule and preparing comments. (The 120-day comment period closes on May 16, 2013.)

"Our industry should pretty much be in alignment with the guidelines," said one source, who asked to remain anonymous. "Our customers require us to have HACCP [Hazard Analysis and Critical Control Point] programs." The bigger question, the source said, concerns the audits mandated by FSMA. "We don't know how deep and wide FDA will go when they come in to audit or what constitutes validation."

Robert L. Collette, president of the Institute of Shortening and Edible Oils, a trade group based in Washington, DC, USA, agrees. He added: "Our members already utilize HACCP programs so I agree with the comment

about existing alignment. Of key interest is how FDA proposes to expand the concept of preventive controls for areas such as sanitation that are not typically documented as part of traditional HACCP programs."

The best advice, all industry sources caution, is to be prepared. Do not wait for final implementation. Processors need to get the proper documentation started now if they haven't already.

NEW COMBUSTIBLE DUST STANDARD IN DEVELOPMENT

The final action of note concerns development of a new combustible dust standard. In brief: The National Fire Protection Association (NFPA; Quincy, Massachusetts, USA) is restructuring its work on combustible dust standards. The group aims to develop a new standard (NFPA 652) that applies to every current dust standard and every industry. This effort has potentially significant implications for oilseed processing.

Enter a group of four associations that have banded together to represent the interests of the agricultural industry with regard to NFPA 652: the National Oilseed Processors Association, the National Grain and Feed Association, the Corn Refiners Association, and the International Oil Mill Superintendents Association (IOMSA). On January 4, 2013, the coalition submitted comments to NFPA on a preliminary draft of NFPA 652 (Standard on Combustible Dust), with the assistance of Marc L. Fleischaker, partner and chair emeritus of Arent Fox LLP in Washington, DC, USA.

BACKGROUND

The intricacies of how NFPA voluntary consensus standards, local fire department codes, and US Occupational Safety and Health Administration (OSHA) regulations mesh are beyond the scope of this news item. Instead, the focus is on the effort, in NFPA's words, "to provide the basic principles of and requirements for identifying and managing the fire and explosion hazards of combustible dusts and particulate solids" by developing NFPA 652.

NFPA currently oversees five major dust standards targeting specific types of dust:

- NFPA 61, Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities;
- NFPA 484, Standard for Combustible Metals;
- NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids;
- NFPA 655, Standard for Preventing Sulfur Fires and Explosions; and

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- NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities.

NFPA's multiple combustible dust standards were a matter of background discussion when OSHA issued an Advanced Notice of Proposed Rulemaking for combustible dusts in October 2009. Users could become confused when seeking the appropriate requirements to follow, OSHA reasoned, and could in some cases obtain either inconsistent or possibly conflicting guidance.

"NFPA created a new committee structure in response to user concerns," explained Guy R. Colonna, division manager of NFPA's Industrial & Chemical Engineering group. That new structure provides two things, he said: (1) an oversight body to work with all of the committees and standards to encourage and drive consistency and uniformity, and (2) a committee focused only on defining the fundamental process by which combustible dusts are identified, evaluated, and controlled. "It is understood that for some industries and dust types additional precautions could apply. Those measures will remain with the process-specific or dust type-specific standards," he noted.

IMPLICATIONS FOR OILSEED PROCESSING

IOMSA and the other coalition member associations have all been represented on the NFPA 61 and NFPA 654 committees for many years.

"NFPA 61, in particular, has been written and rewritten with significant grain industry input," notes Marc Fleischaker in the coalition's comment letter. This is the root of one major concern of the coalition: Might the complexity added by the proposed new standard end up fostering confusion and actually lead to less safe conditions?

The coalition believes that a generic standard, such as NFPA 652, should not override a standard developed specifically for a particular industry, such as NFPA 61. Further, "there is a specific federal OSHA standard involving grain handling facilities, which contains requirements that are not consistent with the draft NFPA 652 standard," the comment letter points out.

These inconsistencies, the coalition says, could lead to a facility being deemed to be compliant with the OSHA standard (29 *CFR* 1910.272) but not with NFPA 652, or the reverse.

The coalition also argues that a phase-in or implementation schedule for hazard assessment be provided for the new standard. "Certainly, NFPA needs to be careful about adopting standards with effective dates that make compliance impossible," the comment letter suggests.

Further comments cover various inconsistencies in the draft document as well as questions concerning several explosibility and combustibility tests called for in the draft.

TIMETABLE

The standard development process for NFPA 652 is in its early stages. NFPA received approximately 150 comments on the first draft by the closing date of January 4, 2013, according to Colonna. A report on the first draft is due on September 6, 2013. The second draft comment period will close on November 15, 2013. The final standard is scheduled for completion in the third quarter of 2014. At that point, it will be presented for action at the next NFPA Technical Meeting, with publication expected in 2015.

"We are committed to the coalition's work to ensure that the final standard is as favorable to oilseed processing as possible," Doug Kennedy, current IOMSA president, affirmed.

The new OSHA rules on combustible dust are also well off in the future. The official regulatory calendar shows that the agency expects to begin its Small Business Regulatory Enforcement Fairness Act review in October 2013. That review takes 90 days. Only after that can OSHA publish the Notice of Proposed Rulemaking with regulatory text to which public comments can be submitted. Whether—and when—a proposed rule will be published in 2014 remains to be seen. ■

BRIEFS

Data from the Malaysian Palm Oil Board (MPOB) show that the 10 biodiesel producers in Malaysia operated at an average capacity utilization of 17.7% in 2012. The MPOB indicated the annual production capacity in the biodiesel sector is 1.5 million metric tons (http://tinyurl.com/Malaysia-BD-capacity).

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As of January 17, 2013, corn oil is being produced at 25 of POET's 27 corn ethanol plants. Total capacity is about 250,000 tons (230,000 metric tons) of oil per year, enough feedstock to produce 68 million gallons (260 million liters) of biodiesel. POET, headquartered in Sioux Falls, South Dakota, USA, has been selling its Voilà™ brand of corn oil into biodiesel and feed markets since January 2011. POET is also capturing by-product CO_2 at five of its corn ethanol plants for sale to beverage producers and other users.

■■■

Popular Science magazine named the flight of a jet plane powered by 100% unblended biofuel derived from *Brassica carinata* as one of the 25 "Big Science Stories of 2012" (also see *Inform 24*:21, 2013).

■■■

Since 2005, the Corporate Knights, a Toronto-based media and investment research company, has published annually its list of the world's 100 most sustainable companies. These are defined as "leading a resource productivity revolution, transforming waste into treasure and doing more with less." The Global 100 list for 2013 was released on January 23 during the World Economic Forum in Davos, Switzerland. StatOil ASA (Stavanger, Norway), Neste Oil OYJ (Porvoo, Finland), and Novo Nordisk (Bagsværd, Denmark) were ranked third, fourth, and fifth, respectively. Novo Nordisk and StatOil were also in the top five in 2012, whereas Neste rose from 19th place in 2012 to its fourth place listing in 2013. Novozymes (Bagsværd, Denmark) fell from fourth place in 2012 to 19th place in 2013. ■

BIOFUELS NEWS

Energy from Vietnamese fish wastes

The Hiep Thanh Seafood JSC (Can Tho City, Vietnam) generates 81 metric tons (MT) of waste per day from processing *Pangasius*, or shark catfish, into fillets for export. The waste from processing these high-fat fish includes entrails, scales, and bones.

At this facility, Aulis Ranne, of the Technical Research Center of Finland, is coordinating a research project, "Enerfish Wege," to develop procedures for converting this waste into biodiesel and for best using that energy. The European Union and other partners are sponsoring the project.

A pilot plant for making biodiesel, which is 14 m long, 5 m wide, and 5 m high, has been constructed next to the fish processing plant. Once it is up and running at full capacity, it is expected to produce 13 MT of biodiesel annually.

The plan is to use the biodiesel to power electric generators for the processing plant, thus establishing a circular flow economy. The energy is needed to cool and then freeze the fish fillets prior to export. If more biodiesel is produced than the plant needs, then it can be sold, making it a local energy source.

Generating its own power means the processing plant will no longer have to contend with power outages, which currently happen about every other day (http://tinyurl.com/DW-energy-fish).

Until now, both the food and pharmaceutical industries have sought the oil isolated from this fish-processing plant. The residue has also been used by animal feed producers. Although making biodiesel from fish oil at this plant is not yet profitable, Son Ha-Dang, from the Vietnamese project Partner Research Center for Energy and Environment, expects that this situation will change shortly. Vietnam is the world's third-largest aquaculture producer.

Use of renewable energy in USA increasing

Natural gas and renewable energy are the only US energy sources that are growing, according to data published by the US Energy

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Information Administration as interpreted by Worldwatch Institute (http://tinyurl.com/worldwatch-blog). Renewable resources—including wind, solar/photovoltaic, biomass, geothermal, and hydroelectric—grew from 7.5% of US energy in 2007 to 10% in 2012. Factors contributing to the increase include falling prices, for example the 30% drop in the cost of wind turbines and the 60% drop in the price of solar electric panels, as well as supportive governmental policies. The renewable energy tax credits that the US Congress extended just after the end of the 2012 are noteworthy.

The blog also found the US carbon dioxide emissions have declined by 13% from 2007 to 2012, preceded by a 20% increase from 1990 to 2007.

Chris Flavin, president of Worldwatch Institute and writer of the blog, indicated that "US energy consumption declined in 2012 for the fourth time in the last five years—even as economic recovery began to take hold." Total US energy consumption was 101,296 quadrillion Btu in 2007; the level in 2012 was 7% lower.

Growing algae in Canada

U.S. Steel Canada announced in December 2012 that it would be cooperating with Pond Biofuels (headquartered in Toronto) in a project to take CO_2 from the steelmaker's smokestack in Nanticoke, Ontario, and pipe it to algae-growing tanks. Union Gas, the supplier of natural gas to U.S. Steel Canada, is also part of the project.

Oil isolated from the algae grown in these tanks will be processed into biodiesel and other by-products. Besides producing oil, this process will keep the greenhouse gas CO_2 out of the atmosphere by capturing it as biomass.

This is Pond Biofuel's second trial of this concept. In 2009, it set up a pilot project with St. Marys Cement (St. Marys, Ontario). Cement manufacture is the most carbon-intensive industry in the world. According to http://tinyurl.com/StMarys-USSteelCanada, production of 100 tons of cement generates 83 tons of CO_2. The end product of this initial trial from St. Marys was biodiesel made from algal oil.

Algae require light to grow photosynthetically, and in Canada the supply of sunlight can limit algal growth for much of the year. If one uses power to supply electricity for grow lights, the additional cost could easily make the project uneconomical. The effects of cold weather on algal product rates also can reduce growth rates, but this drawback can be at least partly mitigated by the process heat present in the gases being sent up the smokestack.

Steve Martin, chief executive officer of Pond Biofuels, plans to sidestep the light issue by using high-efficiency LEDs (light-emitting diodes) powered by solar energy to illuminate the algae tanks, thus reducing the cost of electricity and making the operation profitable.

Indonesia to make biodiesel

According to *The Jakarta Post* newspaper (http://tinyurl.com/palm-oil-Indonesia), Indonesia is considering making biodiesel as a partial solution to its oversupply of palm. Deputy Trade Minister Bayu Krisnamurthi said on January 9 that there was need to convert up to 3 million metric tons (MMT) of palm oil into biodiesel. The government is considering subsidizing the production of more biodiesel as a means to lessen the country's dependence on fossil fuels. Because of the current oversupply of palm oil, Bayu also told the newspaper that the government expected the local palm oil industry to enlarge the capacity of its storage tanks from around 2.5 MMT, a one-month stock supply, to 8 MMT.

Aviation biofuel test results in Canada

The National Research Council (NRC) of Canada flew the first civilian jet powered by 100% unblended biofuel on October 29, 2012 (see *Inform 24*:21, 2013). A Dassault Falcon 20 twin-engine jet flew over Ottawa, Canada, at 30,000 feet (9,000 meters), an altitude normally used by commercial aircraft. A Lockheed T-33 followed the Falcon 20 to collect information on the emissions generated by combusting the biofuel.

A team of experts analyzed the data and announced on January 7 there had been a 50% reduction in aerosol emissions when using biofuel compared to conventional fuel. Furthermore, additional tests performed on a static engine showed a significant reduction in particles (up to 25%) and in black carbon emissions (up to 49%) compared to conventional fuel. These tests also showed a comparable engine performance, but an improvement of 1.5% in fuel consumption during the steady-state operations. The jet's engines required no modification, as the biofuel tested in-flight meets the specifications of petroleum-based fuels (http://tinyurl.com/AviationBiofuel).

Encouraging *Miscanthus* to produce more biomass

Efforts to produce greater quantities of ethanol for fuel from non-edible plants have included examining the growth and productivity of species of grasses including *Miscanthus sacchariflorus* and *M. sinsensis*, as well as natural hybrids of these two such as the sterile triploid *M.* × *giganteus*.

Elaine Jensen and coworkers at Aberystwyth University (United Kingdom) recently published results of their efforts to understand the cues that signal *M. sacchariflorus* to start flowering. With this information they will be able to expedite the introduction of new germplasm optimized to different environments.

Six different *M. sacchariflorus* accessions from a range of latitudes were grown under controlled photoperiod and temperature conditions. Data on flowering, biomass, and morphological phenotypic data were recorded.

Regardless of the geographic origin of the accessions, *M. sacchariflorus* was found to be a quantitative short-day plant. Growing the plants under static long days (15.3 hours daylength) resulted in a delay in flowering of 61 days, accompanied by an average associated increase of 52% of above-ground biomass (*J. Ex. Bot.*, doi:10.1093/jxb/ers346, 2012).

The discovery could have important implications for biofuel production from *Miscanthus* and other grasses, which are being investigated as feedstock for the production of bioethanol. Goals are higher yields and increased productivity from the crop—helping increase its commercial viability and reducing carbon emission for energy and fuel production.

For another approach to understanding the effect of flowering on plant growth, see *Inform 24*:IPR, 2013). ■

BRIEFS

Cocoa-rich dark chocolate might help protect against heart disease and strokes but probably more so if you are male. Spanish and British researchers studied what happened to the blood of volunteers after they ate dark chocolate boosted with cocoa extract. The enriched dark chocolate significantly decreased both platelet activation and aggregation in men; however, it only decreased platelet aggregation in women. The study found that compounds deemed responsible for the beneficial effects—flavanols and their metabolites—were present in the blood within hours of consumption. The work appeared in *Molecular Nutrition & Food Research* (doi:10.1002/mnfr.201200283, 2013).

■■■

Now, for some interesting research that concerns how the language we speak may influence how we think and then act. A study by M. Keith Chen of the Yale School of Management (see http://tinyurl.com/Chen-Marshmallows; in press, *American Economic Review*) attempts to link language to future-oriented behaviors, such as a child who resists the temptation to eat one marshmallow immediately in order to receive two treats to enjoy just a few minutes later. Chen notes that use of the future tense is grammatically required in some languages such as French and hypothesizes that this allows a sense of the future as being distinct from the present. "Empirically, I find that speakers of such languages: save more, retire with more wealth, smoke less, practice safer sex, and are less obese," Chen writes. "This holds both across countries and within countries when comparing demographically similar native households."

■■■

Australia's *Herald Sun* newspaper reports that a clinical trial will be conducted in Western Australia investigating preventing and/or delaying the onset of Alzheimer's disease via periodic administration of a combination of testosterone and fish oil. Led by Ralph Martins of Perth's McCusker Alzheimer's Research Foundation, the study will involve about 400 men over the age of 60. ■

HEALTH & NUTRITION

Diet and gene damage

The question of whether diet can damage genes and increase the risk of cancer was the focus of a study conducted by British researchers at the Institute of Food Research (IFR) in Norwich and Newcastle University.

The study, led by Henri S. Tapp of IFR, suggests that although aging has the greatest impact on gene damage (as shown by the methylation of cytosine, one of the four main bases found in DNA and RNA), dietary factors can also have an impact. Obesity and high blood folate seemed to increase the amount of damage; selenium and vitamin D appeared to reduce the damage.

The findings were based on a study of epithelial cells taken from the colons of 185 male and female volunteers who were free of colonic disease and who ate their normal, unregulated diet. The researchers looked at 11 genes in all subjects—genes where abnormal methylation is known to correlate with the onset of colorectal cancer.

The scientists downplayed the possible relevance of a link between folate and gene damage. They acknowledge other studies that show no link between folate and cancer risk, and call for follow-up studies to investigate potential mechanisms for their observed effect of folate on DNA methylation. They were more certain of the protective effects of selenium and vitamin D, although the impact of selenium appears to be stronger in female subjects than in males, which mimics evidence obtained in studies of some other cancers.

The study appeared in *Aging Cell* (doi:10.1111/acel.12030, 2013).

Total fat intake and body weight

A meta-analysis conducted by researchers at the Norwich Medical School and Durham University School of Medicine, both in the United Kingdom, and New Zealand's University of Otago in Dunedin examined the

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relationship between total fat intake and body weight in children and adults. The work was led by Lee Hooper at the Norwich Medical School and appeared in the *British Medical Journal* (doi:http://dx.doi.org/10.1136/bmj.e7666, 2012).

The World Health Organization's Nutrition Guidance Expert Advisory Group Subgroup on Diet and Health called for the study as part of its work drafting guidelines on total fat intake.

"It was agreed that any effect of total fat intake on body weight was crucial to making global recommendations (in the context of increasing overweight and obesity, in particular in low and middle income countries undergoing rapid transition in nutrition)," the researchers noted, adding that "overweight and obesity increase the risk of many cancers, coronary heart disease, and stroke."

The team looked only at studies where weight loss was not the intended outcome. They searched for studies on adults or children that compared lower vs. usual total fat intake and assessed the effects on measures of body fatness (body weight, body mass index, or waist circumference) after at least six months (randomized controlled trials) or one year (in cohorts). The researchers excluded studies in which weight loss was the intended outcome because "they were potentially confounded by the implicit objective of reducing calorie intake to produce weight loss and would therefore lead to an overemphasis on studies carried out in highly selected obese populations," the researchers explained.

The scientists identified 33 randomized controlled trials involving over 70,000 participants of varying health states and 10 cohort studies, noted the *RSSL* (Reading Scientific Services Ltd.) *Food e-News*. "Meta-analysis of the trials in adults indicated that diets lower in total fats on average reduced body weight by up to 1.6 kg, body mass index by –0.51, and waist circumference by 0.3 cm. However, the size of this weight difference varied [among] the trials and analyses indicated that greater reductions in fat intake and having lower fat intake at baseline were associated with greater weight loss," the RSSL report continued.

The meta-analysis found that this trend is also visible in children and young people. Additional trials, however, are needed to examine these groups, as well as the populations of developing countries, the researchers said.

Host cholesterol secretion likely to influence gut microbiota

For more than half a century, researchers have known that the bacteria colonizing the gastrointestinal tract of mammals influence their host's cholesterol metabolism. Now, Jens Walter and colleagues at the University of Nebraska (Lincoln, USA) show that changes in cholesterol metabolism induced by diet can alter the gut flora. The research was published in *Applied and Environmental Microbiology* (doi:10.1128/AEM.03046-12, 2013).

In the study, the researchers added plant sterol esters to the diets of hamsters. The overall effect of this was to inhibit several bacterial taxa, from the families Coriobacteriaceae and Erysipelotrichaceae, says Walter. But the immediate effect of the plant sterols was to physically block cholesterol absorption by the intestine. That decreased cholesterol levels in the liver and the plasma, prompting the hamster's body to respond by synthesizing more cholesterol. That, in turn, boosted cholesterol excretion into the gut; the extra cholesterol was the direct inhibitor of those bacterial families.

"The abundance of these bacterial taxa and the levels of cholesterol in the fecal samples followed a mathematical model of bacterial inhibition," says Walter.

Practically speaking, the microbial inhabitants of the gut are part of the metabolic system. Researchers have shown that certain health problems are related to changes in the gut flora, such as can be induced by overuse of antibiotics. Since changes in diet can influence composition of the gut flora, health problems such as obesity might be targeted by dietary interventions designed to suppress bacteria that contribute to weight gain. "However, for these to be successful, we need to know which bacterial patterns not only are associated with disease, but actually contribute to it," says Walter, noting that his research showed that some alterations associated with metabolic disease might be the consequence, rather than the cause of the disorder.

Walter says that the work was a real student project. Among the coauthors, three were graduate students, and two were undergraduates. "As a supervisor, it is extremely nice to see young scientists work as a team, and staying dedicated through the five years that this project took to complete," he says.

Food prepared away from home

People the world over are eating more food prepared away from home. Research conducted by the US Department of Agriculture's (USDA) Economic Research Service (ERS) examines the nutritional quality of those meals.

Previous ERS studies have shown that food prepared away from home (FAFH) tends to be lower in nutritional quality than food prepared at home (FAH). Research in the 1990s found that FAFH contained less of the food components traditionally underconsumed, such as calcium and dietary fiber, and more of those overconsumed, such as fat, compared with home-cooked food.

Examining the changes in intake from FAFH and FAH, as reported in national surveys for 1977–1978 and 2005–2008, ERS found that:

- Consumers increased their away-from-home share of caloric intake from 17.7% in 1977–1978 to 31.6% in 2005–2008 (the latest period studied), mainly from table-service and fast-food restaurants.
- Mean daily consumption of total fat declined significantly over the period studied in both absolute terms and as a share of calories. On average, Americans consumed 85.6 grams of total fat per day in 1977–1978, compared with 75.2 grams in 2005–2008. The percentage of calories from total fat also declined substantially from 39.7% to 33.4% between 1977 and 2008.

Comparing estimates for total fat content between FAFH and FAH shows that the gap has widened over time. Total fat in 1977–1978 accounted for 39.6% and 39.9% of calories from FAH and FAFH, respectively, compared with 30.5% and 37.2% in 2005–2008.

- Mean daily calcium intake rose from 743 mg in 1977–1978 to 919 mg in 2005–2008. For every 1,000 calories from FAH, consumers increased their calcium intake from 425 mg to 559 mg in that time period, whereas the calcium density in FAFH remained relatively constant at 452–460 mg per 1,000 calories.

Data from 2005–2008 also included information on saturated fat, cholesterol, sodium, and dietary fiber intake that was unavailable in 1977–1978, allowing further analysis of the nutritional differences between FAH and FAFH in the more recent period. ERS found that in 2005–2008:

- FAFH was higher in saturated fat than FAH. The higher percentage of calories from saturated fat in fast foods was especially noteworthy at 13.5%, compared with 11.9% in restaurant foods, and 12.3% in school foods. Calories from saturated fat in FAH was 10.7%.
- FAFH contained 1,820 mg of sodium per 1,000 calories, considerably higher than FAH at 1,369 mg of sodium. Foods from restaurants and fast-food establishments were particularly sodium-dense at 2,151 mg and 1,864 mg of sodium per 1,000 calories, respectively.
- Similarly, FAFH was more cholesterol-dense than FAH at 144 mg and 126 mg of cholesterol per 1,000 calories, respectively. Within FAFH sources, restaurant foods were most cholesterol-dense at 206 mg per 1,000 calories.
- Even though school foods had the highest calcium content among all food sources, low calcium content in foods consumed at restaurants and fast-food places resulted in lower calcium content overall for FAFH at 460 mg per 1,000 calories, compared with 559 mg for FAH.
- FAFH, especially fast foods, were lower in dietary fiber (an underconsumed food component) than FAH, at 6.8 grams vs. 7.7 grams per 1,000 calories.

The ERS analysis used national food consumption survey data from the 1977–1978 Nationwide Food Consumption Survey conducted by USDA, as well as data from the 2005–2006 and 2007–2008 National Health and Nutrition Examination Survey, conducted jointly by USDA and the US Department of Health and Human Services. The analyses incorporated "complex survey design effects and sample weights to estimate population means and test differences in means over time and by food source," the ERS analysts said in a statement. ■

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BRIEFS

In an early January interview appearing on FoodNavigator.com (http://tinyurl.com/Lynas-GM-FoodNav), Mark Lynas, a former critic and now supporter of genetically modified (GM) food, was asked what the implications would be if anti-GM activists were to prevail. He replied, "The danger is the EU will become a . . . food museum, where farmers are only allowed to grow old varieties of things . . . and technological innovation at the genomic level has been foreclosed as an option forever. . . . That's bad news for global food security. That's bad news for the world environment."

■■■

The Polish government passed ordinances on January 2, 2013, banning the cultivation of two genetically modified (GM) crops: MON 810, a corn variety developed by Monsanto (St. Louis, Missouri, USA) and the Amflora potato (BASF, Germany), cultivated for industrial starch. Poland becomes the eighth European country to ban the cultivation of GM crops that were approved by the European Food Safety Authority as safe for cultivation. Poland took advantage of a "safeguard clause" that allows individual nations to reject European Union approval of GM crops.

■■■

Saffron Road, the packaged food brand of American Halal Co., planned to introduce the first Non-GMO Project (www.nongmoproject.org)-verified frozen food entrée to the US market in late January 2013. The product, Chana Saag with Cumin Rice, was released through the Whole Foods grocery chain. The fact that the product contains no ingredients that come from genetically modified organisms (GMO) will be included on the label. The company anticipates releasing five more non-GMO-verified frozen products by the end of 2013. ■

BIOTECHNOLOGY NEWS

Forever-young plants

Dirk Prüfer and colleagues at the Fraunhofer Institute for Molecular Biology and Applied Ecology IME (Münster, Germany) have located a genetic switch that can keep plants young for years. Their studies were carried out in tobacco plants, which normally grow and flower for 3–4 months, reaching a height of 1.5–2 meters, and then die.

The researchers found a way to prevent the plants from flowering. If they do not flower, they also do not progress to senescence. In a news release from Fraunhofer, Prüfer said, "We modify the expression of a certain gene—or rather, the information contained within it—so that the plant's flowering is delayed" (http://tinyurl.com/Prufer-tobacco).

The first of the tobacco plants on which they worked is now almost eight years old and still growing. Prüfer said, "Although we regularly cut it, it's six and a half meters tall. . . . Its stem is already 10 centimeters in diameter." Unlike normal tobacco leaves, which grow from the bottom of the stem, turn yellow, and drop off, the leaves in these experimental plants have stayed green and healthy.

The principle is transferable. The scientists presently are working on potato plants with this technology; the desired outcome is the production of a greater amount of biomass with more starch.

The method will be useful so long as the flowers (leading to seeds) of the plant in question are not what is sought; for example, the economically desirable part of a sugar beet is its root, not its seed. The technique would not be useful for soybean or canola, since these plants are valued for their seeds. It is possible, however, that the technology could be used to improve yield of biomass that is subsequently processed into biofuels such as bioethanol or renewable diesel.

UK official promotes GM crops

In his first major speech to farmers after becoming UK Secretary of State for the Environment, Food, and Rural Affairs, Owen Paterson told the Oxford Farming Conference

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(held January 2–4, 2013), "We should not be afraid of making the case to the public about the potential benefits of GM beyond the food chain—for example, significantly reducing the use of pesticides and inputs such as diesel. As well as making the case at home, we also need to go through the rigorous processes that the EU has in place to ensure the safety of GM crops." He added, "I believe that GM offers great opportunities but I also recognize that we owe a duty to the public to reassure them that it is a safe and beneficial innovation" (http://tinyurl.com/Paterson-UK-GM).

Genetically engineered salmon

On December 20, 2012, the US Food and Drug Administration (FDA) announced the availability for public comment of its draft environmental assessment of the proposed conditions of use specified in materials submitted by AquaBounty Technologies, Inc. (Waltham, Massachusetts) in support of a new animal drug application (NADA) concerning a genetically engineered Atlantic salmon. The FDA also made available for comments its preliminary finding of no significant impact for those specific conditions of use. In the event of an approval of the application the approval would only allow AquaAdvantage Salmon to be produced and grown-out in the physically contained freshwater culture facilities specified in AquaBounty's NADA. FDA set a deadline of 60 days (February 18, 2013) to receive public comment and said it did not intend to grant requests for extension of the comment period.

Efforts continue in US to limit GMO

In November 2012 voters in the state of California rejected Proposition 37, which would have required companies to disclose if foods sold in the state's grocery stores were "genetically engineered" (for raw agricultural commodities) or "may have been entirely or partially produced with genetic engineering" (*Inform 24*:30, 2013). Groups that had sponsored Proposition 37 vowed to continue their efforts, concentrating on introducing legislation to force labeling of products from genetically modified organisms (GMO), whether state by state or nationwide.

Petitions for a ballot measure calling for the labeling of foods containing genetically modified ingredients were submitted to Washington state legislature in January 2013. Over 350,000 people signed the petitions—241,153 verified signatures are needed to move the initiative forward. The effort has been entitled I-522, "The People's Right to Know Genetically Engineered Food Act." According to *The Spokesman-Review* newspaper (Spokane, Washington; http://tinyurl.com/Wash-state-GMO), the legislature will review the document and could pass it as written, making it a law. If the legislature rejects it, it could either send I-522 to the general election ballot or pass an alternative. In the latter case, both I-522 and the alternative would be presented to voters in November 2013. The legislature rejected a similar proposal in 2012.

The state of New Mexico has joined the parade as well. State Senator Peter Wirth (Democrat–Sante Fe) pre-filed State Bill 18 (SB18) in December 2012, which would "mandate the labeling of food and commercial animal feed containing genetically modified material" (http://tinyurl.com/NewMex-GMO-SB18). The bill was scheduled to be taken up by the legislature when it returned from winter break on January 15. Eleanor Bravo, New Mexico organizer of the consumer advocacy group Food & Water Watch (www.foodandwaterwatch.org) which promoted GM labeling in California, told FoodNavigator.com (http://tinyurl.com/New-Mex-GMO-SB18), "This [SB18] is different to Prop 37. It's not a ballot. It's a proposed amendment . . . and will go to the senate, then the committee stage, and if it passes, it will go to the senate floor, and if it passes there it will go the House." That is, registered voters will not vote on this, unlike California.

Legal implications of the two approaches are discussed at http://tinyurl.com/legal-Washington-New-Mexico.

EFSA releases GM corn data

On January 14, 2013, the European Food Safety Authority (EFSA) released almost all of the documents and data that Monsanto had submitted in 2003 for authorization to permit planting its genetically modified (GM) corn NK603 (see http://tinyurl.com/EFSA-NK603). These data were released in response, in part, to a challenge by the University of Caen (France) researcher Gilles-Eric Séralini and colleagues.

These researchers published a peer-reviewed paper in September 2012 presenting data alleging that rats fed NK603, which EFSA had approved in 2003, suffered long-term carcinogenic effects (*Inform 24*:33, 47, 2013). The scientific community quickly challenged this article, asking among other things that Séralini and co-workers release their raw data so that others could consider the materials and methods used in developing these conclusions. Seralini and colleagues responded that they would not release their data until EFSA released its 2003 data.

Followings EFSA's action, Seralini released his data through a bailiff to the European Parliament on January 15, 2013. According to GM Watch (http://tinyurl.com/Seralini-EFSA-NK603), Seralini also announced he was filing "complaints of defamation against claims of 'fraud' and 'falsified data' that were respectively published in *Marianne* [a weekly Paris-based French news magazine] and *La Provence* [newspaper located in Marseille, France] by Jean-Claude Jaillette and Claude Allègre who is a member of the French association for plant biotechnologies (AFBV)" for comments appearing in those publications following the initial furor associated with September paper.

Loblolly pine genome

Researchers at the University of California-Davis (USA) released the initial draft genome sequence of the loblolly pine (*Pinus taeda*) in January 2013. This is the most economically important tree species in the United States. Tall oil is one by-product of the Kraft processing of loblolly pine wood pulp. Components of tall oil include sterols, resin acids, fatty acids, fatty alcohols, and other alkyl hydrocarbon derivatives. The US Department of Agriculture funded the five-year research project, with collaboration of five other organizations. The team generated 16 billion short sequence

CONTINUED ON PAGE 159

BRIEFS

France's Air Liquide has acquired BiotechMarine via the former's subsidiary SEPPIC. The latter specializes in the design and marketing of biobased cosmetic active ingredients made from algae. BiotechMarine is based in Pontrieux, France, and has 35 employees.

■■■

Clariant (Muttenz, Switzerland) has opened a new $20 million production site for its Industrial & Consumer Specialties Business Unit in Coatzacoalcos, Mexico. The company said in a statement that the four-hectare production unit will produce "several chemical specialties and technological solutions for different markets, including personal care, crop protection, metalworking, construction, and painting." In other company news, Clariant announced it has purchased CRM International SAS, a French-based manufacturer of "natural" ingredients for the personal care industry.

■■■

Tight supply in some markets will help US solvents producers, according to a recent analysis by *ICIS Chemical Business* magazine, and "after a slow start, demand is expected to pick up after the first half of 2013." Year-end supply constraints in the US isopropanol market were easing, the report noted, with supply expected to remain tight well into the first quarter of 2013. "Similar conditions will continue to exist in the US methyl isobutyl ketone market," the ICIS report continued, which also will contend with limited supply from domestic sources as well as some pricing designed to discourage sales from product-limited producers.

■■■

The Procter & Gamble Co. (P&G; Cincinnati, Ohio, USA) sold its bleach products business in Western Europe to Fater, an Italian joint venture that P&G has operated with Italy's Angelini Group since the early 1990s. According to Cincinnati's *Business Courier* newspaper, P&G transferred hard-surface cleaning products sold under the Ace and Neoblanc brand names on December 31, 2012. The deal did not include Ace laundry products, the newspaper noted. ■

SURFACTANTS, DETERGENTS, & PERSONAL CARE NEWS

Ambergris and essential oil breakthroughs

Large amounts of a substitute for one of the world's most treasured fragrance ingredients—a substance that also has potential anticancer activity—could be produced with a sustainable new technology, scientists are reporting. The advance enables cultures of bacteria to produce a substitute for natural ambergris, which sells for hundreds of dollars an ounce (about 28 grams).

Laurent Daviet, Michel Schalk, and colleagues at Firmenich SA, a Swiss fragrance firm, explain that ambergris—a waxy substance excreted by sperm whales—has been prized as a fragrance ingredient for centuries. Ambergris has a pleasant sweet and earthy scent of its own, and it enhances other scents in high-end perfumes. With sperm whales an endangered species and natural ambergris not used in perfumes in the United States, perfume makers have turned to substitutes.

One is made from sclareol ($C_{20}H_{34}(OH)_2$), obtained from the Clary sage plant. But the plant contains only small amounts of sclareol, and it is laborious to extract and purify. That is why the researchers looked for a better way of making large amounts of sclareol.

Their report describes isolating the genetic material that produces the two Clary sage enzymes needed to make sclareol. They put the DNA into bacteria, which made large amounts of sclareol in bioreactors. The research appeared in the *Journal of the American Chemical Society* (doi:10.1021/ja307404u, 2012).

In related research, scientists are reporting use of a Nobel-Prize-winning technology to transform plant "essential oils"—substances with the characteristic fragrance of the plant—into high-value ingredients for sunscreens, perfumes, and other personal care products. The report on the approach, which could open up new economic opportunities for tropical countries that grow such

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plants, also appears in the *Journal of the American Chemical Society* (doi:10.1021/ja310054d, 2012).

Deryn Fogg, Eduardo dos Santos, and colleagues at the University of Ottawa in Canada and Universidade Federal de Minas Gerais in Brazil explain that breaking down plant material into ingredients for making commercial products is getting much attention as a sustainable substitute for raw materials now obtained from petroleum. They decided to test a complementary approach, which involves enhancing the complexity of substances found naturally in plants in ways that form antioxidants and other components of cosmetics and perfumes.

Current methods for making some of these ingredients from plants are time-consuming, costly, and wasteful. That is why the scientists turned to metathesis—topic of the 2005 Nobel Prize in Chemistry—to make personal care product ingredients from plant essential oils. They describe use of metathesis in the laboratory to transform compounds in essential oils into highly valuable personal care product ingredients.

"These methodologies offer the potential for economic expansion via the sustainable cultivation and elaboration of high-return source species in the tropical countries that represent the major producers of essential oils," say the researchers.

Sustainability is the megatrend of the moment

Sustainability is the megatrend of the moment, according to Brian T. Sansoni, vice president of communication and membership and vice president of sustainability initiatives at the American Cleaning Institute (formerly The Soap and Detergent Association). The ACI is the trade association for the US cleaning products industry and is based in Washington, DC.

Sansoni recently was interviewed by *Planet Laundry*, the magazine of the Oakbrook, Illinois, USA-based Coin Laundry Association (see www.planetlaundry.com).

"Basically, the manufacturers are increasingly being asked—either by the marketplace, by their stakeholders, and/or by the consumers in general—to take into account their global footprint," Sansoni said. "Sustainability is on everyone's mind, and how it all works into products for the consumer. This has led to the current changes in laundry detergent packaging and formulation—where products still have to pack a punch when it comes down to doing laundry, yet also be manufactured as environmentally responsibly as possible."

When asked about the most misunderstood aspect of the detergent industry, Sansoni raised the amount of research, development, and testing that "goes into laundry and fabric care product safety and effectiveness . . . . I don't think many people realize the enormity of what goes on behind the scenes before these products are unveiled, especially newer product formats and new scents in the different detergents."

Unilever to phase out "microbeads"

Anglo-Dutch consumer products giant Unilever announced in January 2013 that it will remove the tiny exfoliating plastic beads known as "microbeads" from its personal care products by 2015.

The beads are less than 5 millimeters in size and are a "major type of marine debris," according to CNN News. As for what the company will use in their place, a Unilever spokesman said in an email to CNN: "We are currently in the process of researching suitable alternatives."

Study questions previous BPA research

Following a three-year study using more than 2,800 mice, a University of Missouri (MU; Columbia, USA) researcher was not able to replicate a series of previous studies by another research group investigating the controversial chemical bisphenol A (BPA). BPA is used in a variety of cosmetics packaging and is also found in certain plastic bottles, store receipt paper, and in the lining of some canned foods.

The MU study is not claiming that BPA is safe, the researchers caution, but that the previous series of studies are not reproducible. The research, published in the *Proceedings of the National Academy of Sciences* (doi:10.1073/pnas.1220230110, 2012), also investigated the soy isoflavone genistein in the same three-year study.

"Our findings don't say anything about the positive or negative effects of BPA or genistein," said Cheryl Rosenfeld, associate professor of biomedical sciences in MU's Bond Life Science Center. "Rather, our series of experiments did not detect the same findings as reported by another group on the potential developmental effects of BPA and genistein when exposure of young occurs in the womb."

Creating reliable data on the effects of the chemicals on mice is important to human health since people are frequently exposed to BPA and genistein and humans share similar biological functions with mice. Previous research by Rosenfeld, as well as Frederick VomSaal, professor of biological science at MU, and others has suggested that the chemicals may have adverse effects on many animals, including humans.

Researchers who conducted the original series of mouse experiments, which Rosenfeld repeated, claimed that exposure to BPA and genistein resulted in yellow coat color, or *agouti*, offspring that were more susceptible to obesity and type 2 diabetes than their brown coat color, healthy cohorts. However, Rosenfeld and her team did not obtain the same results when repeating the study over a three-year period with multiple litters of mice.

After failing to repeat the original experimental findings with similar numbers of animals, Rosenfeld's group extended the studies to include animal numbers that surpassed the prior studies to verify that their findings were not a fluke and to provide a sufficient number of animals to ensure that significant differences would be detected if they existed. Even these additional numbers of animals and extended experiments failed to reproduce the earlier findings. However, the current studies demonstrate that a maternal diet enriched in estrogenic compounds leads to a greater number of offspring that express an *agouti* gene compared to those that do not, even though equal ratios should have been born (based on the expected Mendelian ratio of 1:1).

"This finding suggests that certain uterine environments may favor animals with a 'thrifty genotype' meaning that the *agouti* gene of mice may help them survive in unfavorable uterine environments over those mice devoid of this gene. Yet, the downside of this expression of the *agouti* during early development is that the animals may be at risk for later metabolic disorders, such as obesity and diabetes" Rosenfeld said. "In this aspect, humans also have an *agouti* gene that encodes for the agouti signaling protein (ASIP) that is expressed in fat tissue and pancreas, and there is some correlation that obese individuals exhibit greater expression of this gene compared to leaner individuals. Therefore, the *agouti* gene may have evolved to permit humans the ability to survive famine, but its enhanced expression may also potentiate metabolic diseases under bountiful food conditions."

While the research casts doubt on the previous study, Rosenfeld said that by understanding the genetic profile of the mice in the first series of studies, scientists could learn more about the correlation between certain genes and obesity. This could eventually influence prevention and treatment programs for patients with diabetes and other obesity-related diseases in humans.

Biocatalytic processing and cosmetics

Consumer hunger for "green" cosmetics continues to grow, according to Gregory W. Nelson, senior vice president and chief technology officer of Eastman Chemical Co. in Kingsport, Tennessee, USA.

Nelson recently wrote a column for the Environmental Leader online news service (see www.environmentalleader.com). Titled "Green Processing: The Cosmetics Industry's Best-Kept Sustainability Secret," the column suggests that cosmetic ingredient suppliers increasingly are turning to biocatalytic processing to deliver products that can withstand the rigors of green-label scrutiny.

In detailing Eastman's GEM technology, Nelson calls it "a major breakthrough in the greening of cosmetics manufacturing because it reduces the amount of energy needed to make cosmetics and eliminates solvents and other wastes."

Under Nelson's direction, Eastman won a 2009 Presidential Green Chemistry Challenge Award for the GEM biocatalytic process, presented by the US Environmental Protection Agency (EPA) on behalf of the White House. The advantages of the GEM process over conventional manufacturing processes include a 52% reduction in CO_2 emissions, a 59% reduction in energy consumption, a 93% reduction in waste, and a 100% reduction in process water usage, according to Nelson. ■

Biotechnology News (cont. from page 156)

fragments, representing 60-fold coverage of the tree's genome. (Pine genomes are 10 times the size of the human genome.) The sequencing data are available at http://pinegenome.org/pinerefseq.

GM labeling in the UK

The Food Standards Agency (FSA) examined consumer attitudes to the labeling of genetically modified (GM) food and the use of "GM-free" labeling in a study conducted from June to September 2012. The FSA commissioned this research to inform discussions within Europe about GM labeling and to ensure the UK public's views were understood and represented.

Data were developed through 1,467 face-to-face interviews with men and women aged 18 to over 65 in England, Wales, Scotland, and Northern Ireland. Among the results, released in January, were the following:

- Consumer awareness of the current labeling requirements is low.
- Participants were typically not seeking information or labeling with regard to GM foods. Only 2% of participants spontaneously mentioned they looked for information about GM content when buying food products for the first time.
- There was a slight preference for labeling indicating the presence of GM, rather than labeling indicating the absence of GM.
- Labeling foods to indicate the absence of GM ingredients can result in a number of expectations. For example, participants expected a product labeled as "GM-free" to be completely free of the use of GM.
- Participants were generally unaware of the use of GM animal feed by farmers. Once made aware of its use, they typically considered that products from animals fed GM feed should be labeled. This observation was consistent with previous FSA research.
- Although a range of knowledge of GM existed among participants, attitudes were fairly undeveloped and knowledge levels were quite low overall. Only 8% of respondents that had heard of the use of GM claimed to have good knowledge of the use of GM in food or food production.

The full report is available at http://tinyurl.com/GM-labeling-UK. ■

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Robert Ash, Taminco
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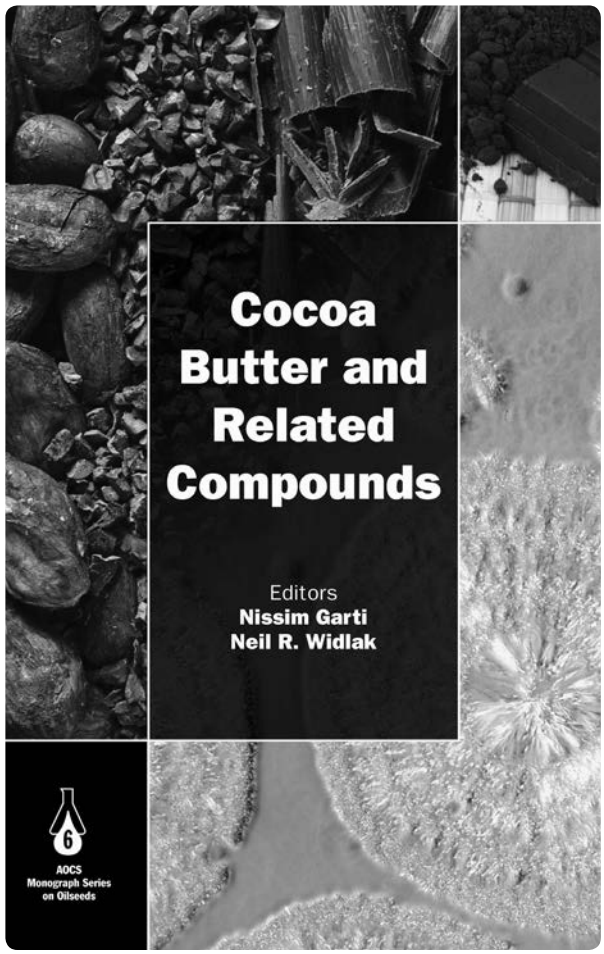
BOOK REVIEW

Cocoa Butter and Related Compounds
Nissim Garti and Neil R. Widlak (eds.),
AOCS Press, 2012,
528 pages, member ($195) or
nonmember ($270),
ISBN 978-0-9830791-2-5

Dominique Guillaume



Hawaii, Paris, Bora Bora, gold, diamond, champagne . . . Some words carry their own magic. Chocolate is one of them.

Cocoa Butter and Related Compounds was written by several chocolate experts. It is Volume 6 of the AOCS Press monograph series on oilseeds and compiles the recent scientific knowledge regarding chocolate's most precious component: cocoa butter. Indeed, even though cocoa butter has been known for centuries, it still has not given up all its secrets and continues to be the topic of intensive and even exciting research.

The book is divided into 20 chapters. Most, but not all of them, focus on bloom, the chocolate manufacturer's nightmare. Chapter 1 deals with some general data regarding chocolate. Amusing statistics are presented. Who knew that Swiss citizens eat almost twice as much chocolate as US citizens and that Western Europeans constitute the world's top chocolate eaters?

But wait, what is chocolate, really? Should we talk about cocoa butter or cocoa butters? Where is cocoa butter presently produced? How does one go from cocoa butter to chocolate? What can be added to cocoa butter without breaking the law regarding identity standards? Why, when left in my car for too long in summer, does my chocolate first turns into a gooey mess then change color when cooling? Answers to all these questions are in the first chapter.

Chapters 2 and 3 are aimed at natural product chemists. Cocoa butter extraction processes and chemical composition are described. Those possibly intimidated by the basic structure of flavonoids (p. 49) need not worry, since readers can skip that subsection without altering their understanding of the rest of the book. These chapters also tell us that eating chocolate is good for our heart and skin health.

The next ten chapters focus on polymorphism, the phenomenon responsible for bloom (undesirable types of cocoa butter crystallization), and the importance of just three triglycerides (i.e., stearic-oleic-stearic, or SOS; palmitic-oleic-stearic, or POS; and palmitic-oleic-palmitic, or POP) on the general behavior of cocoa butter The approach is sometimes theoretical—even mathematical—but still well worth reading. Then more practical aspects are described and different topics are discussed on the macroscopic level: Can the addition of ingredients modify bloom? Do all cocoa butters bloom similarly? How does science can help to evaluate and study bloom?

Milk chocolate also has its place in this book, as well as the various blends of cocoa butter with other vegetable oils or cocoa butter alternatives. Whereas bloom reduction after addition of vegetable oils or modified cocoa butters is a clear advantage for the food industry, is the product still "chocolate" or is it food with a chocolate taste? Anyway, these sections are welcome and inform (some will say warn) readers about the future of chocolate and particularly the possible introduction, in products labelled as "chocolate", of various substances not coming from cooca butter.

In conclusion, this book is very attractive for graduate students, as well as researchers in this subject area. The chapters complement each other nicely. A conclusion section ends each chapter. This is particularly welcome for the theoretical chapters since it helps the readers ascertain whether they have correctly understood the chapter.

Dominique Guillaume is a chocolate lover and professor of medicinal chemistry at the University of Reims Champagne-Ardenne, France, with 20 years of research expertise in food chemistry. She can be reached at dominique.guillaume@univ-reims.fr.

PEOPLE NEWS

Grant to Kansas State for camelina

On January 11, 2013, US Department of Agriculture Secretary **Tom Vilsack** announced $25 million in research and development grants via the National Institute of Food and Agriculture and its Biomass Research and Development Initiative.

Of that total, $5.08 million will go to Kansas State University (Manhattan, USA) for research being led by AOCS member **Xiuzhi Susan Sun** to study the potential of camelina as a commercial biofuel feedstock, particularly for biodiesel and jet fuel. Other members of the team are with Montana State University (Bozeman); the University of Wyoming (Laramie); StrathKirn, Inc. (Chesterfield, Missouri); SBT, LLC; Montana Gluten Free, Inc, (Belgrade); and Henkel.

Sun's research focuses on how plant- and grain-based materials such as oils, proteins, and fibers can be used to create bio-based chemicals and products such as resins, adhesives, and coatings that are safer, more durable, and more environmentally friendly than products currently in use.

New head for Novozymes

The board of directors of Novozymes (Bagsværd, Denmark) appointed **Peder Holk Nielsen** as president and chief executive officer in January 2013, to take effect April 1, 2013. He succeeds **Steen Riisgaard**, who is stepping down after 12 years in those positions and33 years in Novozymes and Novo Industri/Novo Nordisk.

Nielsen is currently serving Novozymes as executive vice president and head of enzyme business, a position he has held since 2007. Before that, he held management positions in Novozymes and Novo Industri/Novo Nordisk across business development, R&D, quality management, and sales and marketing. A company statement indicated the company has delivered average annual growth rates of 7–8% and increased returns of invested capital from 10% to 20% since 2000. Novozymes today holds 47% of the global market for industrial enzymes and is a leader in the increasing use of microorganisms and industrial biotechnology products across a range of industries.

Gerrand to Bunge Canada

Bunge North America, the North American operating arm of Bunge Ltd., announced in January the retirement of **Richard Watson**, who has served as manager of Bunge's Canadian operations since 2008.

Effective March 31, 2013, **Karl Gerrand** will join Bunge from Viterra, Inc., as managing director, Canada. Gerrand most recently served Viterra as chief operating officer of global processing operations. He was responsible for 34 manufacturing facilities with 1,200 employees that crushed oilseeds; produced feed ingredients, milled wheat, durum, and oats; and manufactured malt and pasta. ■

IN MEMORIAM

KARL T. ZILCH

Karl Zilch, who served as AOCS president in 1982–1983, died in Cincinnati, Ohio, USA, on January 7, 2013, at the age of 91. Dolores, his wife of 62 years, preceded him by six months. Survivors include his daughters Marilyn and Nancy and his sons Robert, Brian, Mark, and David; son John preceded him in death in 1992.

Zilch grew up in the St. Louis, Missouri (USA) area and started his higher education at the University of Missouri in the late 1930s with the intention of studying medicine. However, the imminent approach of World War II led to a revision of his plans. As a student already signed up for Reserve Officer Training Corps (a college-based program for training commissioned officers of the United States armed forces), he decided the best use of his time was to get some sort of degree as quickly as possible, so he finished his bachelor's degree in chemistry in 1942 and then enrolled in Officer Candidate School (OCS). After attending OCS and several other Army schools, Zilch was asked to attend pilot's training.

He first experienced combat during the Battle of the Bulge (December 1944–January 1945). Twice his plane was shot down, and twice he reached safe territory. He participated in the liberation of a Nazi concentration camp near Flossenbürg, Germany, and his son David said he became emotional whenever he talked about it afterward (http://tinyurl.com/Zilch-WW2). He remained in the military until 1946, when he returned to the University of Missouri. There he received a Ph.D. in organic chemistry in 1949.

Zilch's first position out of graduate school was with the US Department of Agriculture Northern Regional Research Center (NRRC; now the National Center for Agricultural Utilization Research) in Peoria, Illinois. (Concurrently with his work at the NRRC, he taught at Bradley University in Peoria.) His NRRC efforts included basic studies on autoxidation of unsaturated fats, oils, and fatty acids; the fractionation of fats, oils, fatty acids, and fatty acid derivatives; and by-products from these studies.

From Peoria he moved to Cincinnati in 1955 to work as a research chemist and group leader for Emery Industries (now part of BASF Corp.), a leading maker of oleochemicals. He remained with Emery until his retirement in 1989, moving up the ranks in corporate research. Among his responsibilities were quality control, analytical research, market development, technical service, synthesis, applications research, product development, and process research. Some of his work resulted in US patents. Zilch received the Fatty Acid Service Award from the Fatty Acid Producer's Council of the Soap and Detergents Association in 1979.

His efforts on behalf of AOCS were many over the years. As well as being president, he served as vice president in 1981–1982, and co-chairperson of the 1965 AOCS National Meeting. Zilch was also committee chairperson for the 1977 World Conference on Soaps and Detergents in Montreux, Switzerland, which has become the recurring World Conference on Fabric and Home Care, held every four years in Montreux.

Zilch served on numerous administrative committees, including the Governing Board, the National Program Planning Committee, the Publications Committee, the Journal Committee, and the Membership Development Committee. He was a member for many years of the Editorial Advisory Board for the *Journal of the American Oil Chemists' Society*. He also was the AOCS representative to Codex Alimentarius.

Zilch was elected to honorary membership in AOCS in 1996, and became an AOCS Fellow in 1998. ■

PATENTS

Fire extinguishing and/or fire retarding compositions

Beck, M., *et al.*, BASF Aktiengesellschaft, US8273813, September 25, 2012

The invention concerns fire-extinguishing and/or fire-retarding compositions comprising at least one water-absorbing polymer and at least one alkali metal salt of a nonpolymeric saturated carboxylic acid, processes for their production and the use of the compositions for firefighting or as fire-retarding coatings.

Synthetic compositions obtained from algae

Brown, J.A., *et al.*, US8273694, September 25, 2012

The application provides a base stock or a lubricant composition comprising the substances derived from algae by chemical modification of algal oil, including compositions comprising estomers. Methods for obtaining the same are also provided, including chemically modifying the algal oil with a saturated fatty acid under conditions favorable to the formation of a poly-estomer.

Phospholipid copolymers

Stopek, J., Tyco Healthcare Group IP, US8268958, September 18, 2012

The present disclosure provides copolymers including a first monomer including at least one phospholipid possessing at least one hydroxyl group and a second monomer including a cyclic monomer. Compositions, medical devices, and coatings including such copolymers are also provided.

Δ-15 desaturase genes suitable for increasing levels of omega-3 fatty acids

Damude, H.G., and N.S. Yadav, E.I. Du Pont de Nemours and Co., US8273957, September 25, 2012

The present invention relates to fungal Δ-15 fatty acid desaturases that are able to catalyze the conversion of linoleic acid (18:2, LA) to α-linolenic acid (18:3, ALA). Nucleic acid sequences encoding the desaturases, nucleic acid sequences which hybridize thereto, DNA constructs comprising the desaturase genes, and recombinant host plants and microorganisms expressing increased levels of the desaturases are described. Methods of increasing production of specific omega-3 and omega-6 fatty acids by over-expression of the Δ-15 fatty acid desaturases are also described herein.

Biaxially oriented hydrolysis-stable polyester film comprising epoxidized fatty acid derivatives, and process for production thereof and use thereof

Kliesch, H., *et al.*, Mitsubishi Polyester Film GmbH, US8277710, October 2, 2012

The invention relates to biaxially oriented polyester films which contain 0.1–5.0% by weight (based on the weight of the film) of a hydrolysis stabilizer based on epoxidized fatty acid esters and 0.2–10% by weight (based on the weight of the film) of epoxidized fatty acid glycerides, the epoxidized fatty acid esters having a mean molecular weight of at least 425 g/mol. Such films find use in outdoor applications, as a ribbon cable, as a backside laminate of solar modules, and in electrical insulation applications.

Method of making soaps from oil-bearing microbial biomass and oils

Day, A.G., *et al.*, Solazyme, Inc., US8278261, October 2, 2012

Soap and cosmetic products can be made from oil-bearing microbial biomass via the alkaline hydrolysis of glycerolipids and fatty acid esters to fatty acid salts. The saponified microbial oils/lipids can be combined with a variety of additives to produce compositions for use as soaps and other cosmetic products, which may also contain other constituents of the biomass, including unsaponified oils, glycerol, and carotenoids, among others.

Insect attractants and their use in methods of insect control

Hamilton, J.G.C., Keele University, US8277825, October 2, 2012

The present invention utilizes a fatty acid as an attractant in a method of attracting whiteflies. By using a fatty acid as a whitefly attractant, it is possible to attract whiteflies to a desired location. The fatty acid can be used in a lure or other propagator to provide a dispersion of fatty acid in the air, the variation in the concentration of the fatty acid in the air being such that a whitefly is attracted to the lure as the source of the fatty acid. The use of a fatty acid as an attractant results in significantly higher levels of attraction, as measured by the number of whiteflies attracted to a sticky trap, as compared to the use of color alone.

Method for increasing ruminant fertility

Strohmaier, G.K., *et al.*, Virtus Nutrition LLC, US8278354, October 2, 2012

Methods for reducing the likelihood of embryonic death in a female ruminant by feeding the ruminant for at least 30 days after conception an effective amount of free-flowing fatty acid calcium

AOCS MEETING WATCH

April 3–4, 2013. AOCS Oils and Fats World Market Update 2013, Ukrainian House, Kiev, Ukraine. http://worldmarket.aocs.org

April 28–May 1, 2013. 104th AOCS Annual Meeting & Expo, Palais des congrès de Montréal, Montréal, Québec, Canada. http://AnnualMeeting.aocs.org

July 16–17, 2013. AOCS Technical Services Workshop: Laboratory Methods, Des Moines, Iowa, USA. http://www.aocs.org/labworkshop

August 20–23, 2013. XV Latin American Congress and Exhibition on Fats and Oils, Sheraton Santiago Hotel and Convention Center, Santiago, Chile. http://lacongress.aocs.org

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

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

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

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

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

salt product comprising from about 1 to 10% by weight of eicosapentaenoic acid (EPA) and from about 1 to about 10% by weight of decosahexaenoic *[sic]* acid (DHA).

Asphalt mix workable at ambient temperatures with only biodegradable solvents and method of manufacturing the same

Luccarelli, C.J., *et al.*, Green Product Solutions Inc., US8287635, October 16, 2012

An asphalt mix comprising a pine extract, the asphalt mix having low viscosity at ambient temperatures, and workable at ambient temperatures. The asphalt mix comprises asphalt cement, biodiesel, pine extract and an anti-stripping agent. The asphalt mix is an environmentally safe and "green" product. It comprises recycled asphalt product [RAP]. The asphalt mix eliminates petroleum solvents beyond trace amounts used to denature biodiesel. The asphalt mix is used for patching at ambient temperatures. Safety precautions for heat and toxicity are not necessary for use. The asphalt mix comprises only solvents that are biodegradable. The biodegradable solvents are pine extract and biodiesel. A method of manufacturing an asphalt mix comprising: heating aggregate; introducing RAP to the aggregate; dry mixing the RAP and aggregate; forming a coating of AC on all aggregate during the step of dry mixing by extending the length in time of the dry mixing step; separately blending AC [asphalt cement], biodegradable solvents, and anti-stripping agent to produce a blend; and wet mixing the blend into the RAP and aggregate mix. The biodegradable solvents are capable of making the asphalt mix workable at ambient temperatures. The biodegradable solvents comprise pine extract and biodiesel. The length of the dry mixing is extended to at least about 35 seconds. The aggregate comprises coarse virgin aggregate and fine virgin aggregate. The RAP is about 40% of the final product. The asphalt mix is stockpiled. The asphalt mix is bagged. The method of manufacturing further comprises manipulating encrusted material on the outside of the stockpiled cold asphalt mix back into the stockpile.

Patent information is compiled by Scott Bloomer, a registered US patent agent with Archer Daniels Midland Co., Decatur, Illinois, USA. Contact him at scott.bloomer@adm.com.

EXTRACTS & DISTILLATES

PUBLICATIONS

Intakes of long-chain omega-3 (n–3) PUFAs and fish in relation to incidence of asthma among American young adults: the CARDIA study

Li, J., *et al.*, *Am. J. Clin. Nutr.* 97:173–178, 2013.

Although long-chain ω-3 (n–3) polyunsaturated fatty acids (LCω3PUFAs) have been linked to the prevention of some inflammatory disorders, little is known about the association between these fatty acids and incidence of asthma. The association between LCω3PUFAs and fish intake and incidence of asthma was investigated prospectively among American young adults. A 20-y follow-up longitudinal analysis was conducted in a biracial cohort of 4,162 Americans, aged 18–30 y, with a history of asthma at baseline in 1985. Diet was assessed by a validated interviewer-administered quantitative food-frequency questionnaire at the examinations in 1985, 1992, and 2005. Incident self-reported asthma was defined as having a physician diagnosis of asthma and/or the use of asthma medications between 1985 and 2005. During the 20-y follow-up, 446 incident cases of asthma were identified. LCω3PUFA intake was significantly inversely associated with incidence of asthma after adjustment for sociodemographic, major lifestyle, and dietary confounders. The multivariable-adjusted HR for the highest quintile of LCω3PUFA intake as compared with the lowest quintile was 0.46 (95% confidence interval: 0.33, 0.64; *P*-trend < 0.01). However, a higher frequency of nonfried fish consumption was not significantly associated with the risk of asthma. Docosahexaenoic acid showed a greater inverse association than did eicosapentaenoic acid. The association between LCω3PUFAs and incident asthma was not appreciably modified by sex, race, body mass index, smoking status, or atopic status. This study showed that intakes of LCω3PUFAs are inversely longitudinally associated with the incidence of asthma in American young adults.

Furan fatty acids—valuable minor fatty acids in food

Vetter, W., and C. Wendlinger, *Lipid Technol.* 25:7–10, 2013.

Furan fatty acids (F-acids) are heterocyclic lipid components with a furan moiety in the center of the molecule. Reports on F-acids in the literature are rather scarce, although they are

CONTINUED ON PAGE 168

Journal of the American Oil Chemists' Society (February)

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- Odor significance of the volatiles formed during deep-frying with palm olein, Osawa, C.C., L.A.G. Gonçalves, and M.A.A.P. Da Silva
- Thermal degradation kinetics of carotenoids in palm oil, Sampaio, K.A., J.V. Ayala, S.M. Silva, R. Ceriani, R. Verhé, and A.J.A. Meirelles
- Refractive index and density measurements of peanut oil for determining oleic and linoleic acid contents, Davis, J.P., D.S. Sweigart, K.M. Price, L.L. Dean, and T.H. Sanders
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- Comparison of fatty acid, sterol, and tocol compositions in skin and kernel of turpentine (*Pistacia terebinthus* L.) fruits, Ertas, E., S. Bekiroglu, I. Ozdemir, and I. Demirtas
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- Influence of surfactants on the rheology and stability of crystallizing fatty acid pastes, Thareja, P., A. Golematis, C.B. Street, N.J. Wagner, M.S. Vethamuthu, K.D. Hermanson, and K.P. Ananthapadmanabhan
- Contents of fatty acids, selected lipids and physicochemical properties of Western Australian sandalwood seed oil, Hettiarachchi, D.S., Y.D. Liu, M.R. Boddy, J.E.D. Fox, and V.B. Sunderland
- Polyol-derived alkoxide/hydroxide base catalysts I. production, Gok, H.Y.F., J. Shen, S. Emami, and M.J.T. Reaney

- Polyol-derived alkoxide/hydroxide base catalysts II: transesterification reactions, Gok, H.Y.F., S. Emami, J. Shen, and M.J.T. Reaney
- Effect of microwave treatment on sinapic acid derivatives in rapeseed and rapeseed meal, Niu, Y., M. Jiang, C. Wan, M. Yang, and S. Hu
- Rapid lipid extraction from egg yolks, Shinn, S.E., and A. Proctor.

Lipids

Lipids (February)

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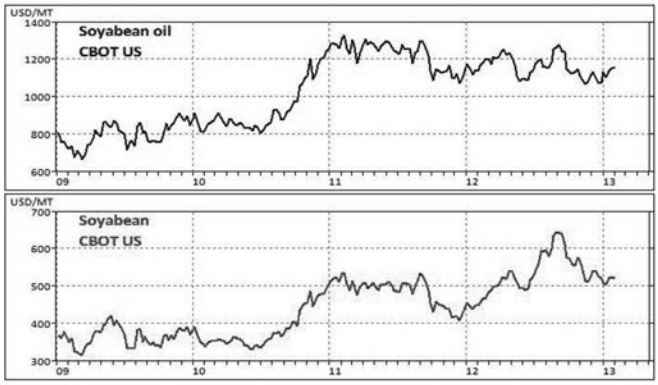
STATISTICAL ANALYSIS FROM MINTEC

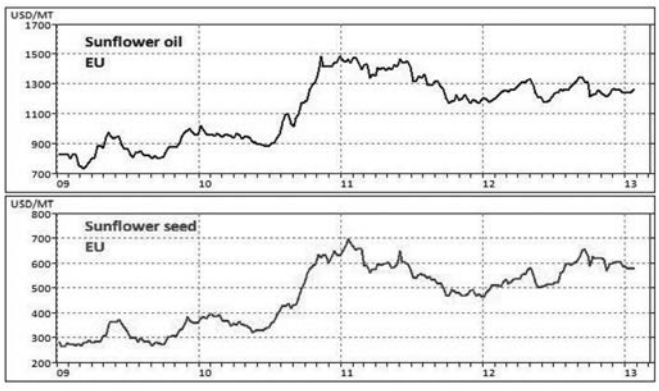
Global oilseed production for 2012/13 is forecast to reach a record 465.8 million metric tons (MMT), up 6% year-on-year, driven by higher soybean, cottonseed, and peanut forecasts.

Soybean production in 2012/13 is forecast to reach 269.4 MMT, recovering by 13% from last season's crop, as global weather conditions have improved. Brazil in particular has enjoyed much better moisture conditions this season with soybean yields in southern Brazil likely to be 30–50% better than last year. As a result, Brazilian soybean production is forecast to reach 82.5 MMT, up 24% from last season and poised to overtake the United States as the world's largest soybean producer for the first time ever. US production is forecast to reach 82.1 MMT, down 3% year-on-year.

Despite this rise in production, soybean oil prices rose at the start of 2013, driven by the reintroduction of a US biodiesel tax credit that is expected to increase oil demand. Sunflower oil prices in general have been steadier. World sunflower oil production for 2012/13 is forecast at 13.7 MMT. This will be 10% down on the previous year, but still 5% up on the five-year average.



US soybean and soybean oil prices (US dollars/metric ton) on the Chicago Board of Trade (January 2009–January 2013)



European Union sunflower oil and sunflowerseed prices (US dollars/metric ton) from January 2009 to January 2013

considered as particularly valuable food ingredients. F-acids occur as minor compounds in the lipids of different food samples. Despite the low concentrations, some studies produced evidence that the F-acids are excellent radical scavengers and thus are able to protect polyunsaturated fatty acids from lipid peroxidation. Accordingly, they may play a currently underrated and largely overlooked positive role in human nutrition. The limited data available result from difficulties in the analysis of these trace compounds. F-acids in food can hardly be determined without selective enrichment and the use of gas chromatography with mass spectrometry for their determination. The lack of reference standards is a further drawback that hampers the exact assessment of the actual relevance of F-acids in human nutrition.

Model for human milk fat substitute evaluation based on triacylglycerol composition profile

Zou, X.-Q., *et al., J. Agric. Food Chem. 61*:167–175, 2013.

Being the dominant components in human milk fat (HMF), triacylglycerol (TAG) composition might be the best approximation index to represent the composing characteristics of HMF. In this study, TAG composition of HMF from different lactation stages was analyzed by RP-HPLC-APCI-MS (reversed phase-high performance liquid chromatography-atmospheric pressure chemical ionization-mass spectrometry), and the establishment of a model for the precise evaluation of human milk fat substitutes (HMFS) based on TAG composition was indirectly realized by employment of fatty acid composition and distribution and polyunsaturated fatty acid and TAG compositions. The model was verified by the selected fats and oils with specific chemical compositions, and the results revealed the degrees of similarity of these fats and oils in different evaluation aspects reflected their differences in corresponding chemical composition with HMF. The newly established evaluation model with TAG composition as a comparison base could provide a more accurate method to evaluate HMFS and might have some inspirations for HMFS production in the future.

Identification of tocopherols, tocotrienols, and their fatty acid esters in residues and distillates of structured lipids purified by short-path distillation

Zou, L., and C.C. Akoh, *J. Agric. Food Chem. 61*:238–246, 2013.

The fate of endogenous vitamin E isomers during production and purification of structured lipids (SL) was investigated. Two SL involving tripalmitin, stearidonic acid soybean oil, and docosahexaenoic acid were synthesized by transesterification catalyzed by Novozym 435 (NSL) and acidolysis by Lipozyme TL IM (LDHA) and purified by short-path distillation (SPD). The electron impact and chemical ionization mass spectra of tocopheryl and tocotrienyl fatty acid esters in the distillates measured by gas chromatography-mass spectroscopy in synchronous scan/selected ion monitoring mode demonstrated that these esters were formed during acidolysis as well as transesterification. The predominant esters were tocopheryl palmitate, tocopheryl oleate, and tocopheryl linoleate homologs, and no tocopheryl or tocotrienyl linolenate, stearidonate, or docosahexaenoate was found. Meanwhile, none of these esters were detected in the residues for either NSL or LDHA. Less than 50% of vitamin E isomers were present in residues after SPD. This loss played a major role in the rapid oxidative deterioration of SL from previous studies with less contribution from the formation of tocopheryl and tocotrienyl esters. The lost tocopherols and tocotrienols present at high concentration in the distillates may be recovered and used to improve the oxidative stability of SL.

Effect of omega-3 (n–3) fatty acid supplementation in patients with sickle cell anemia: randomized, double-blind, placebo-controlled trial

Daak, A A., *et al., Am. J. Clin. Nutr. 97*:37–44, 2013.

Blood cell aggregation and adherence to vascular endothelium and inflammation play a central role in vaso-occlusive crisis in sickle cell disease. The antiaggregatory, antiadhesive, antiinflammatory, and vasodilatory omega-3 (n–3) fatty acids [docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA)] are significantly reduced in patients with the disease. The therapeutic potential of omega-3 fatty acids for patients with homozygous sickle cell disease was investigated in a randomized, placebo-controlled, double-blind trial. One hundred forty patients recruited from a single center in Sudan were randomly assigned and received, daily, 1 (age 2–4 y), 2 (age 5–10 y), 3 (age 11–16 y), or 4 (age ≥17 y) omega-3 capsules containing 277.8 mg DHA and 39.0 mg EPA or placebo for 1 y. Of these patients, 128 were followed up and the data were obtained. The primary and secondary end points—rates of clinical vaso-occlusive crisis and hemolytic events, blood transfusion rate, school attendance, and blood count—were analyzed by intention-to-treat analysis (n =

140). Omega-3 treatment reduced the median rate of clinical vaso-occlusive events (0 compared with 1.0 per year, $P < 0.0001$), severe anemia (3.2% compared with 16.4%; $P < 0.05$), blood transfusion (4.5% compared with 16.4%; $P < 0.05$), white blood cell count (14.4 ± 3.3 compared with 15.6 ± 4.0 $\times 10^3/\mu L$; $P < 0.05$), and the OR of the inability to attend school at least once during the study period because of illness related to the disease to 0.4 (95% confidence interval: 0.2, 0.9; $P < 0.05$). The findings, which need to be verified in a large multicenter study, suggest that omega-3 fatty acids can be an effective, safe, and affordable therapy for sickle cell anemia.

Structure elucidation and chemical profile of sphingolipids in wheat bran and their cytotoxic effects against human colon cancer cells

Zhu , Y., *et al., J. Agric. Food Chem. 61*:866–874, 2013.

Sphingolipids are known to have diverse properties and physiological functions. These distinctive lipids have been identified in wheat bran, a food well-known for its chemopreventive activity. However, the complete profile of sphingolipids in wheat bran and their contributions to the cancer-preventive effect of wheat bran have not been fully explored until this study. Twelve sphingolipids (**1–12**) were purified from wheat bran extract and characterized by analyzing their one-dimensional and two-dimensional nuclear magnetic resonance(NMR) spectra, and seven sphingolipids (**13–19**) were characterized based on their tandem mass spectra (MS^n: n = 2–4). To the best of our knowledge, this is the first report of sphingolipids **1**, **6–9**, **11–14**, and **16–19** in wheat bran. In particular, 2-*N*-(2′-hydroxy-15′-tricosenoyl)-4-hydroxysphinganine (peak **17**) is a novel compound. Additionally, compounds **2–4** were reported with complete NMR data for the first time. Sphingolipids (**1–12**) showed little growth inhibition against human colon cancer cell lines (HCT-116 and HT-29) *in vitro*.

Rapid magnetic solid-phase extraction based on monodisperse magnetic single-crystal ferrite nanoparticles for the determination of free fatty acid content in edible oils

Wei, F., *et al., J. Agric. Food Chem. 61*:76–83, 2013.

This study proposes a rapid magnetic solid-phase extraction (MSPE) based on monodisperse magnetic single-crystal ferrite (Fe_3O_4) nanoparticles (NP) for determining the quantities of eight free fatty acids (FFA), including palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2), linolenic acid (C18:3), arachidic acid (C20:0), eicosenoic acid (C20:1), and behenic acid (C22:0) in oil. The amine-functionalized mesoporous Fe_3O_4 magnetic NP were applied as a sorbent for MSPE of FFA from oil samples in a process that is based on hydrophilic interaction. The extraction can be completed rapidly in a dispersive mode with the aid of vigorous vortex. Additional tedious processing steps such as centrifugation and evaporation of organic solvent were not necessary with this procedure. Furthermore, esterification of FFA can be accomplished during the desorption procedure by using methanol/sulfuric acid (99:1, vol/vol) as the desorption solvent. Several parameters affecting the extraction efficiency were investigated, including the matrix solvent for extraction, the desorption solvent and desorption time, and the amount of sorbent and extraction time. The pretreatment process was rapid under optimal conditions, being accomplished within 15 min. When coupled with gas chromatography–flame ionization detection (GC-FID), a rapid, simple, and convenient MSPE-GC-FID method for the determination of FFA in oil samples was established with a total analysis time within 25 min. The limits of detection for the target FFA were found to be 7.22–26.26 ng/mL. Recoveries in oil samples were in the range of 81.33–117.75%, with relative standard deviations of <6.4% (intraday) and <6.9% (interday). This method was applied successfully to the analysis of dynamic FFA formation in four types of edible oils subjected to an accelerated storage test. The simple, rapid, and cost-effective method developed in the current study offers a potential application for the extraction and preconcentration of FFA from hydrophobic sample matrices, including edible fats and oils, fatty foods, and biological samples with high amounts of lipid.

Three short perioperative infusions of n-3 PUFAs reduce systemic inflammation induced by cardiopulmonary bypass surgery: a randomized controlled trial

Berger, M.M., *et al., Am. J. Clin. Nutr. 97*:246–254, 2013.

Fish oil (FO) has antiinflammatory effects, which might reduce systemic inflammation induced by a cardiopulmonary bypass (CPB). We tested whether perioperative infusions of FO modify the cell membrane composition, inflammatory responses, and clinical course of patients undergoing elective coronary artery bypass surgery. A prospective randomized controlled trial was conducted in cardiac surgery patients who received three infusions of 0.2 g/kg FO emulsion or saline (control) 12 and 2 h before and immediately after surgery. Blood samples (seven time points) and an atrial biopsy (during surgery) were obtained to assess the membrane incorporation of polyunsaturated fatty acids (PUFA). Hemodynamic data, catecholamine requirements, and core temperatures were recorded at 10-min intervals; blood triglycerides, nonesterified fatty acids, glucose, lactate, inflammatory cytokines, and carboxyhemoglobin concentrations were measured at selected time points. Twenty-eight patients, with a mean ± SD (standard deviation) age of 65.5 ± 9.9 y, were enrolled with no baseline differences between groups. Significant increases in platelet eicosapentaenoic acid (EPA; +0.86%; P = 0.0001) and docosahexaenoic acid (DHA; +0.87%; P = 0.019) were observed after FO consumption compared with at baseline. Atrial tissue EPA concentrations were higher after FO than after control

CONTINUED ON PAGE 191

New biodiesel production easier and more economical

Michael Logli

- **Conventional biofuels production creates unwanted waste products and involves chemicals that can be dangerous to handle.**
- **Enzymatic processes generate fewer waste products and allow lower grade raw materials to be used.**
- **Several companies are already building plants that will make these processes a reality.**

Biodiesel fuels are not new. And the process for mass production, which is quite old, creates unwanted waste products that require additional effort and finances to remove and chemicals that are dangerous to handle. Now a sustainable and affordable process, once out of reach, has come forward, and several companies will use this process to develop and distribute their own biodiesel fuels.

Biodiesel can be made in several ways. The most common method involves the use of animal fats or vegetable oils. These contain triglycerides, which react with alcohols to make fatty acid esters. Methanol is usually used, as it is the cheapest available alcohol. A catalyst is then used to speed up the reaction, converting the triglycerides into biodiesel and glycerin. But the catalyst must be removed at the end of the process; if left in the biodiesel, the base catalyst can damage the vehicle engine, and handling the acid catalyst can be dangerous.

The company Novozymes (Franklinton, North Carolina, USA), after more than 10 years of research, has developed an enzymatic process, the BioFAME process, that reduces the waste products from the biodiesel reaction and enables the use of lower-grade raw materials high in free fatty acids. The new enzyme, the Novozymes Callera Trans, replaces the sodium methoxide base catalyst, producing a higher-quality glycerin free of salts.

Piedmont Biofuels also developed an fatty acid esterification process (FAeSTER) alongside Novozymes, which allows producers to use lower grade oils, such as used cooking grease, and recycle the enzyme catalysts. This process eliminates the need for sulfuric acid-catalyzed esterification of free fatty

acids. The enzymatic process is overall far more cost effective and safer than the acid chemical process, said Rachel Burton, co-founder and research director of Piedmont.

"The old process is quite good if you have pure materials," said Hans Christian Holm, head of global industry sales for Novozymes. "The new process will not have such drawbacks. We have shown how the BioFAME process can handle more or less all oils and fats while being cost competitive to the old sodium methoxide catalyzed process."

The Novozymes process allows for the safe, environmentally friendly, and, most important for Holm, cost-competitive option. Other processes attempting to be more sustainable are not cost-effective enough to become popular options.

"At the end of the day, you are not going to sell anything by the environmental aspect. You have to compete on cost," Holm said.

Piedmont has begun to build a factory employing the FAeSTER process in Pittsboro, North Carolina, that will be able to produce up to one million gallons of biodiesel each year. Using yellow and brown grease, Burton is confident in being able to fulfill the needs of Piedmont's more than 500 customers in the local North Carolina area.

"We have a wide range of feed stocks. We have the flexibility," Burton said. "We ship it directly to our customers. It is a much different model."

Piedmont is also unique in that it is a B-Certified corporation. The B-Lab certification is proof of adhering to strict standards of social and environmental performance and transparency, and it is the only business in North Carolina with this designation. Piedmont has also been recognized with the BQ9000 certification because of the high quality of its biodiesel. This gives them the ability to work with government agents and distribute biofuels to those markets. It also supports Piedmont's commitment to sustainability in products and production.

Viesel Fuel is also building its own plant implementing the enzymatic process in Stuart, Florida, said process engineer Graham Towerton. The facility should be completed in the first quarter of 2013 and will make 5—10 million gallons a year, distributing mainly to the transportation industry. Viesel will mostly use vegetable oil in its process, but it has looked into using the abundant supply of fish oil as another option. Working in Florida also has the advantage of warm weather. Biodiesel can crystallize in colder weather due to its low boiling point, gumming up engines and reducing performance and durability.

"The Florida climate gave us advantages," Towerton said. "We can sell fuel here that might not work in northern climates. We expect to be able to sell all year round."

Viesel's biggest concern is transportation costs. While Viesel must transport its fuel by truck to its customers, it must also clean its biodiesel tankers. The closest facility to clean the trucks is over 200 miles away. This is why Viesel plans to build its own facility for this purpose, as well as encourage other companies to use the facilities, Towerton said. Viesel also plans to use the biodiesel process as a base for self-lubricating oils. These oils, such as engine oil and hydraulic oil, can be used in a variety of applications.

"There are no process limitations. We already got a number of customers looking to purchase all of our volume," Towerton said.

Both Burton and Towerton plan to market the technology to other interested companies. Towerton will likely bring the process to Texas, while Burton has already given presentations on the process in other states.

"The technology we drew up . . . we intend to market to other folks in the industry," Towerton said.

"We believe that this technology will shift the industry to cleaner, more efficient means of production for today's advanced diesel engines," Burton said.

The process, however, is not a panacea for the industry. The challenge now is proving the process will be efficient and fulfill market needs on an industrial scale, said Michael Haas, research biochemist at the US Department of Agriculture. The US government, according to Haas, wants to increase the production of biodiesel from the current one billion gallons produced annually to four billion annually in the next five to seven years. To meet that goal, sustainable biodiesel processes must meet the quotas while remaining efficient and environmentally friendly.

Haas fears working with used cooking oils and animal fats will not be enough to satisfy this. There is currently no perfect oil solution either. Vegetable oils and animal fats may be recycled in multiple biodiesel production processes, but recovering the enzyme from a viscous solution through ultrafiltration becomes difficult. Haas believes oil isolated from algae may be a solution in the future. Algae are easier to cultivate and grow compared to soybeans and produce more oil per acre, and their by-products can be converted into biobutanol, bioethanol and other forms of fuel and consumer-grade oil. The potential for growth and advancement is there, just as it was before. The key now is finding the solutions.

"Engineers know the engineering solutions that biochemists cannot solve," Haas said. "If we are going to increase production fourfold, we need to pursue more fats."

Want to know more?

Those looking to learn more about this biodiesel production process can find it at the 104th AOCS Annual Meeting and Expo. The session "Enzyme processes enable high-yield biodiesel production" will focus on this important topic. For more information, go to http://annualmeeting.aocs.org.

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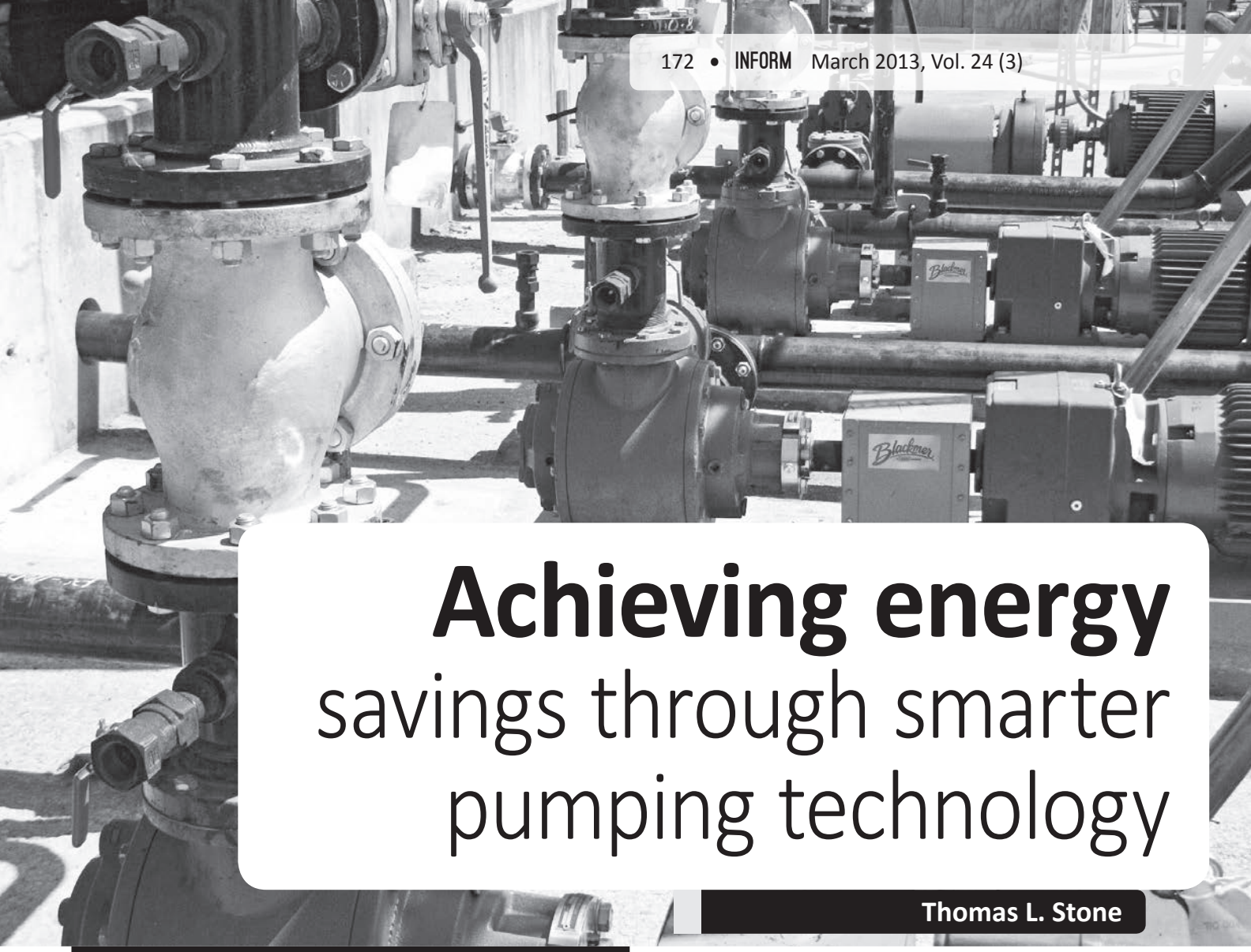

Achieving energy savings through smarter pumping technology

Thomas L. Stone

- **Twenty-seven percent of the electricity consumed in an industrial system that requires liquid handling is used to operate pumps.**
- **With worldwide industrial energy consumption expected to increase by 42% through the year 2035, pumping technologies that save energy can give manufacturers a competitive edge.**
- **Side-by-side comparisons show that sliding vane pumps can be as much as 24% more efficient than gear models.**

In recent years, two new variables have been introduced to the oils, surfactants, detergents, and related materials manufacturing equation. As energy costs continue to rise, manufacturers are pressed to control those costs through the implementation of pumping systems that are more bottom-line friendly. At the same time, plant operators are being asked to introduce operational enhancements that are deemed to be more environmentally friendly. While it may seem as if these are competing goals, it is possible to achieve both ends with one solution.

Research conducted by The Hydraulic Institute (HI), a trade association based in Parsippany, New Jersey, USA, and presented in *Improving Pumping System Performance: A Sourcebook for Industry* has determined that more than one-quarter of the electricity consumed in an industrial system—27% to be exact—is used to operate pumps. This makes pumping

systems a natural target when identifying ways to reduce energy consumption.

Toward that end, HI has created a video training program designed to help viewers identify ways to achieve energy savings. Some of these include:

- Designing systems with lower capacity and total head requirements. Reducing flow capacity through the use of lower velocity in the heat exchanger and eliminating open bypass lines will lower energy consumption. So will a reduction in total head requirements through a decrease in pressure and elevation changes, along with the use of larger pipes and low-loss fittings.
- Avoiding the use of an excessive margin of error in capacity or total head. Energy savings can be as high as 20% if pumps are sized based on reasonable system head and capacity requirements. This means identifying the pumping system's actual flow and pressure rates and sizing equipment based those measurements.
- Selecting the most efficient pump type and size from the outset. Ultimately, the choice of pump depends on the service needed from the pump. However, one must also consider flow, pump speed, inlet pressure, and net positive suction head, as well as the type of liquid to be pumped. Selecting the proper pump for the job at the start based on readily quantifiable operational parameters—rather than emphasizing initial cost—will result in additional energy savings in the long run.
- Using two or more smaller pumps instead of one larger pump to optimize capacity. Two pumps can be operated in parallel during peak demand periods with one pump operating by itself during periods of lower demand. In this setup, energy savings result from running each pump at a more efficient operating point while avoiding the need to throttle back a larger pump during low-demand periods.
- Maintaining pumps and components in virtually new condition. Wear is a significant cause of decreased pump

CONTINUED ON PAGE 192

Two markets, one pump solution

Industries do not operate in a vacuum. One industry's waste product may be another's feedstock. For example, take the manufacture of two seemingly unrelated products—soap and detergents, and biodiesel.

As the production and use of biodiesel has grown, so has the world's supply of crude glycerin, a by-product of the transesterification process used to make biodiesel. Beginning in 2006 and continuing through 2015, the United States biodiesel industry is expected to produce 1.4 billion pounds (more than 635,000 metric tons) of glycerin. This glut of crude glycerin has forced prices for the commodity down, meaning that many biodiesel producers are selling their excess glycerin at a loss.

As it happens, crude glycerin that has been filtered to remove food particles and impurities can be made into bar soap. Bar soap made from glycerin has excellent degreasing abilities, making it ideal for cleaning applications that require the breakdown and removal of greases and oils. Additionally, by adding various fragrances and dyes, glycerin can be used to make household soap, as well.

So, while these two industries may appear to have nothing in common, they actually do, and sliding vane pumps offer advantages to both. The energy-saving features outlined above make them highly effective in the production of soap and detergents, while their stainless-steel construction, metallized-carbon sleeve bearings, and nonmetallic vanes give them the ability to handle the caustic fluids used in the biodiesel production process. Meanwhile, the wetted parts of SNP Series Sliding Vane Pumps from Blackmer, which are ideal for use in these types of applications, are not affected by friction, which also reduces maintenance worries and costs.

How to successfully manufacture
a low-fat spread with only 10% fat

Instability problems and insecure production parameters can make low-fat spreads challenging to produce. In this article, a product and applications manager from the Danish emulsifier specialist Palsgaard A/S describes how his company:

- **created an emulsifier system for 10% low-fat spreads**
- **stabilized the fat and water phases**
- **set up optimal processing and storage conditions**

Anders Mølbak Jensen

Reducing the fat content in a margarine spread beyond the traditional 40% can help meet the growing consumer demand for spreads with less saturated fat and total fat, while decreasing the total cost of raw materials . Yet, historically, margarine, dairy, and other spread producers have been cautious about developing and producing low-fat spreads due to the problems these products can present during production, such as an increased risk of unstable products and insecure production parameters.

At Palsgaard we therefore decided to see if it were possible to successfully create a low-fat spread with only 10% fat content with the following boundaries:

- 10% fat content
- no hydrogenated oils or fats
- no hydrogenated emulsifiers
- offers the potential to use sustainable palm oil (RSPO certified)
- no allergenic ingredients
- non GMO
- no *trans* fatty acids (<1 %)

To do so, we created the recipe shown in Table 1, which we subsequently tested in our large-scale margarine pilot plant to specify the right processing parameters. The following explains how we achieved the desired results.

TABLE 1. Recipe suggestion for a 10% low-fat spread

Emulsifier	Mono- diglyceride (High Oleic)	0.60%
	PGPR (extra polymerised)	0.40%
	Oil absorber (TAG)	0.70%
Oil blend	RDB palm oil	2.00%
	Rape seed oil	6.26%
	Flavour	0.02%
	Colour Annatto	0.02%
Water phase	Salt	0.60%
	Potassium sorbate	0.20%
	Maltodextrine	1.50%
	Sodium alginate	0.55%
	Water	87.15%
	Adjusted to pH 4.5 with citric acids	
Total content		100%

The emulsion type used in the recipe was water in oil (W/O) as used in other margarine and spread products. In theory, it is difficult to reduce the fat content of a spread to lower than 25.4% if the water droplets have exactly the same size in a W/O emulsion, as shown in Figure 1a. In practice, however, by utilizing the combined benefits of the two emulsifier types unsaturated mono- diglyceride (MAG) and polyglycerol polyriceneolate (PGPR) it is possible to create water droplets with different sizes. By doing so, the emulsion can be much more closely packed as shown in Figure 1b. This is the reason why it is possible to produce 20% - 15% or even 10% low-fat spreads.

INSTABILITY PROBLEMS IN LOW-FAT SPREADS

When creating a low fat spread, it is important that the fat composition contains more liquid oil than similar high-fat products, due to the fact that the oil phase needs to cover a higher amount of water droplets. If the fat phase contains too much solid fat, the smoothness of the product will disappear. Equally, if the emulsion contains too much palm stearin it will tend to become more unstable in 10% low-fat spreads compared to palm oil. The reason is probably more brittleness during and after production.

Figures 2a and 2b (page 176) demonstrate the build-up of the primary crystal bond structure and how the fat, if it is brittle more or less, squeezes out the water with mechanical treatment. The emulsifiers that are located at the surface between the water- and oil phase cannot avoid this phenomena. Only a combination of the right process parameters and fat composition can solve the problem. Thus, when free water is found, it is not always because of an emulsifier problem.

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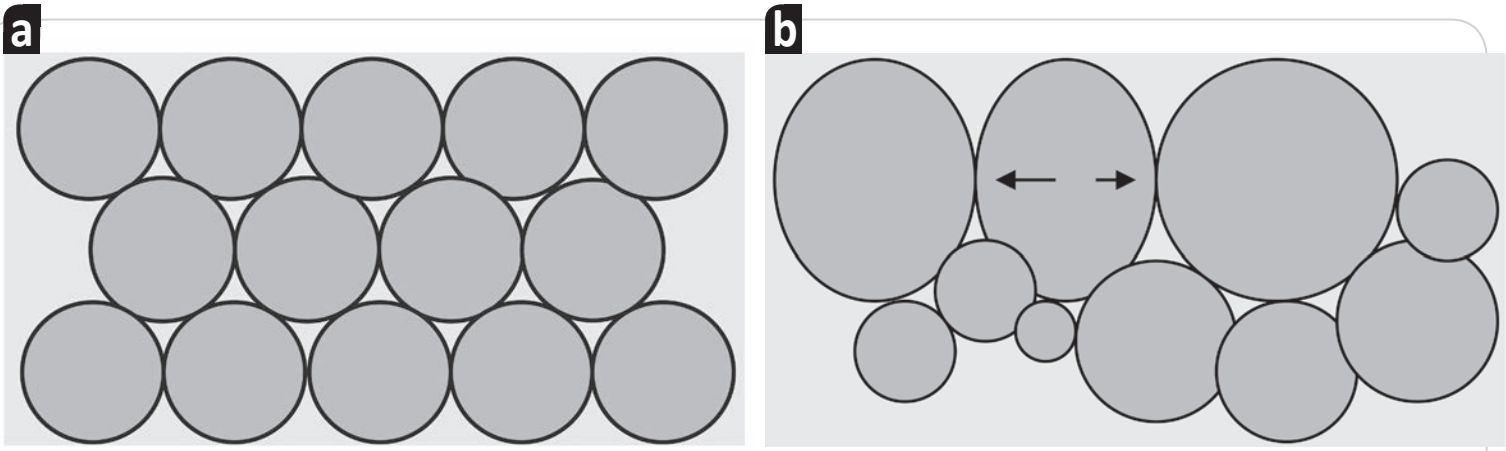

FIG 1. a: Water droplet size in a traditional 25.4% spread. **b:** Water droplet size in a 10% spread made with mono-diglyceride and PGPR.

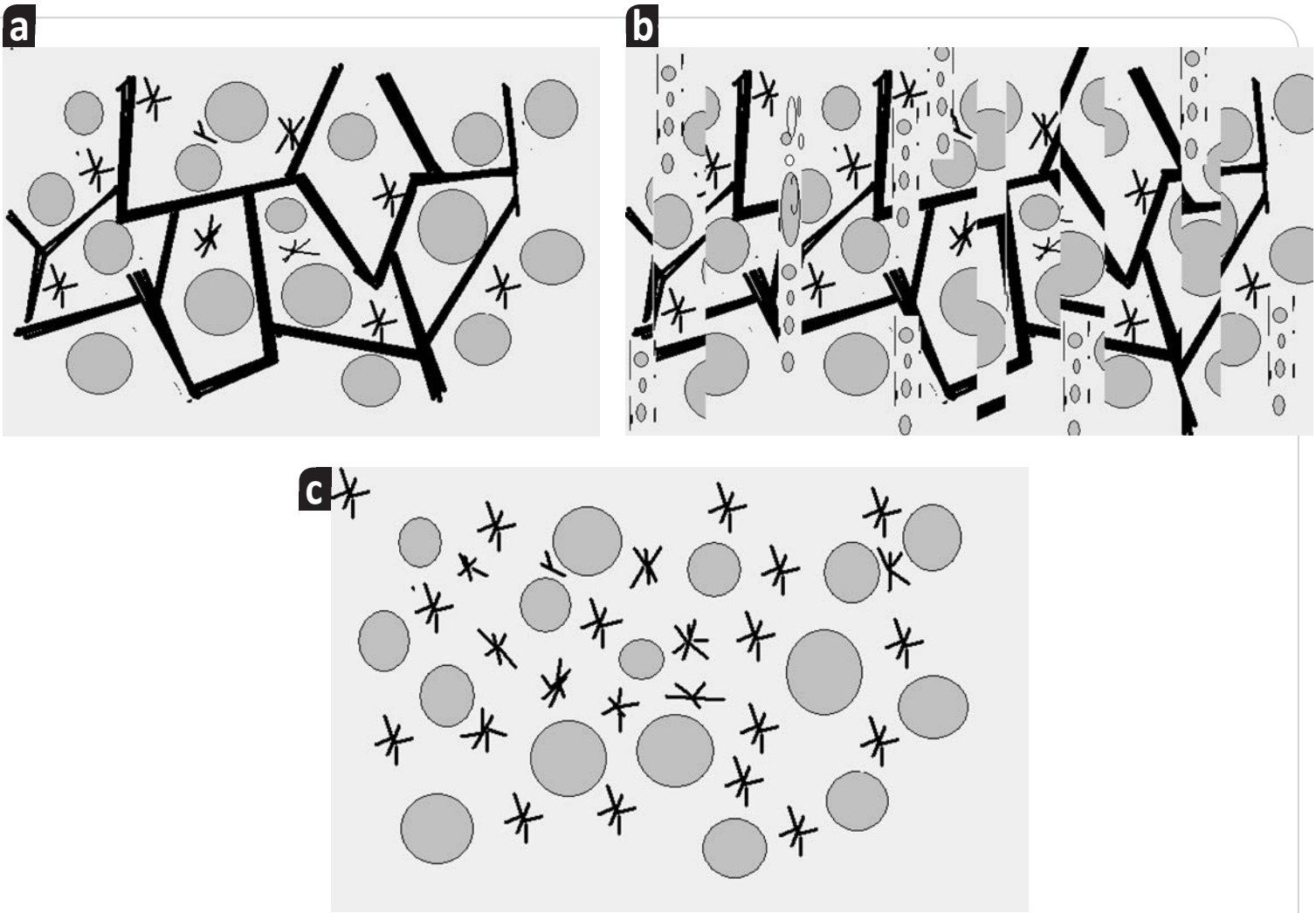

FIG. 2. a: Primary crystal bond structure. **b:** Free water after squeezing. **c:** Secondary crystal bond structure.

Figures 2a and 2c show the effect of crystallization, the development of crystals, and the formation of a crystal network. Mechanical treatment will break down the primary crystal bond structure and give a more smooth structure with plasticity mainly based on van der Waals forces (secondary crystal bond structure).

CREATING AN EMULSIFIER SYSTEM FOR 10% LOW-FAT SPREADS

To face the challenge of oil separation and secure the right mouth-feel of the spread, we used two different types of emulsifiers. One was a special unsaturated mono-diglyceride in which the fatty acid composition is mainly based on oleic acids. These unsaturated fatty acids offer better emulsification and emulsion stability for reduced and low fat spreads compared to standard mono-diglycerides. The other emulsifier used in the trials was a polyglycerol polyricineolate (PGPR) based on fatty acids of polymerised castor oil esterified with highly polymerised polyglycerol ester.

PGPR is a co-emulsifier, meaning that you will only obtain the desired effect if it is used in combination with another type of emulsifier. In low-fat spreads PGPR is exceptionally good at coating water droplets and fat crystals, and increasing viscosity in low-fat emulsions.

It was therefore critical in stabilizing the 10% low-fat spread, avoiding fluctuations during the production process, and reducing the amount of rejected product. It is important that the PGPR be neutral in both taste and smell to avoid any off-tastes in the spread.

STABILIZING THE FAT PHASE

Oil absorbers based on non-hydrogenated fractionated vegetable fats (TAG) are especially suited for applications in which we do not want to use hydrogenated products. The oil-absorbing effect is effective in products which contain a high amount of liquid oil, such as the oil phase in low-fat spreads. The oil-absorbing behavior reduces the risk of oiling out.

THE EFFECT OF SODIUM ALGINATE IN 10% LOW-FAT SPREADS

In the water phase, we added sodium alginate, which reacts as a thickener of the water phase. It stabilizes the water phase in

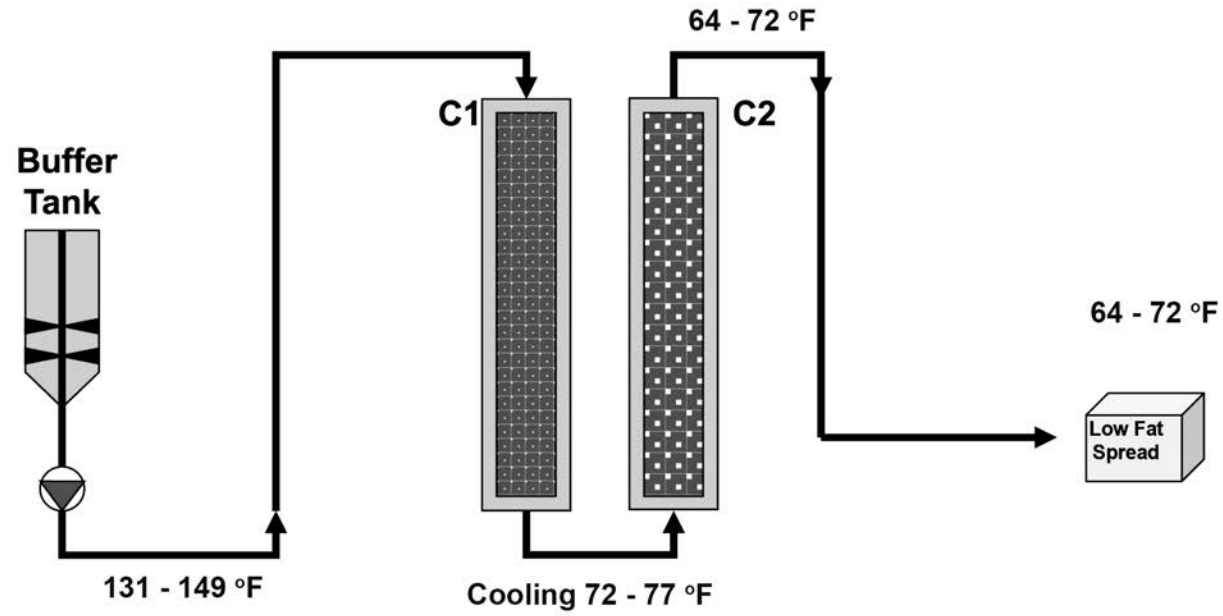

FIG. 3. Process flow chart of a low-fat spread emulsion.

the 10% low-fat spread and reduces the risk of squeezing out the water.

Sodium alginate also improves the mouth-feel of very low-fat spreads. The optimal effect is achieved when using 0.55% sodium alginate. At 0.75% sodium alginate the water droplets become too viscous , and the spread starts to become less stable with a higher risk of free water.

HOW TO SET UP THE RIGHT PROCESSING CONDITIONS

The process of manufacturing these low-fat spreads is the opposite of what is traditionally used when making a 40% spread. Therefore, the practical experience from producing 40% low-fat spreads cannot be used in the production of very low-fat spread emulsions. Figure 3 shows the process flow needed to successfully manufacture a 10% low-fat spread.

The water phase needs to be added slowly, but the emulsion itself will have a tendency to build up a lot of viscosity in very low-fat spreads if the mechanical treatment is too intensive. The stirrers that are functioning fine when making 30 - 40% low-fat spread emulsions need to be designed for more viscous emulsions otherwise "dead" areas will arise in the emulsion tank. Anker stirrers function very well in emulsion tanks for

CONTINUED ON NEXT PAGE

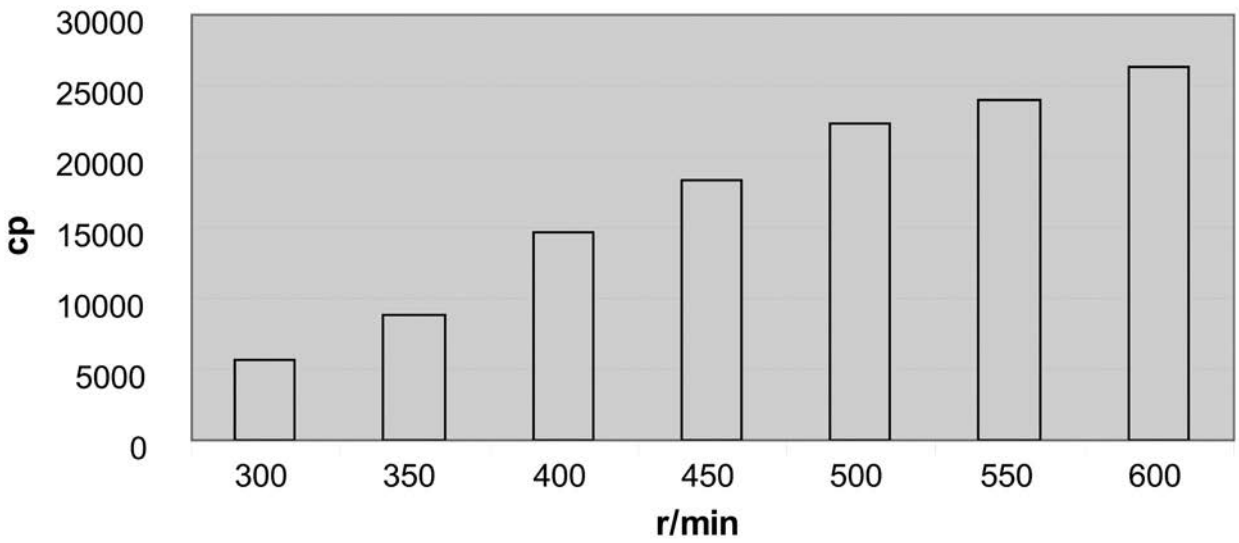

FIG. 4. Viscosity in low-fat spread emulsions.

the relative high-viscous emulsions. Slow agitation is important to avoid the build-up of too viscous emulsions. Figure 4 (page 177) shows that double up of agitation in a pre-emulsifying unit can increase the viscosity up to 5 times.

Keeping the temperature between 131 – 149°F in the emulsion and buffer tanks is important for reducing the risk of high viscous emulsions. If this is not heeded the viscous emulsion may become so thick that it is impossible to pump from the tanks. This is also why pin machines are not necessary in the production flow. The production capacity can be high and the packing temperatures do not need to be very low because of the cooling capacity in the water phase.

The crystallization part of the process is important, but in another way compared to high fat margarine products. In low fat spreads the fat crystals do not dominate the structure in the same way as in margarine and butter. The concentrated packing of water droplets produce a W/O emulsion with a more mayonnaise-like structure. In high fat margarines the mouth-feel is affected by the melting crystals and the subsequent phase inversion of the emulsion. Low-fat products and their very strong emulsifier systems reduce the instability effect just because the fat crystals melt down unlike the high-fat products.

STORAGE—THE LAST STEP IN PRODUCTION

In the first days after production the crystallisation and formation of crystal network will continue, thereby affecting the low-fat spread. It is our experience that high storage temperatures help transform the spread to a softer product also after cooling to low temperatures. Contrary, fast cooling directly from production will increase the tendency to brittle and more unstable low-fat spreads. Therefore, the best way to store low fat spreads is at 59°F for 3-5 days before cooling it down to 41°F.

CONCLUSION

As described above, it is possible to create a low-fat margarine spread with only 10% fat and overcome the usual challenges of oil separation and poor mouth-feel, but it must be done with a clear focus on the recipe and on the production parameters. Choosing the right combination of emulsifiers will get you most of the way, and getting your processing parameters right will get you the rest of the way.

Anders Mølbak Jensen worked as a research and development and quality control laboratory manager at a Danish margarine factory (VM Margarine) for 10 years. For the past 14 years, he has been a product and application manager at the Danish emulsifier specialist Palsgaard A/S (www.palsgaard.com), with technical responsibility for the Lipid and Fine Food Group (margarine and mayonnaise) including products and their applications. He can be contacted at am@palsgaard.dk. or 011 45 7682 7682. This article was originally published as a Palsgaard Technical Paper in September 2012.

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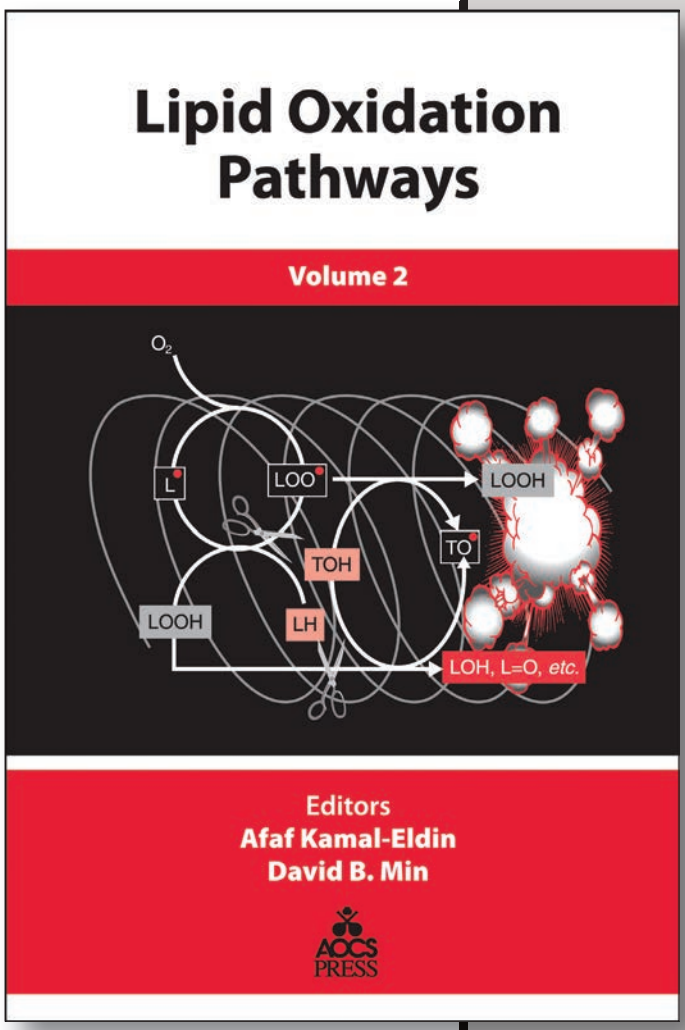

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FIG. 1. Vials show the range of phase behaviors possible from variations in surfactant, oil, and salt compositions and concentrations.

High throughput research for formulators

J. Keith Harris, Melinda H. Keefe, and Chris Tucker

- **The use of automated tools for the fabrication, processing, and evaluation of liquid formulations can lead to faster results, reduced waste streams, and more effective training.**
- **The key is to identify redundant, but critical, processes that can be automated easily using existing technology.**
- **A successful tool design should be able to rank samples, tolerate small variations in operating conditions, differentiate between samples at a level similar to what a researcher could do, and be statistically repeatable.**

High throughput screening (HTS) has become almost ubiquitous in biological and pharmaceutical research. The Scripps Research Institute describes HTS as "a drug-discovery process widely used in the pharmaceutical industry. It leverages automation to quickly assay biological or biochemical activity of a large number of drug-like compounds" (1). PRWeb recently reported that "High Throughput Screening today accounts for a significant 35% share in the global drug discovery technologies market" (2).

The appeal of HTS is easy to recognize. Automation not only increases reproducibility, it can operate 24 hours a day, 7 days a week, accelerating the discovery process often at better-than-break-even costs. Combine that with well-defined screens, smaller sample size, parallel sample processing, and automated data analysis, and clearly HTS is the logical decision for drug discovery. What about other areas of fundamental research? Could they benefit from the same approach to discovery?

CONTINUED ON NEXT PAGE

At its core HTS consists of multiple lab procedures that have been highly refined to make them amenable to automation, miniaturization, and parallelization. The key to a successful HTS program is the identification of redundant, but critical, processes that can be automated easily using existing technology. Liquid transfers, sample mixing, and thermal processing are examples of common actions that can be completed by a typical automated liquid handler. Since these are the bulk of a formulation chemist's activities, a clear opportunity exists to accelerate research in this field as well.

HIGH THROUGHPUT FORMULATIONS

High throughput preparation of liquid formulations follows a common procedure. The formulation components are identified, loaded, and calibrated on the liquid handler. The formulation recipe for each destination, which can be generated either by the chemist or Design of Experiment software, is compiled and executed by the instrument. The samples are then removed, covered, agitated, and allowed to equilibrate. Samples are evaluated for the characteristic of interest, such as clarity, pH, or thermal stability.

Initial formulation assessments generally focus on physical properties such as viscosity, odor, pH, clarity, and color. For example, analysis of sample clarity can be used to generate a phase diagram as a function of formulation temperature or composition. This procedure is so common that The Dow Chemical Company (Midland, Michigan, USA) designed and built a device specifically for this evaluation based on digital image analysis (3). Figure 1 (page 183) shows the quality of images captured during the process.

The transfer capabilities of a well-calibrated liquid handler are only limited by two factors: (i) liquid viscosity and (ii) component stability. While most devices can easily aspirate liquids up to 500 centipoise (cps), some units can handle more viscous material with fluids reaching 5,000 cps. Additionally, the source component, whether heterogeneous or homogeneous, must possess sufficient phase stability for reproducible transfer. Thus, any formulation composed of a set of uniform, low-viscosity liquids (including slurries, dispersions, solutions, emulsions, and suspensions) can be prepared using a liquid handler.

The formulations themselves are generally prepared in one of two devices: a microtiter plate, which is a one-piece substrate containing up to 96 wells, or a vial tray that holds up to 96 separate and removable vials. Each substrate offers specific advantages, and the desired results determine which device is appropriate. From source fluids (such as solvents, surfactants, and oils) to solutions (of buffers, biocides, chelants, defoamers, dyes, and fragrances) to dispersions (of pigments, thickeners, and polymers), potential products can include shampoo, paint, household cleaner, cutting fluids, laundry detergent, lubricants, heat transfer fluids, antiseptic solutions, coatings, adhesives, and much more. Basically, if a product can be formulated from low-viscosity liquids and shows enough stability, there is a way to create it using a liquid handler.

The real value, however, lies in the evaluation of formulation performance. Characteristics such as cleaning efficacy, soil suspension, wetting, filming and streaking, and fragrance release are just a few of the criteria that are studied to determine formulation performance. Producing a vast number of samples that cannot be adequately assessed simply moves the research "bottleneck" downstream. Therefore, a complete high-throughput research (HTR) program must also include rapid formulation performance screening. There are few manufacturers of such tools, so many research departments have invested substantial resources into creating specific HTR performance tests; but the principles of the workflow development are the same as with any analytical tool.

IMPACT/VALUE

HTS methods are usually pass/fail evaluations. To gain an even greater understanding of sample potential, more extensive preparation and testing methods are involved. As the lab extracts more information from each sample, the methodology moves from HTS to high-throughput research (HTR) or high-productivity research (HPR). The expectation is that much of the fundamental research can be completed using automated testing that has a strong correlation to conventional test results. Successful formulations no longer simply exceed some pre-defined threshold; they are ranked on several aspects of physical properties and performance. The results are weighted to provide a balanced evaluation of potential applicability. Much of HTS screening is based on the sample's physical properties. However, in the HTR approach, new tools are developed that use the HTS format and provide performance data on the formulation. A "cradle to grave" mentality is fostered that takes the formulation from synthesis through performance testing using miniaturization and parallelization methods throughout.

The impact of this HTR approach is threefold. The first is the acceleration of research. Not only does the lab generate more samples more rapidly (which alone is a valuable feature); but also one can leverage one's conclusions faster. The design of the second sample set can begin as soon as the initial tests of the first set are completed, allowing the researcher to begin narrowing the region of interest within minutes rather than days.

A second advantage is that HTR requires much less sample, often one-tenth the sample volume of conventional research. This lowers raw materials costs and waste handling challenges. The amount of experimental material required for evaluation is also significantly reduced. Often even this reduced sample volume is more than adequate for selected testing. After conducting nondestructive tests such as thermal stability, color, or clarity, aliquots of the formulation can be used in other tests. For example, soil solubility analysis requires typically 500 µL, a surface tension measurement about 50 µL and particle size distribution determination less than 100 µL, so a single 1000 µuL sample can be used for four evaluations.

A third advantage is the learning curve. Formulation chemists are a somewhat unique breed, to say the least, and formulation work is as much art as science. The complex interactions, both antagonistic and synergistic, can be overwhelming to the novice. HTR provides an exceptional format for training new chemists in this complex field. Using HTR, the novice can quickly see the outcome of using nonionic vs. anionic surfactants on foam formation; the effects of increasing electrolyte levels on emulsion stability, and the impact of a hydrotrope on

CONTINUED ON PAGE 186

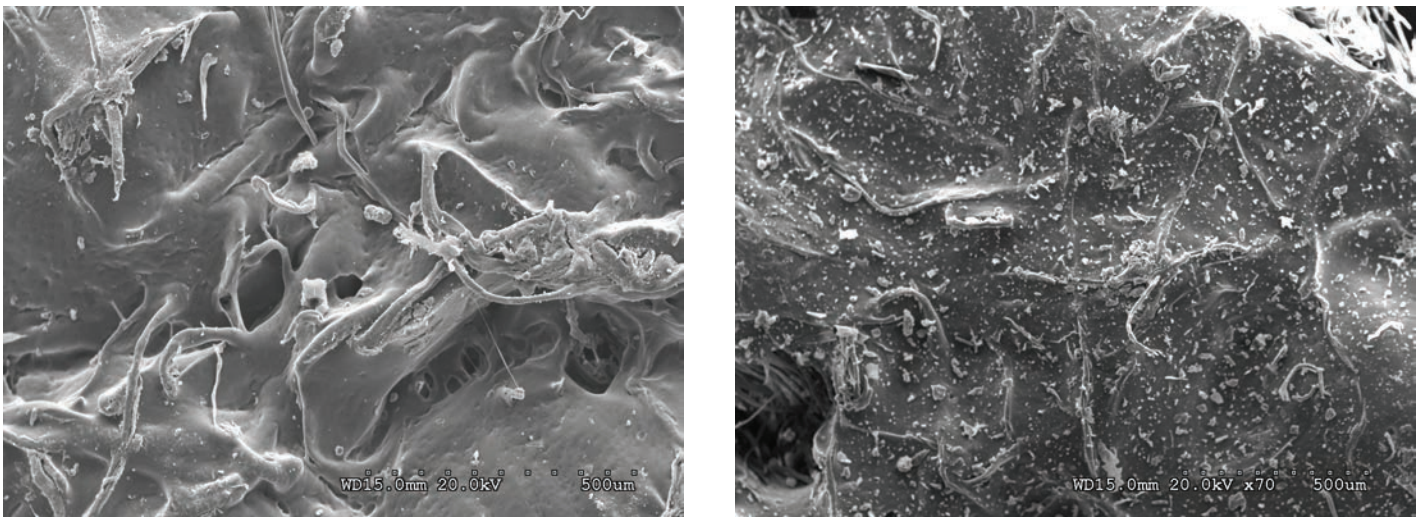

FIG. 2. Scanning electron micrographs of acrylic-painted surfaces. The image on the left is a clean (never soiled) surface and the image on the right is typical of a soiled surface Image, courtesy of Tate, © Tate, 2004.

Case study: evaluating and developing cleaning systems for artists' acrylic latex paints

Since their introduction in the mid-1950s, waterborne acrylic latex paints—commonly referred to as acrylic emulsion paints—have been widely adopted by artists (7). As a class of material, they exhibit great stability, being highly resistant to deterioration, discoloration, embrittlement, and/or mechanical failure. However, new materials present new challenges for those involved in the conservation and restoration of works of art.

One of the most commonly executed conservation treatments on any work of art is surface cleaning, that is, the removal of dust, dirt, and other deposits that have built up over time. Eventually, the dirt build-up may compromise the painting's appearance to such a degree that a cleaning treatment is warranted. The surface cleaning of acrylic emulsion paintings is, however, not a straightforward procedure for a number of reasons:

- Acrylic paintings are rarely varnished (unlike traditional oil paintings); as a result, dust and dirt deposit directly onto the paint surface. Acrylic latex paints are generally soft at room temperature, and dirt can become firmly ingrained (see Fig. 2).
- Dirt deposition can be exacerbated by greasy deposits on the surface, such as skin oils resulting from improper handling.
- Artists' acrylic emulsion paints are sensitive to a wide range of liquid agents commonly used for surface cleaning of other works of art. The surfaces of modern and contemporary paintings are often delicately nuanced, with subtle differences in gloss and texture critical to the painting's appearance and coherence.
- Surfactant originally present in the paint can migrate and collect at the surface, where it may contribute to the retention of surface dirt.

One of the key challenges therefore is to find cleaning agents that avoid or minimize these risks, but that are also effective at dirt removal. Other concerns highlighted by research studies include possible pigment removal (especially of organic pigments) and paint swelling by both organic solvent and aqueous systems.

An opportunity to advance research into the cleaning of acrylic paintings arose in early 2008 when scientists at The Dow Chemical Company began collaboration with the Getty Conservation Institute (GCI) in Los Angeles, California, and Tate in London, that was aimed at developing more effective methods for cleaning works of art created with acrylic latex paint. One of the key innovations of this research collaboration has been the application of Dow's HTR automated formulation, testing, and analysis facilities to the problem of formulating and evaluating cleaning efficacy of liquids applied in a way that reliably simulates the manual cleaning process typically used by conservators. In this collaboration, HTR tools from the coatings and consumer products workflows were modified to prepare and screen hundreds of cleaning formulations for the application of surface cleaning fine art acrylic paints. A key element of this work was the adaptation of one of Dow's HTR cleaning robots to closely simulate the process of manual swab cleaning. The leading candidates in each class of cleaning formulations were then evaluated in parallel via manual testing trials by conservators, with guidance and feedback coordinated by researchers at Tate.

Three classes of cleaning solutions were formulated and tested: aqueous solvents, aliphatic hydrocarbon solvents, and water-in-oil microemulsions. The goal for both the aqueous and aliphatic hydrocarbon solvent- based options was to formulate systems with optimum cleaning efficacy, so that contact time with the paint surface could be minimized during cleaning procedures. Water-in-oil microemulsions are a relatively new material class to the painting conservation field. Microemulsions were identified as a group of materials that could address the deficiencies of water-based and aliphatic hydrocarbon solvent systems.

In traditional cleaning solutions, aqueous systems have more powerful cleaning efficacy but also potentially pose more risk to paint films. Aliphatic hydrocarbon solvent-based systems are believed to have less impact on the original paint film, but demonstrate poorer cleaning efficacy. A series of aliphatic hydrocarbon-based water-in-oil microemulsions have recently been developed as part of the Dow/Tate/GCI collaboration. These systems provide new options for the treatment of acrylic paintings and other water-sensitive substrates. ■

liquid crystal formation. They can generate and evaluate more formulations in a month than they could in a year using the conventional methods. Ultimately, candidate formulations will be tested using conventional evaluation methods, but along the way the formulators are learning far more than they would be able to on a typical project. While HTR alone may not create a good formulation chemist, HTR can make a good formulation chemist better.

Whereas an HTR liquid formulations lab offers many advantages, it is not inexpensive. A simple, multichannel liquid handler can start at $100,000 and, with additional features, can easily exceed $200,000. Support equipment, such as plate readers, are typically $20,000 each, but, depending on function, can be more than $40,000. Heaters, shakers, balances and other processing equipment vary in price depending on capacity and versatility; however, one should expect a starting HTR lab to cost close to $500,000 once everything is in place.

There are ways to reduce this cost, such as purchasing used equipment, which is often half the cost of new equipment, or securing tools via leases or rental arrangements. A second option is to minimize the automation component of the HTR process and focus on the miniaturization and parallelization aspects instead. Working with HTS plates and vial trays to minimize volumes, purchasing multichannel hand-held liquid pipetters to formulate in parallel, and using statistically designed experiments can all help facilitate the transition to an HTR lab with minimal upfront investment.

HTR STRATEGY

There are two general approaches to HTR tools, comprehensive and modular; and they can be combined as desired within a given lab. In the comprehensive approach, a single device is built that includes the capability to perform all of the critical evaluations required within a given test methodology. For example, the BASF and Bosch companies worked together in 2005 to produce an HTR device that applies a coating to a substrate, transfers the substrate through a series of processing steps to cure the coating, then both visually and physically evaluates the coatings (4). Since then, BASF has purchased the European High Throughput Research Group HTE, to expand its HTR tool package (5).

The advantages of such an approach are significant. A single tool handles all aspects of a specific test protocol. Operator training can be minimal and yet consistently produce quality data. The unit described in the previous paragraph eliminates the biases introduced by manual sample preparation and can process dozens of samples per day. While limited in versatility, these units are extremely efficient, rapid-testing systems. Comprehensive devices such as these are intended to produce better-than-bench-scale data at several times the bench rate. All steps, including data processing, can be standardized and optimized for speed and accuracy. Plus, the device can be duplicated as needed to expand research and development (R&D) capability.

In the modular approach, individual devices are purchased or designed to perform a specific sample evaluation, much like

conventional lab equipment except that these tools generally test multiple samples simultaneously. Using this approach, the researcher defines a sequence of sample preparation, processing, and evaluation steps, called a workflow, for a given experimental activity. Samples are generally moved manually from workstation to workstation, making a comprehensive Lab Information Management (LIM) System invaluable. Each workstation provides an increase in sample evaluation rate by processing multiple samples simultaneously.

An example of one step in the workflow would be colorimetric evaluation. This procedure is so common that many liquid handlers have a compact UV/Vis (ultraviolet/visible) plate reader fixed to the formulation deck. A conventional UV/Vis reader requires about 5 mL of sample be placed into a cuvette, which is inserted into the test chamber, scanned, then replaced with the next sample. The SpectraMax 190 Plus (Molecular Devices, Sunnyvale, California, USA) is a UV/Vis spectrophotometer plate reader that can measure the UV/Vis absorbance of 96 samples at a single wavelength in about two minutes. It can complete a full spectral sweep (190 to 800 nm) of all 96 samples in about 12 minutes and it does so using sample volumes of between 50 and 300 µL. (Newer models may be faster.) A reference cuvette can be inserted into the instrument to provide a background or baseline measure for comparison if desired. The samples can then be transferred to another device for additional evaluation.

There are several advantages to the modular approach when creating an HTR lab. This strategy maximizes the versatility of lab equipment, allowing the users to perform a variety of different processes on the same instrument. Up-front capital costs are lower since equipment can be purchased and integrated as needed. Physical workflows can be optimized for the lab space. Finally, as advances in specific HTR technology occur, they can be integrated into the workflow without a major tool redesign.

Another aspect of the HTR strategy, which also must be determined early on, involves allocation of the HTR resources. For smaller businesses the decision may be obvious because the options are limited; they have a single R&D facility and all resources are centrally located. In some larger corporations, for example the Dow Chemical Company, the HTR labs are services accessible to any R&D group. In others, such as Procter & Gamble (Cincinnati, Ohio, USA), some of the equipment is highly specific to a certain technology and is restricted to a selected group or set of groups. Additionally it is important to decide early on if there will be a strategy to implement HTR capabilities at multiple sites or contain it at a single location. Unilever (London, UK) has made a corporate decision to have HTR tools only in its Port Sunlight, UK location. The logistics of database management, network capacity, and hardware and software support all depend heavily on these decisions.

TOOL DESIGN

While HTR offers numerous advantages to R&D departments, it is not an option for all research organizations. Each R&D lab must first consider the type of experimentation that they routinely conduct and the amount of resources currently committed to that effort. For groups that see little constancy in their activities, HTR

CONTINUED ON NEXT PAGE

Some useful tips

- **Initially consider only the most commonly used research procedures to convert to HTR processes.**
- **Evaluate the entire process, from formulation synthesis to performance testing.**
- **When equipment such as a UV/Vis unit is replaced, consider a plate reader, which often provides improved accuracy at reduced sample volumes, instead of the standard benchtop unit.**
- **Create a library of Excel templates that can be used to generate formulation recipes and connected to performance data.**
- **Where feasible, integrate digital imaging, via cameras or scanners, to record data on sample stability or performance.**
- **Leverage freeware such as ImageJ (http://rsb.info.nih.gov/ij/) to do image analysis.**
- **Keep in mind that improvements in research efficiency will come more slowly than with automated systems, but they will come as you begin to increase your sample throughput.**

becomes a challenging approach. Additionally, there are the issues of maintenance and repair of both the hardware and software. However, in labs that historically perform repetitive processes, HTR can provide a significant R&D advantage.

Even so, identifying the proper instrument can be difficult, and sometimes the needed tool doesn't exist. The only option is to design and build the required device. When designing an HTR tool, the expectation would be that the tool would produce similar quality data to the conventional test at 10 times the conventional rate by running multiple samples in parallel. The key to a successful HTR tool design follows the four R's pattern: rank, robust, resolution, and repeatability. The new tool must provide some ability to rank the samples; that is, it should not be simply a pass/fail test, but rather be able to clearly distinguish between good, fair, and poor samples. The test method must be robust in that it can tolerate small variations in operating conditions without complete failure. It must also provide sufficient resolution to differentiate between samples at a level similar to what the researcher would be able to do. Above all, the test must be statistically repeatable. Otherwise, the instrument is obviously useless.

TOOL MANUFACTURE

There is an ever-increasing supply of HTR instruments on the market; however, tools for evaluating the specific performance of a formulation, for example, the efficiency of a new laundry detergent formulation, remain fairly rare. Often the R&D department must either create, design, and fabricate such a device "in-house"—something outside the capabilities of many moderate-sized corporations—or they must find an external firm willing to do so on their behalf. While such firms are not ubiquitous, they do exist and often provide a full range of the specialized skills necessary to deliver the desired tool capabilities. Many, such as Freeslate (Sunnyvale, California), will customize an existing tool or software package to a specific need for a fee.

In some cases the best option for R&D groups with limited resources is to partner with a local university. Many schools have programs in robotics and are eager to engage their students in "real-world" challenges. The cost can be lower than working through a contract manufacturing firm; however, the development time may also be longer. One key advantage is that the R&D department can be involved in every step of the construction and provide immediate and crucial feedback to the design/development team on the performance of a specific component. Conversely, a robotics manufacturer generally provides exactly what has been requested with no options for changes or feedback.

SUPPORT STAFF

There are two major aspects to the maintenance and operation of an HTR system: the hardware and the software. In both cases there are several options to consider. The first is to purchase a prepackaged system through a reputable vendor such as Tecan®, Hamilton®, Matrix®, or Zinsser®, to name a few. Most manufacturers will offer a service plan for the hardware, including scheduled maintenance; and technical support agreements are available. Training on these systems will generally allow the lab to begin producing samples within days of installation. Many of these systems can import/export data in a variety of formats to allow for integration into a range of LIM programs and for broad sharing throughout the company.

The second option is to contract this service out to a third party. Again the local university may be an ideal choice. Unilever, which has its global High Throughput Facility located in Port Sunlight, England, contracts a portion of its software maintenance program through the Centre of Materials Discovery (University of Liverpool), providing a great opportunity for partnership (6). Additionally, this ensures that these students consider Unilever a high-tech player as they look for employment opportunities after graduation.

Finally, many corporations, especially those that design and build their own automation tools, will create a department whose role in the organization is to provide service and support to the HTR equipment. Such a department offers the advantages of being highly integrated into the corporate HTR strategy, including unrestricted access to high-speed networks, development of standard test procedures, and overall integration of a single tool into a suite of HTR tools. The Dow Chemical Company has an Automation and Robotics Department of over two dozen electricians, engineers, and robotics specialists who work on everything from the initial device design through final installation.

DATA VISUALIZATION

It goes without saying that a LIM system becomes critical as the HTR lab expands. A single 96-well vial tray can routinely produce more than 1,200 data points during its lifetime. While generation, handling, and storage of HTR data are an immense challenge, extracting knowledge from the data can be just as formidable. The quantity of data alone can make the process of reaching a conclusion unwieldy as the user is simply overwhelmed by the volume of data generated. Specialized software such as Origin®, Spotfire®, Miner3D®, and JMP® all focus

on handling large data sets in a manner that makes visualizing trends and patterns much easier. Even so, a rudimentary understanding of statistical experimental design and access to a trained statistician is invaluable in assessing the primary, secondary, and tertiary patterns of formulations behavior.

Typically, these software packages allow the user a wide range of options for viewing the data set as well as simple methods of truncating the data viewed. Compatibility with more common software such as Microsoft Excel® means the selected data sets, and the conclusions associated with them, can be distributed throughout the company, even to those who do not use the HTR software.

CONCLUSION

The use of automated tools for the fabrication, processing, and evaluation of liquid formulations is a rapidly emerging field built on the proven foundation of the HTS methods. By expanding this approach to include formulation synthesis through performance testing, this methodology can greatly impact R&D, leading to faster results, reduced waste streams, and an effective training tool. Options for working in this area change almost daily as tool prices drop and product offerings increase. However, the barrier to entry is not insignificant, and the corporation as a whole must decide to support this endeavor for maximized success.

J. Keith Harris is a Technical Leader in the corporate R&D function of the Dow Chemical Company and has been working in the area of aqueous-based formulations for almost 20 years. He began working with High Throughput Formulation tools in 2003 and has developed more than a dozen consumer products using this approach along with several patents in this area. Harris graduated from Michigan State University with a Ph.D. in physical chemistry focused on self-assembly and interfacial chemistry. He can be contacted at KHarris@dow.com.

Melinda H. Keefe is a research chemist in the Dow Coating Materials division of The Dow Chemical Company. Her current areas of research include binder development and formulation design for waterborne architectural coatings. In 2008, she initiated collaboration between Dow, Tate, and The Getty Conservation Institute. The initial aim of this unique collaboration between the chemical industry and the art conservation community was to identify improved approaches to conserving modern art. From this work, water-in-oil microemulsion systems tailored for the cleaning of modern acrylic paintings and other water-sensitive substrates have been developed and brought to the field. This group continues to develop improved cleaning approaches for fine art and facilitates communication to the field via training workshops, conference proceedings, and publications. She can be contacted at mhkeefe@dow.com.

Chris Tucker is a fellow in the Formulation Science Group within Dow's Core R&D function. He has worked primarily in the area of colloid and interface science including new surfactant synthesis, ionomers, micro-emulsions, consumer and industrial product formulation, reaction media, nanoparticle synthesis, enhanced drug solubilization, drug delivery, and high throughput research. Tucker received his B.A. from Kalamazoo College (Michigan, USA) and is author of 26 publications and patents.

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Extracts & Distillates (cont. from page 169)

treatments (+0.5%; $P < 0.0001$). FO did not significantly alter core temperature but decreased the postoperative rise in interleukin-6 ($P = 0.018$). Plasma triglycerides increased transiently after each FO infusion. Plasma concentrations of glucose, lactate, and blood carboxyhemoglobin were lower in the FO than in the control group on the day after surgery. Arrhythmia incidence was low with no significant difference between groups. No adverse effect of FO was detected. Perioperative FO infusions significantly increased PUFA concentrations in platelet and atrial tissue membranes within 12 h of the first FO administration and decreased biological and clinical signs of inflammation. These results suggest that perioperative FO may be beneficial in elective cardiac surgery with CPB.

Lipidomic profiling of model organisms and the world's major pathogens

Layre, E., and D.B. Moody, *Biochimie 95*:109–115, 2013.

Lipidomics is a subspecialty of metabolomics that focuses on water-insoluble metabolites that form membrane barriers. Most lipidomic databases catalog lipids from common model organisms, like humans or *Escherichia coli*. However, model organisms' lipid profiles show surprisingly little overlap with those of specialized pathogens, creating the need for organism-specific lipidomic databases. Here we review rapid progress in lipidomic platform development with regard to chromatography, detection, and bioinformatics. We emphasize new methods of comparative lipidomics, which use aligned datasets to identify lipids changed after introducing a biological variable. These new methods provide an unprecedented ability to broadly and quantitatively describe lipidic change during biological processes and identify changed lipids with low error rates.

Identification of plasma lipid biomarkers for prostate cancer by lipidomics and bioinformatics

Zhou, X.C., *et al.*, *PLoS One 7*:e48889, 2012.

Lipids have critical functions in cellular energy storage, structure, and signaling. Many individual lipid molecules have been associated with the evolution of prostate cancer, however, none of them has been approved to be used as a biomarker. The aim of this study is to identify lipid molecules from hundreds plasma apparent lipid species as biomarkers for diagnosis of prostate cancer. Methodology/principal findings: By using lipidomics, lipid profiling of 390 individual apparent lipid species was performed on 141 plasma samples from 105 patients with prostate cancer and 36 male controls. High throughput data generated from lipidomics were analyzed using bioinformatic and statistical methods. From 390 apparent lipid species, 35 species were demonstrated to have potential in differentiation of prostate cancer. Within the 35 species, 12 were identified as individual plasma lipid biomarkers for diagnosis of prostate cancer with a sensitivity above 80%, specificity above 50%, and accuracy above 80%. Using the top 15 of 35 potential biomarkers together increased predictive power dramatically in diagnosis of prostate cancer with a sensitivity of 93.6%, specificity of 90.1%, and accuracy of 97.3%. Principal component analysis (PCA) and hierarchical clustering analysis (HCA) demonstrated that patient and control populations were visually separated by identified lipid biomarkers. RandomForest and 10-fold cross validation analyses demonstrated that the identified lipid biomarkers were able to predict unknown populations accurately, and this was not influenced by patient's age and race. Three out of 13 lipid classes, phosphatidylethanolamine (PE), ether-linked phosphatidylethanolamine (ePE), and ether-linked phosphatidylcholine (ePC) could be considered as biomarkers in diagnosis of prostate cancer. Conclusions/significance: Using lipidomics and bioinformatic and statistical methods, we have identified a few out of hundreds plasma apparent lipid molecular species as biomarkers for diagnosis of prostate cancer with a high sensitivity, specificity, and accuracy.

Lipase activity, mesocarp oil content, and iodine value in oil palm fruits of *Elaeis guineensis*, *Elaeis oleifera*, and the interspecific hybrid O×G (*E. oleifera* × *E. guineensis*)

Cadena, T., *et al.*, *J. Sci. Food Agric. 93*:674–680, 2013.

One factor affecting crude palm oil quality is the formation of free fatty acids (FFA), often attributed to the hydrolytic action of mesocarp lipase. The aim of this work was to evaluate the enzyme behavior and to look toward new genotypes with low FFA production, high yield, and better oil quality. Lipase activity was strongly activated at low temperatures (5°C). At this temperature PLL, SOO, POL, and POO (where P, palmitic; L, linoleic; S, stearic; O, oleic) were the most hydrolyzed triacylglycerols in *Elaeis guineensis* fruits. Ethylene production decreased from 36 nL g^{-1} h^{-1} at room temperature to 2 nL g^{-1} h^{-1} at 5°C. Lipase activity of *E. guineensis*, the *E. oleifera* × *E. guineensis* (O×G) hybrid, and *E. oleifera* were 52.7%, 32.9%, and <0.6% FFA, respectively. The *E. guineensis* showed oil in the mesocarp of 54.7%, followed by the O×G hybrid (47.0%), and *E. oleifera* (13.6%), and the iodine values were 52.0, 66.3, and 77.4 g I_2 100 g^{-1}, respectively. This work allowed the identification of interspecific O×G hybrids as promising crosses with less lipase activity and higher iodine value than *E. guineensis*. Although O×G crosses produce less oil in the mesocarp than commercial *E. guineensis*, this feature could be improved by further breeding to introduce new genes from *E. oleifera* into the hybrids. ■

Pumping technology (cont. from page 173)

efficiency. To avoid excessive wear, pump bearings must be properly lubricated and replaced before they fail. Shaft seals also require constant maintenance to avoid premature mechanical failure. In the long run, properly maintaining pumps not only will optimize the quality of the products that they are charged with producing, but also will maximize energy usage.

HI also suggests performing a life-cycle cost analysis before installing a pumping system. Too often, plant operators are concerned only with front-end costs, without realizing that the total life-cycle cost of a pumping system can escalate precipitously if inefficient or unreliable pumps and components are used. Determining the total life-cycle cost of a pumping system may mean a higher outlay in the beginning, but it could deliver a series of money-saving advantages through the complete lifetime of the pump. To aid in this important task, HI has created *Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems,* which can be found at the HI web site, www.pumps.org.

With worldwide industrial energy consumption expected to increase by 42% through the year 2035, pumping technologies that save energy can give manufacturers a competitive edge. Traditionally, centrifugal pump technology has been the most commonly used technology for many industrial operations that require liquid-handling, with some estimates indicating that centrifugals are used in 75% of all industrial process-pump applications. However, centrifugal pumps are rarely the most energy-efficient choice in industrial liquid-handling applications because they have a tendency to operate off their Best Efficiency Point (BEP). The further removed a centrifugal pump is from its BEP, the less efficient it becomes, resulting in energy loss and operational inefficiencies that can lead to increased maintenance and downtime.

Conversely, among the leading positive displacement pump technologies, sliding vane pumps are the most energy efficient owing to a series of design features that give them an edge in mechanical efficiency over centrifugal, gear and lobe pumps. Side-by-side comparisons show that sliding vane pumps can be as much as 24% more efficient than gear models. The self-adjusting vane design of Blackmer sliding vane pumps, for example, eliminates energy-robbing product "slip" and promotes high volumetric consistency even after substantial in-service time. Readers can learn more about such technologies through Blackmer's Smart Energy Flow Solutions program at www.blackmersmartenergy.com.

Thomas L. Stone is the PSG® Director of Marketing for Blackmer®, based in Grand Rapids, MI, USA. Blackmer is a founding member of the Dover Corporation's Pump Solutions Group (PSG®), Oakbrook Terrace, IL, USA, which is comprised of several of the world's leading pump brands. He can be reached at tom.stone@psgdover.com or (616) 248-9252.

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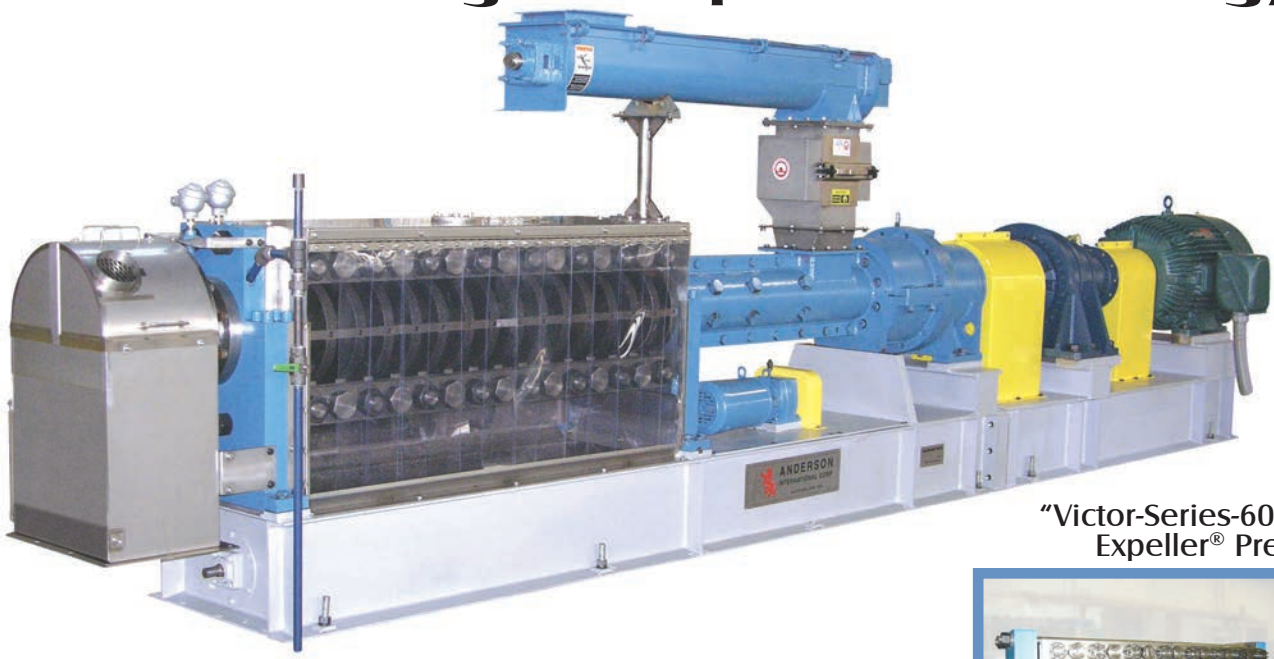

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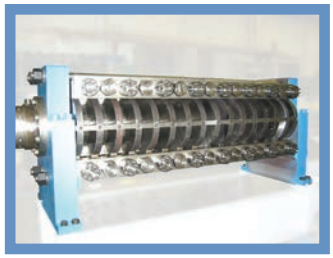

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