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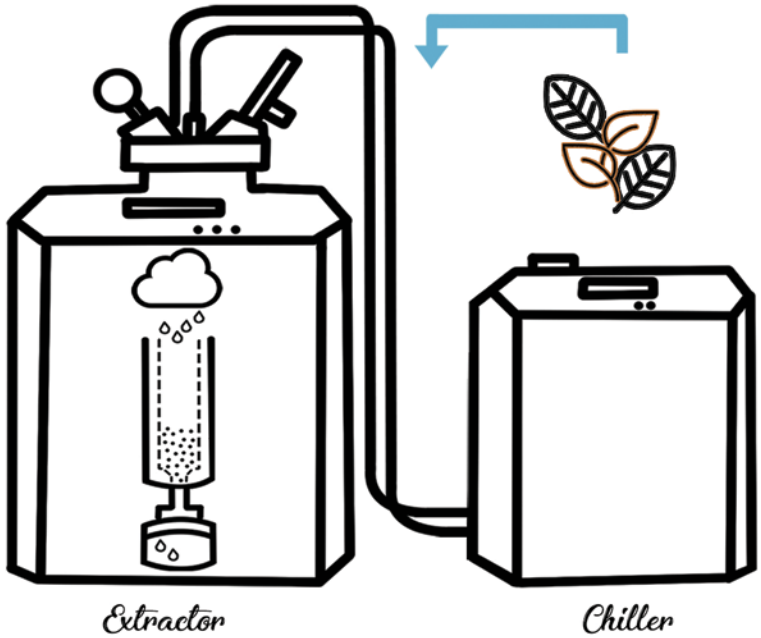

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CONTENTS

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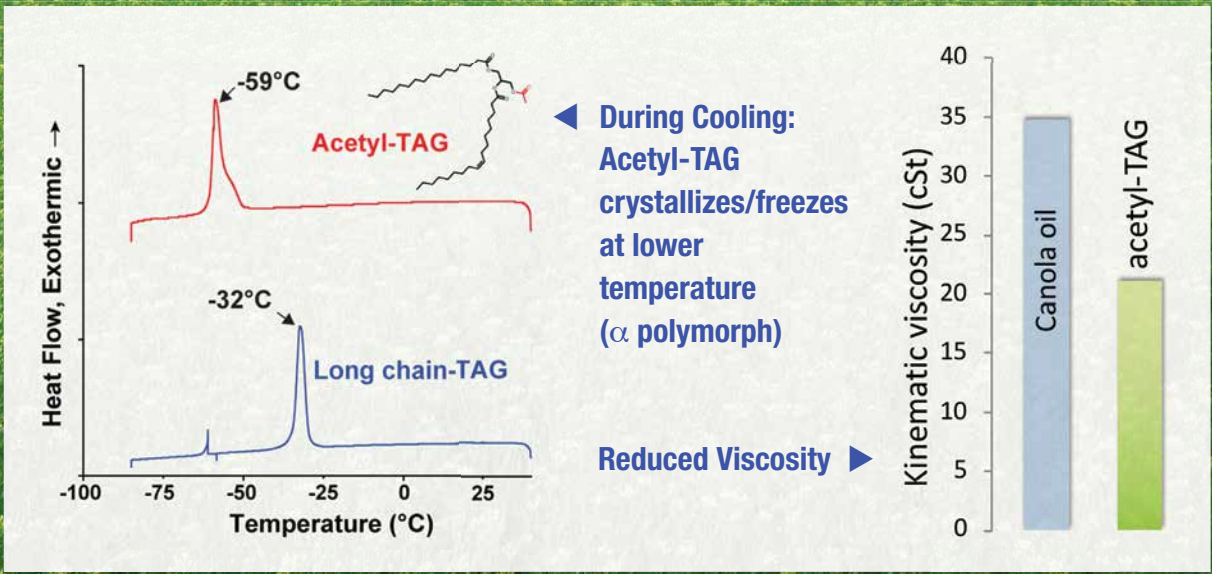
Novel Vegetable Oil with Improved Low-Temperature Fluid Properties and Reduced Calorie Content



Researchers at Michigan State University and Kansas State University have engineered oilseed crops to produce high levels of acetyl-triacylglycerol (Acetyl-TAG). This unique plant oil has reduced freezing point, lower viscosity, lower calories and additional attractive qualities. Acetyl-TAG has a wide range of food and non-food application as emulsifier, plasticizer, solvent and drop-in biofuel. The oil has been produced in field trials in the US and Canada.

Acetyl-TAG is similar in structure to vegetable oil based plasticizers and emulsifiers (e.g. ACETEM) that currently are produced semi-synthetically using chemical modifications. Biological synthesis of such structures directly in the oilseed can reduce the production costs of the end product.

Acetyl-TAG oil samples are available by contacting oilseeds@msu.edu

MORE INFORMATION

https://doi.org/10.1111/pbi.12325 | https://doi.org/10.1016/j.indcrop.2014.11.019
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Rethinking plastic packaging

Rebecca Guenard

- Corporations that use plastic packaging are investing in programs that reduce the potential for it to become marine waste, while also evaluating more sustainable ways to package their products.
- Packaging made of bio-based polymers could potentially reduce plastic waste, but natural starting materials do not necessarily lead to bio-degradable plastic, and bio-based products currently have a minor share of the plastics market.
- Researchers are exploring new chemistry to expand the recycling capabilities of plastic, for example, polymers that decompose back to their original monomer.

The United Nations reports that 8 million tons of plastic leak into the sea each year, the equivalent of a dump truck's worth a minute. At this rate, in another 40 years there will be more plastic than fish in the sea (https://tinyurl.com/UN-ocean-plastics).

The issue has at last reached a tipping point, and organizations are taking action. The European parliament recently approved a ban on single-use plastics that will become effective within the next two years (https://tinyurl.com/yas9vof6). However, the American Chemistry Council argues that plastic is too vital a material for an outright ban (https://tinyurl.com/y7lh2mxm). Plastic provides safety in the form of bike helmets and air bags. It allows the medical field to maintain the sterilization of lifesaving devices and fluids. And, when it comes to consumer products, plastic gives us freshness and convenience. Our modern life depends on plastic.

"We fundamentally think plastics are a great way to package things like liquid laundry detergent," says Martin Wolf, director of sustainability and authenticity at Seventh Generation, a company headquartered in Burlington, Vermont, USA, that specializes in responsibly sourced cleaning and personal care products. "What is needed is the will and the infrastructure to see that bottles are collected and reused or recycled."

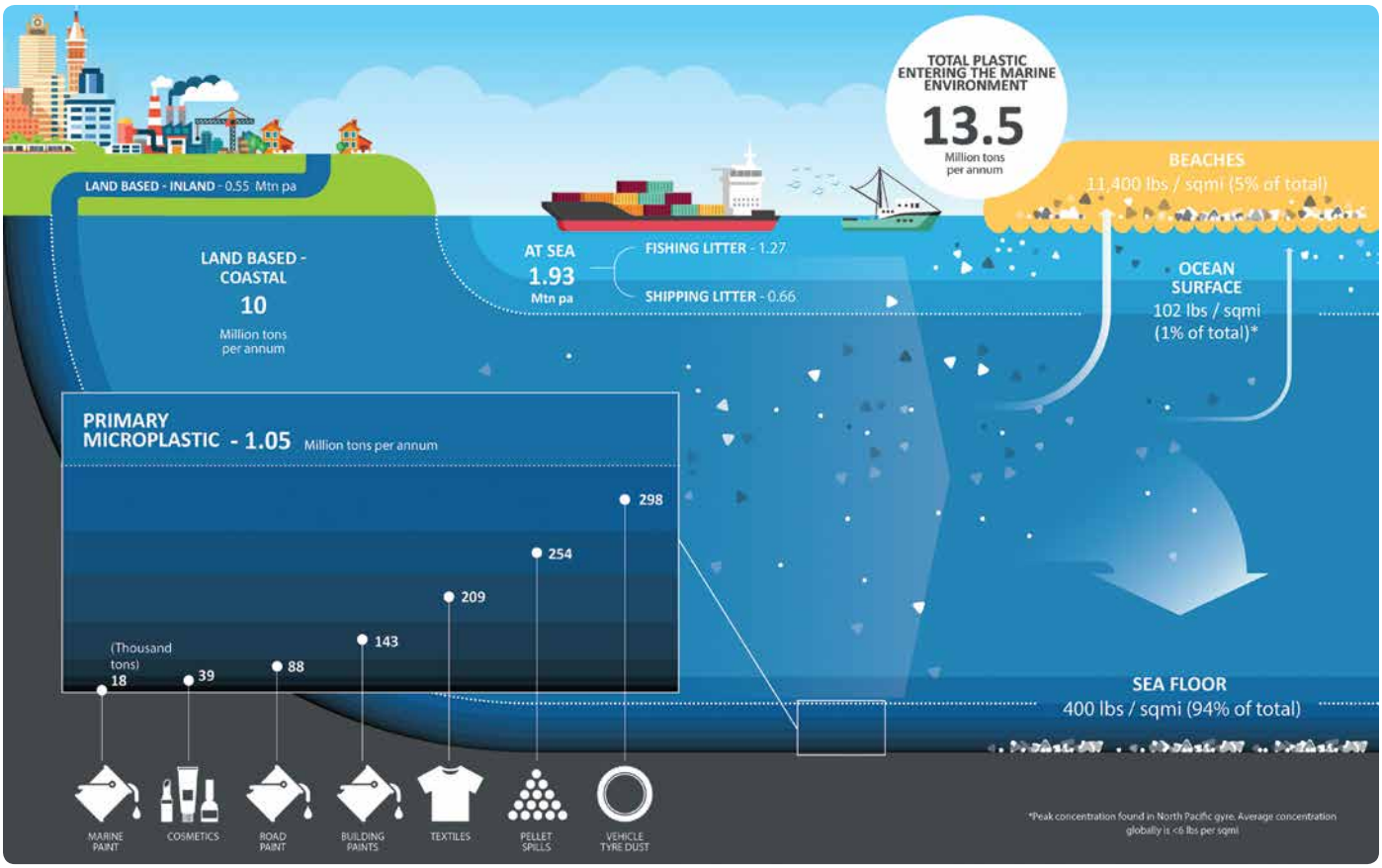
Most corporations, like Unilever, Starbucks, and PepsiCo, now have sustainability initiatives to ensure that the packaging used for their products no longer contributes to the problem of marine waste.

SUSTAINABILITY GOALS

Founded on a mission of environmental sustainability, Seventh Generation continually evaluates their packaging to reach their most recent goals. "We think that any resource we use on this planet today needs to be available to future generations," says Wolf. His company set a goal to make all their packaging material 100% recyclable by 2020.

Creating a recyclable bottle from post-consumer recycled (PCR) plastic is not easy. Each time plastic is recycled, its polymer chains are cut shorter, weakening the resulting polymer's structure and limiting its reuse to one or two cycles. Bottle designs for recycled plastics must be carefully considered to ensure stiffness and avoid faults that may cause cracks under environmental stress. Wolf says it helps for the bottle blower and the resin supplier to have a good relationship. That way, the bottle blower can determine the quality of the resin and communicate directly with the supplier if changes need to be made.

Even when a bottle's design is sound, packaging tricks may be needed to distract consumers from cosmetic imperfections, such as the



This infographic depicting sources of plastics in the marine environment is reprinted with permission from, "Plastics in the Marine Environment," a June 2016 report by Eunomia (http://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/).

grey tinge of a PCR bottle. Since Seventh Generation does not use dyes in their detergents, this slight coloration is noticeable. Adding a colored label to the bottle makes the greyness less obvious and more appealing to consumers who expect a cleaning product to look clean.

For all the work the company puts into their bottles, Wolf acknowledges that consumers are ultimately responsible for getting them to a recycling facility. If their municipality has no facility, the bottle goes into a landfill. Instead of waiting for local governments to establish recycling infrastructure, many companies provide the resources to expedite the expansion or construction of recycling programs around the world.

Henkel is a German chemical and consumer goods company headquartered in Düsseldorf, Germany. According to their website the company has dedicated itself to establishing a functioning waste and recycling management system for plastic materials to overcome the lack of a global standardized approach to handling waste responsibly. They are partnering with an organization called Plastic Bank, which provides people in impoverished communities with an incentive to recycle plastic waste by paying them for the plastic they collect. (https://www.plasticbank.com).

Henkel has also joined more than 250 large corporations including Nestle, Unilver, PepsiCo, and Walmart in a global initiative known as the New Plastics Economy (https://newplasticseconomy.org). The group is working with the United Nations (UN) Environment to establish a circular plastic economy and eliminate the current mode of using plastic once and then throwing it into a landfill. Participants recently signed a Global Commitment to hold each other accountable on a set of targets to improve plastic packaging management. These targets include a commitment to decreased plastic packaging and increased recycling and composting rates.

Though these efforts will go a long way toward reducing environmental plastic waste, Wolf says more needs to be done. "Recycling alone is not going to solve this problem, but it is one arrow in the quiver of solutions that people are going to have to develop," he says. "There is going to have to be development of reusable packaging. There is going to have to be development of materials that somehow [like paper] are recycled in nature."

A company like Seventh Generation that sells cleaning products has different packaging considerations than one selling products people eat or drink, such as food and beverages. In the United States, for example, the Food and Drug Administration has deemed a limited number of compounds safe for use as adhesives and coatings in food packaging (https://tinyurl.com/y92ystmw). To abide by these regulations and achieve sustainability, food manufacturers are seeking new sources for these compounds.

NATURAL SOLUTIONS

David Grewell, manufacturing engineering professor at North Dakota State University, Fargo, and adjunct profes-

No more microbeads. Now what?

Where have cosmetics formulators turned now that the days of microbeads are officially over? As of July 1, 2018, companies in the United States can no longer manufacture rinse-off cosmetics containing microbeads. And beginning July 1, 2019, it is illegal for a company to sell any microbead products remaining in inventory (https://www.congress.gov/bill/114th-congress/house-bill/1321/text). The United Kingdom passed a ban the following year which took effect in January of 2018. New Zealand's ban will be enforced starting in June, and in November 2018, an industry insider told *Chemical Watch* that it is highly likely that China will follow the global trend to impose a ban..

Legislation to ban microbeads — defined as, "any solid plastic particle that is less than five millimeters in size and is intended to be used to exfoliate or cleanse the human body or any part thereof"— passed swiftly and unanimously in the United States in 2015 after tens of millions were skimmed from the surface of the Great Lakes (https://doi.org/10.1016/j.marpolbul.2013.10.007).

Plastic microbeads are made with polyethylene, which is not toxic to humans, but polychlorinated biphenyls (PCBs) and other harmful environmental contaminants that are primarily hydrophobic concentrate on the large surface area of microbeads. Fish eat microbeads, because they look like food. Humans can then be exposed to these concentrated toxins when they eat fish (https://doi.org/10.1021/acs.est.5b06280).

The beads were so small that they evaded filtration during treatment at municipal plants and ended up in waterways. Attempts to filter the beads from open water also removed lower food chain species like plankton that were essential for the ecosystem's survival. The only option was a complete ban, but where does that leave the cosmetics industry?

Several natural alternatives to plastic microbeads exist, but using them requires that formulators consider a few issues. Natural ingredients can degrade quickly, dissolving into a product, altering its exfoliating effect. And natural alternatives can induce allergic reactions in certain segments of the population. Nutshell powders, like almond and walnut or ground shellfish hold potential as inert abrasives in formulations, but not if a consumer breaks out in a rash when using them.

TABLE 1. Comparison of polyethylene beads vs. replacement options. Reprinted with permission From *Cosmetics & Toiletries*, November 17,2017 (https://tinyurl.com/y7wagauz).

INCI	Density (g/mL)	Particle size range (diameter, in micrometers)	Melt point °C	Relative cost	Abrasiveness
Polyethylene a	0.95	200–400	125–135	$	Moderate
Polyethylene b	0.95	50–200	125–135	$	Moderate
Polyethylene c	0.92	50–297	125–135	$	Low
Polyethylene d	0.92	50–180	125–135	$	High
Polyethylend e	0.92	44–150	125–135	$	High
Jojoba esters f	0.905	250–425	66–70	$$$	Low/moderate
Hydrogenated castor oil g; hydgrogenated jojoba oil	0.953	150–250	82–90	$$$	Low/moderate
Stearyl Stearate (and) *Helianthus anus* (sunflower) seed wax and jojoba esters h	0.959–0.967	250–425	66–72	$$$	Moderate
Behenyl behenate (and) jojoba esters I	0.928–0.936	425–850	69–75	$$$	Moderate
Cellulose j	0.45	200–600	n/a	$$	
Cellulose microcrystalline Cellulose k	0.75	200–500	n/a	$$	Moderate

Fortunately, companies can choose from a long list of other ingredients. Some current exfoliants on the market contain pumice, silica, and apricot kernels. Others use sugar, sea salt, cellulose and castor oil. In every case, the exfoliating particles must be ground to between 125–250 micrometers to achieve the exfoliating affect without being too abrasive, especially for applications on the face where skin is thinner.

Sugar and sea salt exfoliants meet size variability requirements but have the disadvantage of being water soluble. While this property is environmentally favorable, achieving a stable shelf-life requires anhydrous or supersaturated formulations. Consumers will then experience less abrasiveness as the exfoliant dissolves with use. On the other hand, water insoluble abrasives made from biodegradable materials like cellulose fibers derived from plants and wood cannot be processed into spheres, which limits their applications.

Jojoba exfoliators, waxy spheres made from a liquid wax ester that results from pressing or extracting the oil of the jojoba seed, are another alternative. Their properties are relatively easy to control through hydrogenation. In fact, Jojoba is so similar to polyethylene that it is often mistaken for the banned microbead. See Table 1 for a comparison of polyethelene microbeads vs. replacement options.

Finally, there are the truly innovative beads that are not only biodegradable, but also absorb unhealthy chemicals (https://doi.org/10.1007/s41742-018-0066-2). Scientists in Puerto Rico have designed a bead that pulls the coral bleaching compound oxybenzone, a UV-blocking ingredient in sunscreen, from ocean waters (https://www.popsci.com/microbeads-safe-environment). A formulator could potentially find a way to incorporate the beads into soaps and gels, providing a benefit to both the consumer and the environment.

The ban on microbeads has challenged formulators to explore new ingredients, but it has not reduced the availability of exfoliation ingredients and has already led to new innovations in the field.

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sor at Iowa State University, Ames, is also the director of the Center for Bioplastics and Biocomposites (CB^2). The National Science Foundation-funded center consists of a team of university researchers based at Iowa State and Washington State University, in Pullman, who collaborate with automotive, petrochemical, and food packaging industries around the world to establish new plastic processes and products from renewable resources. The center will be expanding this year to include North Dakota State University, Fargo, and the University of Georgia, Athens, is considering becoming a member.

Grewell and the members of CB^2 put nature to work solving problems in polymer science. "Nature has been making fibers for a long, long time; longer than we have," he says. "She's designed these things to be very strong and lightweight. So, there are some advantages to these materials."

Potted plant packaging is an example of one successful product resulting from the research at CB^2. Researchers at Iowa State developed a plastic plant container made of polylactic acid (PLA) derived from a mix of corn and soybean proteins. The natural polymer has a fertilizing effect, because nitrogen is released from the soy protein as it decomposes. Instead of throwing the pot away, gardeners can crush it and place it in the transplant hole, where it will provide nutrients for the plant.

"The pots are degradable and they also contribute to the plant's health. That was an effect we did not anticipate at all," says Grewell. "So here is an example where nature has done something to those proteins with a cause and effect we did not anticipate. This would be very difficult to replicate with a petrochemical plastic."

Another CB^2 member, professor Tong Wang, has developed a soybean oil-based wax that can make coated paper packaging easier to recycle. The waxes are created by modifying the structure of hydrogenated soybean oil to behave like waxes derived from petrochemicals. These waxes could be used to coat corrugated paper boxes for packaging fruits and vegetables, or for the paper coating on milk cartons (https://tinyurl.com/yablmryv).

Consumers and packaging producers should be aware that the bio-based or biodegradable label is difficult to interpret. Naturally derived polymers do not necessarily produce less plastic waste. Bio-based monomers that are drop-in equivalents for petroleum monomers polymerize to the same non-biodegradable products. Just like plastics from petrochemical starting materials, their bio-based equivalents have a carbon backbone that does not readily decompose; although they can be recycled and used as PCR. Even plastics like PLA that are deemed compostable require waste facilities capable of heating polymers to temperatures higher than can be achieved in a backyard composite bin. Consequently, PLA plastics cannot just be thrown in a landfill with the expectation that they will convert back to soil in a reasonable amount of time.

Rather than leaving bio-plastics in the ground to decompose, countries like Denmark and Sweden have installed some power plants that burn plastic. "We put a lot of energy into making plastic, whether it is petrochemical or bio-based. I think that there are some advantages of recapturing that and using it as an energy source," Grewell says. Energy conversion

plants are also popping up across the United States, but they are not an option for a widespread plastic waste solution since the plants are too expensive for most municipalities. (https://tinyurl.com/ybt9tcq7).

To reach goals they have set for 2025, large companies need changes they can implement now. PepsiCo has committed to reducing the environmental impact of their packaging by investing in both bio-based plastics and new plastic sources. The company acknowledges that bio-based plastics reduce the greenhouse gas emissions that accompany petrochemical processing. But PepsiCo aims to have its entire packaging distribution incorporated into a circular plastics economy within the next six years, and that requires innovation.

NEW CHEMISTRY

In 2017, PepsiCo partnered with Danimer Scientific, a company dedicated to developing truly compostable plastic packaging. Using specially engineered bacteria that metabolize canola seed oil, Danimer Scientific produces a polyester called polyhydroxyalkanoate (PHA). In a recent study performed through a collaboration with the University of Georgia, Athens, the company found that after 85 days in soil and 148–195 days in saltwater, its PAH polymers biodegrade until they are indistinguishable from cellulose powder (https://doi.org/10.1021/acs.est.7b06688). In September of 2018, Danimer Scientific purchased a fermentation plant in Winchester, Kentucky, to begin full-scale PAH production.

While Danimer Scientific succeeded in using biology to synthesize polyesters, other researchers continue to explore the capabilities of chemistry. Rong Tong, assistant professor at Virginia Tech in Blacksburg, has designed a catalyst to polymerize a monomer that gives polyesters greater functionality.

Chemically derived polyesters most often start with lactide or β-lactones that are polymerized by a ring-opening. However, the stereoselective nature of this mechanism prohibits a diversity of side chains, thus limiting the resulting polymer's properties. Tong has created a polyester from O-carboxyanhydrides (OCA) using a photocatalyst that allows him to control polymerization (https://doi.org/10.1038/s41467-018-03879-5).

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Tong's lab is the first to synthesize high-molecular-weight polymers using O-carboxyanhydride monomers. Tong says that in just two steps he can synthesize the monomer with a variety of different functional groups on its side-chain. This versatility motivated Tong to understand the chemistry needed to polymerize the monomer. He combined zinc and nickel to create a catalyst that is activated by light. "We hope this plastic can be a degradable and sustainable replacement for non-degradable plastic waste," says Tong. His group is in the process of testing the properties of these new plastics to determine how they can be applied to packaging.

Another chemist whose research could increase polyester's packaging potential is Eugene Chen at Colorado State University in Fort Collins. He identified a way to recycle polyester back to its original monomer. Chen can collect the recycled monomer at a yield of 80–90%, then purify and use it for polymerization again (https://doi.org/10.1126/science.aar5498).

Increasing polyester's functionality and recyclability could encourage packaging producers to consider the material for more applications. "Traditional, non-degradable polyolefins are more widely used in thermal impact or thermal sets or resins or rubbers," says Tong. He explains that the polyesters he and Chen are developing must exhibit similar properties to those polyolefin products to be considered marketable.

Current European market data indicate that bioplastics contribute just 1% of all plastics sold (https://www.europeanbioplastics.org/market/). As new polyesters enter the market, Grewell predicts that number will increase. "You are going to see more and more acceptance as more and more PLA comes online," he says.

Meanwhile, petrochemical plastics production in the United States is experiencing a significant increase to accommodate demands in India and China. Billions of dollars have been invested to build and expand manufacturing plants along the US Gulf Coast.

Wolf says the petrochemical industry missed an opportunity by only focusing on production. If they had embraced recycling early on, he explains, they could have developed the infrastructure to reprocess recycled plastic while still selling virgin resin. "There will always be a demand for product, but because they didn't (and still don't) want to support actual recycling, they are excluding themselves from that business opportunity."

There is evidence that the petrochemical industry has decided to correct that oversight. In October 2018, Dow Chemical created two new positions that, according to a press release, identify ways the company can monetize plastic waste recycling streams in North and South America.

An alliance of 30 investors have recently compiled $1 trillion dollars to fund projects that contribute to a circular plastics economy or the development of recycling facilities (https://tinyurl.com/y8opuut9). Time will tell if investment dollars and public pressure can force the lifestyle shift necessary to eliminate the buildup of plastic waste, but any solution to the problem will have to overcome rising recycling costs and our ongoing dependence on plastic.

Rebecca Guenard is the associate editor of Inform *at AOCS. She can be contacted at rebecca.guenard@aocs.org.*

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Removing environmental contaminants: comparing multi-stage thin-film evaporation with gas stripping and short-path distillation

Perry Alasti and Alex Duncan

- Marine oils are closely monitored for quality and harmful environmental contaminants, and regulatory agencies have established maximum permitted levels for such contaminants in food and animal feed ingredients.
- Some of the more volatile contaminants can be removed by steam deodorization in conventional edible oil processing. However, higher-efficiency technologies are needed to remove less volatile components.
- This article compares two available technologies: multi-stage thin-film evaporation with gas stripping and short-path distillation.

Most edible oils undergo four basic processing steps: refining/neutralization, bleaching, winterization, and deodorization (O'Brien et al., 2000). The last step, deodorization, is basically a stripping process that uses steam to remove undesirable odors or flavors along with other impurities, such as peroxides, carboxylic compounds, and free fatty acids (FFAs). Deodorization also partially removes environmental contaminants and destroys color compounds, which has somewhat of a bleaching effect on the oil. Depending on the type of oil being processed, most deodorizers operate at temperatures above 200°C, and pressures between 2 and 5 torr. FFAs are typically reduced to 0.2 to 0.5% by weight, but this also varies based on the type of oil. Desirable compounds, such as tocopherols and other antioxidants, are also removed. Deodorization can reduce the content of tocopherols in the final RBD (refined, bleached, and deodorized) oil by as much as 60% (Norris, 1985). Typically, a small amount of tocopherols is added to the final product to prevent oxidation after deodorization.

Marine oils are closely monitored for quality and harmful environmental contaminants, such as dioxins, furans, and polychlorinated biphenyls (PCBs). Dioxins have been shown to be extremely harmful to humans and animals, and have been implicated in disrupting endocrine (hormone) systems in humans and wildlife. PCBs are a group of closely related chemicals, and some dioxin-like PCBs exhibit toxicities similar to those of toxic dioxins.

Consequently, regulatory agencies have established maximum permitted levels (MPLs) for such contaminants in food and animal feed ingredients (SCAN, 2000; SCF, 2000). The FDA and the European Commission (EC) have implemented food and feed legislation concerning polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), dioxin-like polychlorinated biphenyls (DL-PCBs), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides (OCPs). Fish, and consequently fish oil, has been identified as one of the most important contributors to the level of PCDD/Fs and DL-PCBs in feed and food products (Table 1).

TABLE 1. Quality parameters for fish oil (GOED, 2017)

Acid value	3 mg KOH/g Max
Peroxide value	5 meq/kg max
Anisidine value	20 max
TOTOX	26 max
PCDDs and PCDFs	2 ppt max
Dioxin like PCBs	3 ppt max
TOTAL PCDDs/PCDFs/DL PCBs	4 ppt max
Total PCBs	90 ppb max

Some of the more volatile PCBs and PAHs can be removed by steam deodorization in conventional edible oil processing. However, for the less volatile components, the higher efficiency of processes like short-path distillation (SPD) and thin-film evaporation is necessary to remove these compounds to levels required by regulatory agencies (Breivik and Thorstad, 2005). SPD and thin film evaporation are both generally used after bleaching and winterization.

FIG. 1. Short-path evaporation

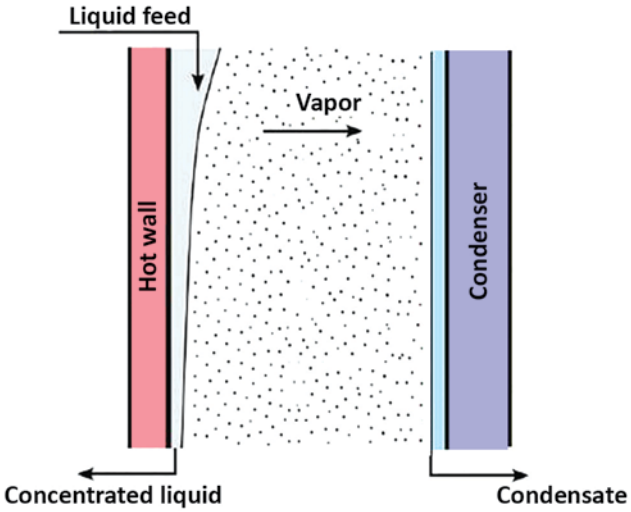
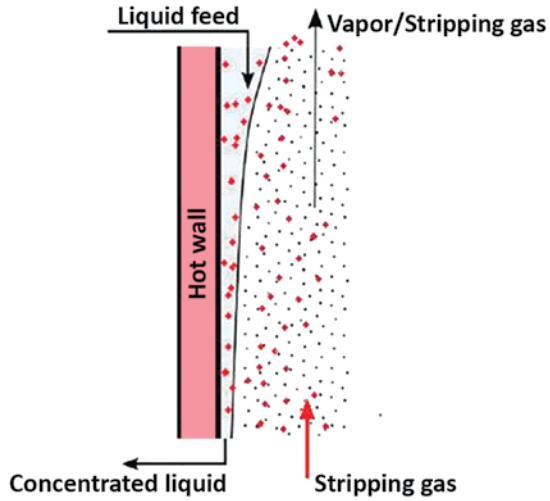


FIG. 2. Thin-film evaporation with gas stripping



SHORT-PATH DISTILLATION

Short-path distillation units generally consist of jacketed vessels. Within these vessels, an agitator, commonly referred to as the rotor, spreads the product on the wall of a heated surface. As various components evaporate from this heated surface, they are condensed a short distance away, as shown in Figure 1. The process is normally operated under deep vacuum (micron range) conditions and is commonly used for high-boiling, viscous, and heat-sensitive materials. The forced circulation of the evaporating fluid at higher velocities (6–30 ft/s) results in higher heat-transfer coefficients and allows for smaller heat-transfer areas, which is particularly useful in high-evaporation applications.

The terms "short-path" and "molecular distillation" are often used interchangeably. However, molecular distillation normally refers to the use of a distillation apparatus where the gap between the evaporator and condenser is equal to or less than one mean free path of the molecules evaporated, thus facilitating collision-free diffusion transport. This is not usually the case in commercial SPD equipment where the evaporation/condensation gap is larger than that required to meet these molecular mass transfer conditions.

The mean free path, j_i, can generally be estimated using Equation 1, where pi^0 is the vapor pressure, M_i is the molar mass, R is the gas constant, and T is the temperature (Arzate-Martínez et al., 2011).

$$j_i = p_i^0 \sqrt{\frac{1}{2\pi M_i RT}} \qquad (1)$$

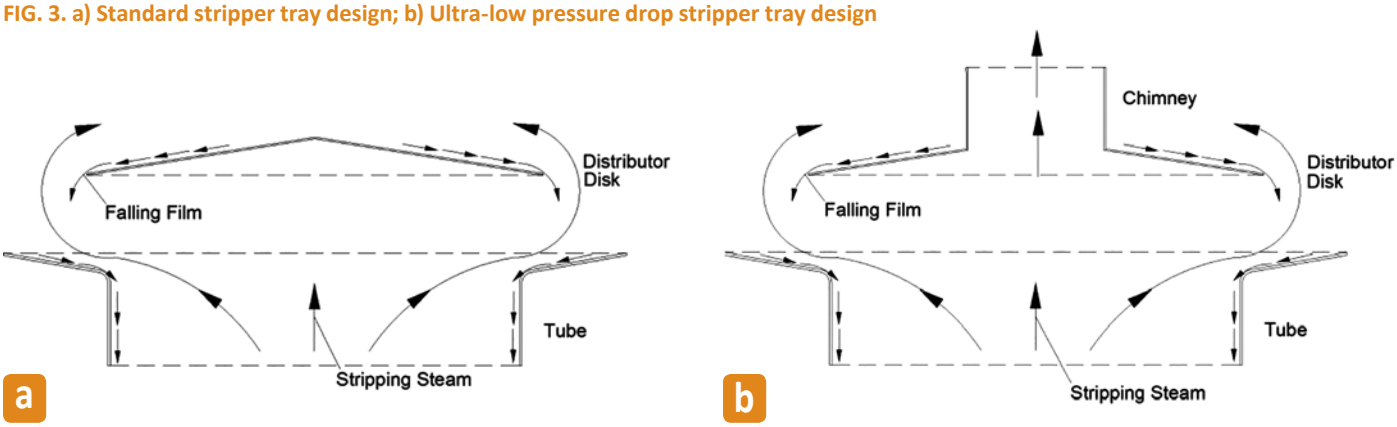
Short-path distillation is generally characterized by the combination of a very short residence time in the evaporator (1–10 seconds), high vacuum levels (0.001–0.02 torr), and a short distance between the evaporator and condenser (10–50 mm). In SPD, efficient mass transfer rates are achieved due to the feed forming a thin film on the inner wall of the distillation unit. The vaporized components are condensed immediately on a cold surface in the interior of the unit. In other words, the vapor stream travels a "short path" directly to the condenser, which is located within the evaporator chamber. Rapid condensing of the vapor stream that is generated precludes the vapor pressure of this stream from adding to the system's operating pressure. SPD typically operates at relatively low distillation rates of 100–200 kg/hr per square meter of evaporator surface area.

There are two types of short-path distillation plants in commercial use. The more common configuration includes thin films generated using devices such as rollers, wipers, fixed clearance blades, or pitched blades rotating inside the column to spread out the film. A second method for the formation of a thin film is to use a rotating disk that spreads a film through the use of centrifugal force on a heated disc. Film thickness and residence time are controlled by the rotation speed of the evaporator disc and the feed rate. The condenser of an SPD system is normally located at the center of the apparatus to minimize pressure drop by internally condensing the volatile components that evaporate, as described above, allowing operation in the micron range of vacuum.

THIN-FILM EVAPORATION WITH GAS STRIPPING

Two different designs of the thin-film evaporation with gas stripping system are used to overcome the problems associated with film distribution in falling-film evaporators. In the standard design, the feed introduced at the top of the unit cascades down as a thin film through a series of tube-and-disc trays where the volatile components are stripped off by the rising vapor under vacuum. Evaporation takes place through several stages where each tube-and-disc tray creates a fresh liquid film at each stage, providing a new surface for evaporation and stripping, as shown in Figure 2. The basic design has semi-cone solid distribution discs for moderate vacuum (10 and higher torr) applications. For high-vacuum applications (0.5 to 5 torr), the discs are replaced with chimneys to achieve extremely low pressure drops. A cross section of each design is shown in Figures 3a and 3b.

FIG. 3. a) Standard stripper tray design; b) Ultra-low pressure drop stripper tray design



Residence time is generally measured in 1 to 3 seconds per stage, and pressure drop in the chimney tray design is generally less than 0.02–0.05 torr per stage, which allows for the distillation process to take place at very high vacuum and reduced operating temperatures at the bottom of the stripping column, where the most difficult part of stripping takes place. Nitrogen and more typically dry, superheated steam is used as the sparging medium flowing through each stage in the column to further enhance mass transfer. For applications which require higher percentages of volatiles to be removed, each tube can be individually jacketed to provide additional heat transfer.

However, in most applications, such as solvent recovery, deodorization of fats and oils, or in the removal of environmental contaminants, the trays are not heated due to the relatively small amount of volatiles being removed by the stripping gas.

The thin-film evaporation system can achieve extremely low residual levels of contaminants by taking advantage of the role of the carrier effect of lights in multicomponent separations. The "carrier effect," which is well-known in the petroleum industry, is when the addition of light hydrocarbons enhances the separation of heavy cuts, such as gas oil from residue. Stichlmair and Fair (1998) presented data obtained numerically, showing that the liquid yield in a flash is lowered when light components are added to the mixture, which is equivalent to feeding stripping gas, such as steam, to the system. The vapor-liquid phase behavior is assumed to follow Raoult's law. For simplicity, we define **K =Y/X,** which is commonly referred to as the "Separation Factor," where Y is the vapor mole fraction and X is the liquid mole fraction of the light component to be removed. In general, if one assumes ideal vapor liquid equilibrium **(Y=1),** this term can be defined by the ratio of the partial pressure of the light component to the system pressure **(K=VP/π)**, where VP is the vapor pressure of the light component and π is the system pressure. Now if we add stripping steam into the simplified equation,

$$K = \frac{VP}{\pi - P}$$

where **P** is the partial pressure of steam in the vapor phase. As can be seen from this equation, "injecting stripping steam is equivalent to reducing the system pressure."

REMOVAL OF CONTAMINANTS FROM EDIBLE OILS

If heat-sensitive oils, such as marine oils, are processed at conditions similar to those used for vegetable oils, losses of up to 30% of the valuable omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) can occur during the long periods of heating in the deodorizer. The main advantages of both short-path distillation and thin-film evaporation for physical de-acidification of edible oils are lower operating temperatures and shorter processing times, enabling treatment of heat-sensitive oils without degradation.

Furthermore, the removal of less volatile components, such as PCDD/F, and PCBs from fish oils, is significantly more challenging than simply reducing the FFA concentration of the oil. As such, the higher efficiency of processes like short-path distillation and thin-film evaporation with steam stripping is more suited to remove these contaminants, while preserving the quality standards shown in Table 1 (page 13).

Figure 4 (page 16) depicts the experimental set-up used for the pilot plant stripping trials conducted on crude fish oil using the thin-film evaporation with gas stripping system described above. Both three and four equilibrium stage, partially heated, as well as unheated disc and tube trays were tested to determine the stage efficiency under various operating conditions.

The trials took place over a period of roughly three months, and more than 50 combinations of critical operating parameters were tested to optimize the process. Feed rate, sparge steam rate, operating temperature, and pressure were the primary variables examined.

Analytical test results for samples of the stripped oil collected during the trials were subsequently used to validate process simulations created using ChemCAD® software. Simulations were performed using various different vapor-liquid equilibrium (VLE) models to determine the model that best fit the data. The results predicted by the simulations were typically within a margin of error of between 5 to 10%, depending on the particular model. Table 2 (page 16) is a sample of three operating conditions and associated analytical results from the test campaign.

Table 3 (page 16) shows results comparing short-path distillation with thin-film evaporation with steam stripping for the removal of environmental contaminants from fish oil.

FIG. 4. Drawing of the experimental setup used during the pilot trials for the removal of contaminants from fish oil using thin-film evaporation with gas stripping

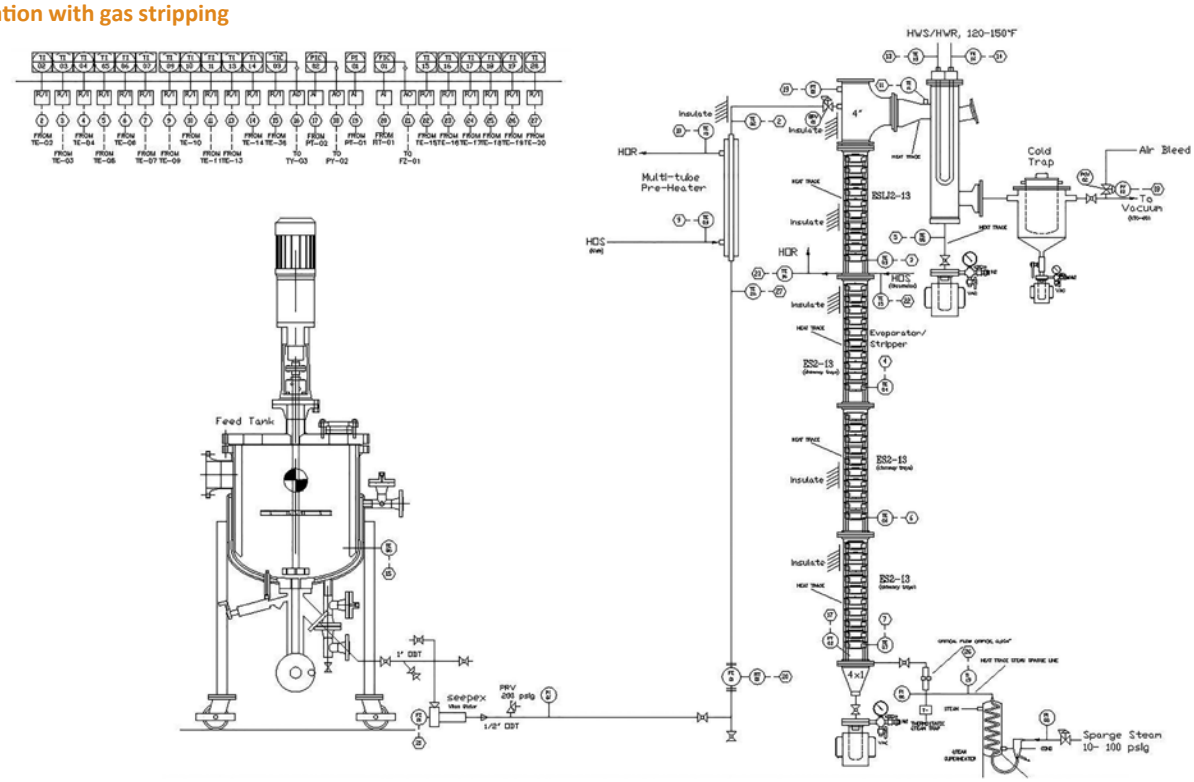


TABLE 2. Sample of operating conditions and analytical results from Artisan's fish oil stripping test campaign

	Condition #	1	2	3
Operating conditions	Feed rate [lb/hr]	25	25	20
	Operating temperature [F]	402	429	442
	Top pressure [torr]	1	2	3
	Bottom pressure [torr]	4.8	5	7.6
	Steam sparge: feed mass ratio [%]	5.00%	5.00%	9.85%
Analytical results for stripped oil	FFA concentration [wt%]	0.23	0.2	0.25
	PCDD/F [pg/g or ppt]	1.4	0.79	0.27
	DL-PCBs [pg/g or ppt]	0.5	0.08	0.007
	Total PCBs UB [ng/g or ppt]	11.2	2.75	0.42

TABLE 3. Removal of environmental pollutants in fish oil. Test results from Artisan's test campaign indicated zero loss of DHA and EPA in the refined oil.

	Sum PCBs (pg/g or ppt) (before stripping)	Sum PCBs (pg/g or ppt) (after stripping)	Sum PCDD/F (pg/g or ppt) (before stripping)	Sum PCDD/F (pg/g or ppt) (after stripping)
Short-path distillation	427	7.78	33.09	2.65
Thin-film evaporation with steam stripping	**370,000**	**420**	**8**	**0.27**

PROS AND CONS OF AVAILABLE TECHNOLOGIES

For large-volume operations, continuous deodorizers are typically preferred over batch units due to higher efficiencies and lower energy consumptions. The standard deodorizers commonly available from a number of manufacturers, such as Desmet Ballestra and Alfa Laval, are either tray columns or come with structured packing to promote stripping. However, both types, particularly the tray deodorizers, carry a high retention time and pressure drop; thus the oil is exposed to high temperatures for up to 30 minutes or longer depending on the type of oil and the desired product specifications.

Furthermore, to achieve extremely low FFA content in the refined oil, since higher temperatures are not desirable, the process would need to operate at very low pressures. However, as the operating pressure is reduced, vapor volumes expand, causing higher pressure drop across the column for a given stripping steam rate. Thus the pressure at the bottom of the column would be too high to achieve high FFA removal at lower operating temperatures.

Although FFA removal or conventional deodorization can be effectively carried out in tray or packed columns, the same does not hold true when the objective is the removal of the closer boiling contaminants, such as PCB's, dioxins, and the like. These compounds have a lower

TABLE 4. Advantages and disadvantages of thin-film versus short-path evaporation systems

Type	Advantages	Disadvantages
Short-path systems	• Suitable for highly viscous materials • No hot, dry spots • Operates at a micron range vacuum • Low-temperature operation • High heat transfer rates • Suitable for fouling service	• Poor separation efficiency • Product yield loss • High capital investment • Expensive to maintain • Costly vacuum system • Throughput limited • Single-stage operation
Thin-film evaporation with steam stripping	• High throughput capability • Multi-staged operation • No moving parts • Moderate capita investment • Little to no maintenance • Low pressure drop • Operates as low as 0.5 mmHg vacuum • Virtually no product yield loss	• Viscosity limited to 10,000 cP • Limited evaporation capacity • Low heat transfer rates • Not suitable for fouling service

vapor pressure than FFAs, and are more difficult to strip to extremely low residual levels.

There are two other alternatives to conventional deodorizers: One is short-path distillation, and the other is the Artisan Evaporator/Stripper, which is a multi-staged, ultra-low pressure drop thin-film deodorizer.

Short-path evaporators are commonly used for distillation of high-boiling, heat-sensitive materials, such as tocopherols and other antioxidants. This technology is manufactured by a number of companies, such as VTA, Buss-SMS-Canzler GmbH, GIG Karasek GmbH, Pfaudler, and others. The technology has also been used occasionally in stripping operations, where the objective is to remove only a very small amount of undesirable odorous compounds, color bodies, or other contaminants.

Although equilibrium prevailing stripping separations can effectively be carried out in short-path evaporators, in nearly all applications where ppm or ppb level purity is desired, multiple passes or evaporation units in series are employed at a

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TABLE 5. Processing costs for fish oil based on conventional processing techniques [$/lb]

Refining	Bleaching	Winterizing	Molecular distillation	Deodorization
0.10–0.20	0.10–0.30	0.08–0.10	0.11–0.20	0.18–0.20

TABLE 6. Processing costs for fish oil based on Artisan's newly developed processing technique [$/lb]

Bleaching	Winterizing	Thin Film Stripping
0.10–0.30	0.08–0.10	0.18–0.20

significant capital and installation cost to reach extremely low levels of impurities. In addition, there is a potential for significant yield loss due to the very low operating pressures which causes the oil itself to evaporate.

Thin-film evaporation with gas stripping is a more suitable and economical solution to short-path evaporation in difficult stripping applications, such as contaminant removal and physical refining of edible oils.

This multi-stage, disc and tube falling film tray design provides ample surface area and has no moving parts. The system can be designed with over 4 to 5 theoretical stages to achieve extremely low residual levels of undesirable contaminants as compared to a short-path evaporator, which is only a single-stage unit operation. The increased separation efficiency due to multiple stages and the use of stripping gas allows the evaporator/stripper to achieve similar product purity at higher operating pressures, resulting in little or no yield losses. Table 4 illustrates the advantages and disadvantages of thin film-stripping versus short path evaporation systems.

Typical cost ranges for the conventional fish oil processing steps, including refining, bleaching, winterizing, molecular distillation, and deodorizing, are outlined in Table 5.

As discussed, Artisan's multi-stage thin-film stripping process can be used in place of the physical refining, short-path, or molecular distillation and deodorization processing steps listed above. Furthermore, the Artisan process is comparable to standard deodorization, just one of the three processing steps it replaces, in terms of cost.

Consequently, the use of this thin film stripping process for fish oil purification results in a cost reduction of 0.21 to 0.41 $/lb as shown in Table 6.

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Too small for supercomputing? Think again.

Catherine Watkins

By definition, a supercomputer is any computer that is one of the largest, fastest, and most powerful available at a given time. Currently, supercomputers (SCs) consist of tens of thousands of networked processors that are capable of performing many quadrillions (10^{15}) of calculations per second. The growth in their speed has been exponential; the iPhone X has thousands of times the processing muscle of the computer that powered the manned mission to the Moon in 1969.

- **Supercomputing, which is also known as high-performance computing, is used by businesses of all sizes to gain a competitive edge by reducing their time to market as well as the expense of engineering new products and processes to improve production quality and efficiency.**
- **Many supercomputing centers around the world work with private-sector businesses ranging from those with only a few employees to those with thousands.**
- **According to analysts, every dollar invested in high-performance computing—whether in-house or outsourced—will produce a return on investment of at least 7% and as much as 500%**

In late 2018, the world's fastest supercomputer was Summit, which is housed in a room the size of two tennis courts at Oak Ridge National Laboratory (ORNL) in Tennessee (USA). This massive machine cost around $200 million and contains 9,216 processors enhanced with 27,648 graphics chips. Its peak energy consumption is about 15 megawatts, or enough to power more than 7,000 US homes. Summit can calculate in one second what it would take a single human brain six billion years to accomplish.

The processing speed of supercomputers is measured in FLOPS, or floating-point operations per second (see Table 1). A floating-point operation is any mathematical operation such as addition, subtraction, multiplication, or division that involves numbers that have decimal points in them rather than strictly binary integers.

Today's behemoth machines are not just bigger and faster than the standard laptop or desktop processor. Thanks to specialized software and their thousands of networked CPUs and GPUs, they are able to perform

TABLE 1. Exponential development of computing power

Unit	FLOPS	Decade
Hundred FLOPS	One hundred (10^2)	1940s
Kiloflops (KFLOPS)	One thousand ($10^{3)}$	1950s
Megaflops (MFLOPS)	One million (10^6)	1960s
Gigaflops (GFLOPS)	One billion (10^9)	1980s
Teraflops) (TFLOPS)	One trillion (10^{12})	1990s
Petaflops (PFLOPS)	One quadrillion (10^{15})	2010s
Exaflops (EFLOPS)	One quintillion (10^{18})	2020s (?)

Abbreviation: FLOPS—floating-point operations per second.
See "Clip-and-save glossary" on page 22.
Source: Adapted from information at explainthatstuff.com

FIG. 1. P&G researchers have used HPC to investigate microbes to develop a more comprehensive understanding of how the company's products affect their consumers and the microbial communities that surround them. (Photo courtesy of OSC).

parallel processing by dividing problems into components and working on many pieces of the calculation at the same time. This is the primary reason why they exhibit such spectacular throughput. Add to that their massive storage capabilities, and supercomputers can crunch unimaginably large data sets at breakneck speed.

WHY USE A SUPERCOMPUTER?

High-performance computing (HPC) can track vast numbers of variables at once, making it ideal for projects such as weather forecasting or predicting the effects of climate change. As a rule of thumb, wherever Big Data and a testable hypothesis exist, HPC is indicated. (For AOCS industries, think of taking a year or more of production-line data and using HPC to predict line failure before it actually happens.)

One of the most exciting uses of supercomputers is to model and simulate the molecular dynamics of physical systems, allowing scientists studying everything from prescription drugs to nuclear bombs to test out their ideas. In other words, SCs can do many things via computation that cannot be done experimentally.

Industry has been using modeling and simulation (M&S) on SCs for more than a decade to design packaging, to engineer new molecules such as sustainable surfactants or synthetic additives, and to create more efficient production processes. Procter & Gamble Co. (P&G; Cincinnati, Ohio, USA) was an early leader in the use of M&S, led by Tom Lange (Fig. 1). Lange retired from P&G in 2015 as director of modeling and simulation and opened a consultancy (see "More information" on page 22). He remains an advocate of HPC for businesses of all sizes.

Early in Lange's career at P&G, he worked on designing cyclonic dust-collectors at a P&G plant. At that time, "we just lived with the fact that every day or so we would have to shut down the line and scrape out the cyclone," he wrote in an email. "Then, a few years after retirement I did some consulting for one of the plants and saw that the cyclone was still a mess. I proposed a new design that I was able to test and demonstrate in a simple 15-second movie. Had that capability existed when I began my career, we would have prevented 40 years of shutting down production every day for 30 minutes."

M&S research into product formulations runs the gamut from testing new synthetic molecules and their phase behavior to cost-effective packaging to the fluid dynamics of edible products. For example, Alan Gray and a team of researchers at the University of Edinburgh used fluid dynamic applications on an SC to study the physics of ice cream mixing, suspensions, and the formation of liquid crystals. This allowed them to optimize phase separation, leading to a smoother ice cream product. (See tinyurl.com/ice-cream-case-study for more information.)

WHAT ABOUT THE COST?

Perhaps the biggest misconception about supercomputing is that it is feasible only for large corporations with big budgets that invest in their own hardware, or is available solely to academic and government researchers with access to a local facility. In reality, a number of HPC facilities in the United States and abroad work with industry.

"We work with anybody and everybody," says Alan Chalker, director of strategic programs at the Ohio Supercomputer Center (OSC; Columbus, Ohio, USA). "Last year, we had 48 active commercial clients ranging from Fortune 500 corporations such as P&G and Honda to small shops with five or six employees."

The majority of OSC's clients spend between $1,000 and $2,000, he notes, adding that the bulk of the expense lies in buying commercial software licenses and the expertise of OSC staff and external experts, not in the cost of running the supercomputer.

OSC caters to three types of clients, Chalker explains. One group includes larger companies with in-house SC resources that simply need access to the capacity of the OSC system. Other clients are already doing some in-house HPC work on desktops using their own engineers, often to debottleneck production. In these cases, OSC provides the expertise (sometimes at no cost) to optimize this work using parallel processing. The final client group recognizes their businesses have problems but need help defining those problems and breaking them down into smaller, more manageable problems.

International Data Corporation (IDC; Framingham, Massachusetts, USA), an international market research firm working with the US Department of Energy on a three-year study, reported in 2016 that HPC users experienced an average return on investment of $515 in revenue and $52 in profits (or cost savings) for every dollar spent on HPC (see tinyurl.com/IDC-ROI). Consultant Tom Lange says that in his experience at P&G and now with his consulting clients, every dollar invested in HPC to do M&S provides a "seven to 15 times multiple of business impact."

The most-documented savings from HPC come from three areas, reports Lange. These include capital avoidance (showing an existing asset can do the job for a new product), material savings (establishing the minimum amount of plastic needed in a liquid detergent bottle to avoid breakage, for example), and virtual testing (Fig. 2). You can watch a video of a "bottle drop visualization test" at https://youtu.be/Yk50gUk5zBU.

"When it comes to the idea that you can 'test' things with a computer," says Lange, "the smaller shops seem to be more reluctant to believe and, therefore, require more [physical] validation instead of just using the digital outputs. Which is a shame, because there has been so much validation work to show that finite element analysis, computational fluid dynamics, discrete element models, and other such computational tools are at least as accurate as any physical test you could construct."

Experimentation may not be adequate to test hypotheses when things are too small to see and measure, systems are too large and remote, processes are too fast or too complex, or if

Clip-and-save glossary

Algorithm: An algorithm is a set of rules for solving a class of problems. Algorithms can be applied to calculations, data processing, and automated reasoning tasks.

Artificial intelligence (AI): AI—a branch of computer science—deals with the simulation of intelligent behavior in computers.

Cloud computing: Cloud computing uses a network of remote servers hosted on the internet to store, manage, and process data instead of a personal computer or local server.

Cluster: A cluster is a group of processors (nodes) connected by a high-speed network, forming a supercomputer.

Computational science: This field involves scientific and engineering research in which the computer plays an essential role. Computational scientists develop models, systems, algorithms, and simulations in order to solve concrete and complex problems.

CPU: The Central Processing Unit or CPU is the core circuitry responsible for all the arithmetic and control operations of a computer.

Floating-point numbers: Floating-point numbers contain decimal points. Numbers that do not have decimal places are known as integers.

Flops: Floating-point operations per second, or flops, is a measure of the memory access performance of computers. In late 2018, the world's fastest supercomputers were operating at the petaflop level, or at more than a billion billion calculations per second.

GPU: A Graphics Processing Unit, or GPU, is designed to handle both 2D and 3D graphics operations, as opposed to a CPU. Combining CPUs and GPUs in today's GPU-enhanced supercomputers improves performance and energy efficiency.

HPC: High-performance computing (HPC) is a general term for the use of supercomputers and parallel processing techniques.

Machine learning: A type of data analysis that is a branch of artificial intelligence in which systems learn from data, identify patterns, and make decisions with minimal human intervention. Applications include fraud detection as well as predicting equipment failure to prevent downtime.

Molecular dynamics (MD): MD is a computer simulation method for studying the physical movements of atoms and molecules over a fixed period of time, "giving a view of the dynamic evolution of the system," as Wikipedia puts it.

Nodes: In parallel computing, the term "node" most often means a server, which might have several processors (CPUs and/or GPUs) sharing a monolithic memory but functioning as a single computer. Nodes that are coupled together are part of a cluster.

Parallel processing: Parallel processing uses more than one CPU or GPU simultaneously on a single application or problem. This is in contrast to **sequential or serial processing,** in which an algorithm is executed sequentially, or once through, from start to finish on a single node or processor.

Supercomputer: Any computer that is one of the largest, fastest, and most powerful available at a given time (from the Academic Press *Dictionary of Science and Technology*).

Top500: Top500 assembles and maintains a list that has been published twice a year since June 1993 of the 500 most powerful computer systems in the world. The list is compiled by ISC Group (Germany), along with news, statistical information, and conferences for the HPC community (top500.org).

experimentation would cause harm, notes OSC's Alan Chalker, making a strictly computational approach necessary.

OTHER SC CENTERS

Another supercomputing resource available to industry is through the National Center for Supercomputing Applications (NCSA) on the campus of the University of Illinois at Urbana–Champaign. NCSA has an industrial cluster known as iForge as well as the Blue Waters supercomputer (Fig. 3), which is "one of the largest and most accomplished supercomputers in the world," according to NCSA Industry Director Brendan McGinty. NCSA's industrial clients include some of the largest in the world, such as P&G, Syngenta, and ExxonMobil. "We've worked with large companies in many sectors as well as small companies with data challenges," he notes, adding that NCSA's industrial partners pay an annual membership fee that covers the initial consultation, computer access, HPC news, and more.

The Texas Advanced Computing Center (TACC; Austin, Texas, USA) also works with industrial clients through its Industrial Affiliates program, Science and Technology Affiliates for Research, which began in 2007. "Start by figuring out what your challenges are and where your pain points are," suggests Melyssa Fratkin, TACC's industrial programs director. "Don't be afraid to engage with HPC centers," she adds. "We collaborate with researchers from all scientific disciplines; we aren't just a bunch of people who run a big machine and talk like geeks."

FIG. 2. Modeling and simulation of consumer goods products help P&G save money and time by using computation rather than physical testing. Here, the company was testing a new plastic bottle for its Crest mouthwash. (Photo courtesy of OSC). Watch a video of a "Bottle drop visualization" test at https://youtu.be/Yk50gUk5zBU.

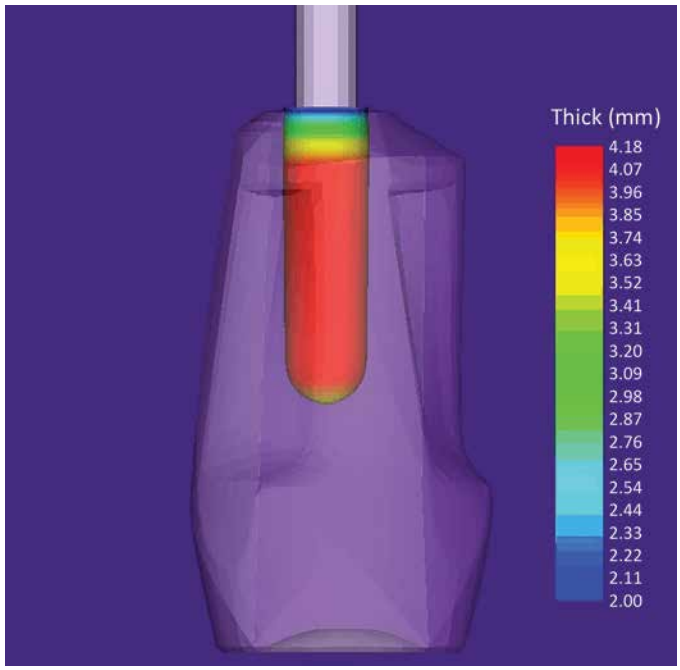
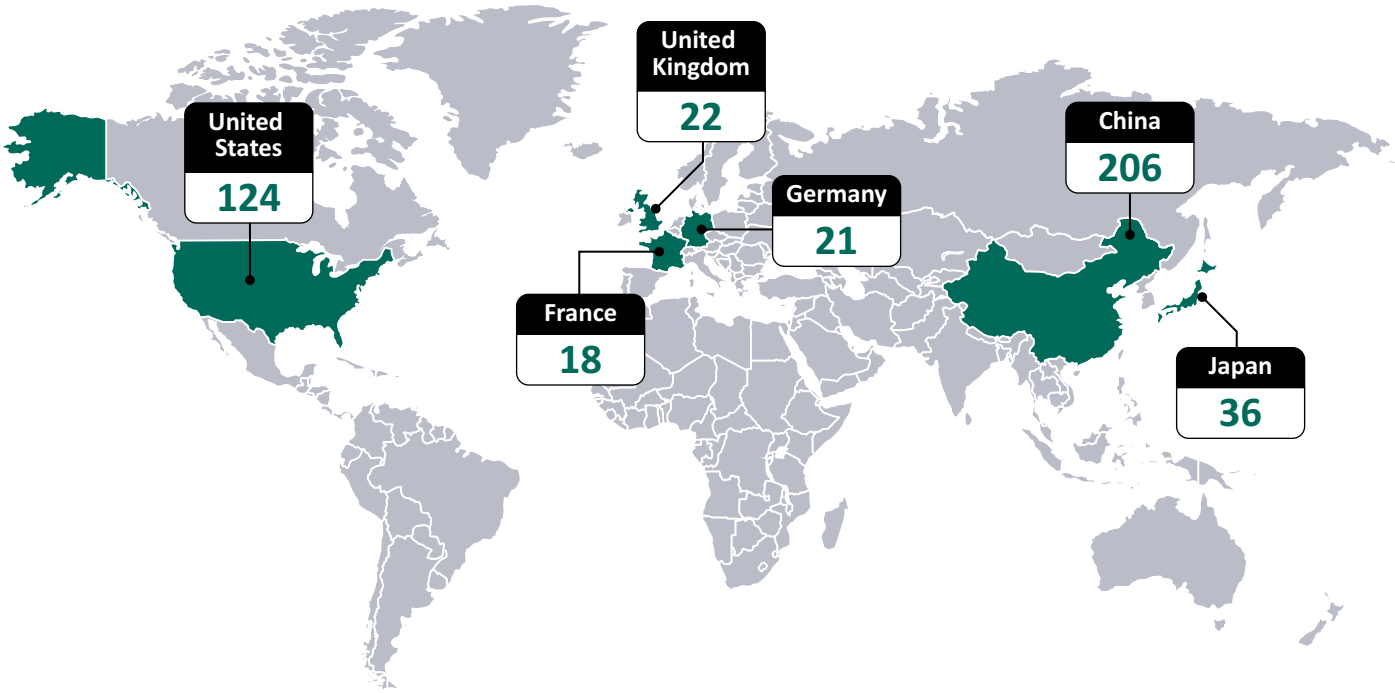


FIG. 3 Known as "Blue Waters," this supercomputer is a petascale (13.3 petaflops) machine at the National Center for Supercomputing Applications (NCSA) on the campus of the University of Illinois at Urbana–Champaign. NCSA works with industrial partners to help them solve problems and increase competitiveness through the use of high-performance computing. (Photo courtesy of NCSA).

Supercomputer (SC) facilities by country



Source: TOP500, June 2018 report (top500.org/lists/2018/06)

ADVICE FOR HPC NEWBIES

Consultant Tom Lange has some practical suggestions for companies that are considering HPC.

- Never throw away any data, he stresses. "The cost of storing data continues to go down dramatically and once the data are gone, they are gone for good."
- Save text and ASCII data in row/column format where rows record observations and columns are variables. "Analysis needs flat files, for the most part," he notes, adding that "magical homegrown Excel files with interim row averages and partial column calculations are a pain to get into serious analytical software for statistical or machine learning."
- All geometrical data can be imported into models and used for simulations, so never delete any physical measurements, he suggests. Further, HPC neophytes should remember they will ultimately pay for a digital transformation of innovation work processes from money that used to pay for doing physical testing and full-scale trials. "Those physical tests were not that predictive anyway," Lange says. "My best suggestion is to replace your full-scale trials with a few well-placed bench tests and some very detailed HPC-based models and simulations."

The parting thought comes from NCSA's Brendan McGinty. "Dream big," he urges. "Most industrial partners can't dream big enough to solve grand challenges by leveraging supercomputing. The ability to dream at massive scale to match massive-scale data and solutions is the key to progress."

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Information

Watch a two-minute video about how a supercomputer was used to improve ice cream (tinyurl.com/SimIce) or a simulation of the evolution of the galaxies in the first 400 million years after the Big Bang (winner of the 2017 Best Scientific Visualization Award at the Supercomputing Conference; visit tinyurl.com/NCSA-Bang).

HPCWire: This ezine covers "the fastest computers in the world and the people who run them," according to its website at www.hpcwire.com.

National Center for Supercomputing Applications (Urbana, Illinois USA): Contact Brendan McGinty, Industry Director, at bmcginty@illinois.edu or +1 (217) 244-6020; ncsa.illinois.edu/industry.

Ohio Supercomputer Center (Columbus, Ohio, USA): Contact Alan Chalker, Director of Strategic Programs, alanc@osc.edu or +1 (614) 247–8672; awesim.org.

Technology Optimization & Management LLC (Cincinnati, Ohio USA): Contact Tom Lange, lange.tj@techoptm.com or +1 (513) 403–7370.

Texas Advanced Computing Center (Austin, Texas USA): Contact Melyssa Fratkin, Industrial Programs Director, mfratkin@tacc.utexas.edu or +1 (512) 471–9961; tinyurl.com/TACC-Industry.

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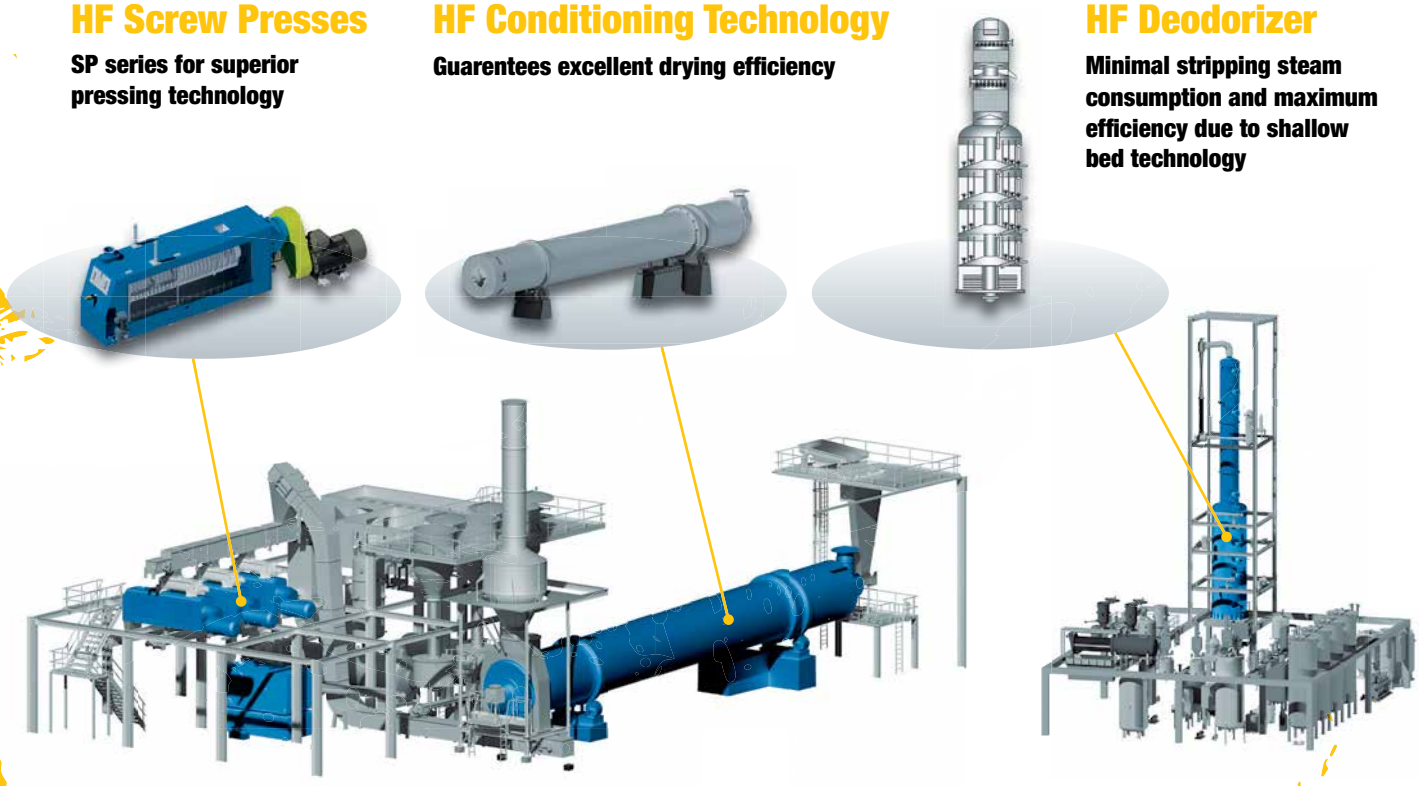

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Lowell Nutter (1937–2018), founder of Nu-Chek Prep

Doug Bibus

Nu-Chek Prep in Elysian Minnesota, produces the vast majority of high-quality fatty acid and lipid standards used throughout science today. The company's founder, Lowell Nutter, was a chemist at the Hormel Institute, where he supported research activities of many lipid researchers, including Dr. Ralph T. Holman, who invented the term "omega-3" and for whom The Ralph Holman Lifetime Achievement Award is named. The highly pure nature of the fatty acids produced by Lowell were a significant advantage for the scientists at the Hormel Institute during the early years of fatty acid research. Holman often attributed the ultimate success of the Hormel Institute to the early availability of these standards which allowed for the development of analytical methods and feeding studies utilizing purified fatty acids. Researchers like Orville Privett, James Mead, William Christie, Herman Slenk, Hans Morhauer, and Holman defined many of the fundamental aspects of essential fatty acids which ultimately led to the Hormel Institute's legacy as a top fatty acid and lipid research institute. Today, NuChek Prep's standards are used in laboratories throughout the world, where they are used on a daily basis to calibrate analytical methods and provide pure compounds for basic research. Lowell Nutter passed away peacefully on September 26, 2018, surrounded by family.

Lowell Nutter was born in the small town of Randall, Minnesota, in 1937, and attended and graduated from St. Peter High School in St. Peter, Minnesota. Lowell continued his education at Minnesota State University in Mankato, where he majored in chemistry and biology, and minored in mathematics and physics.

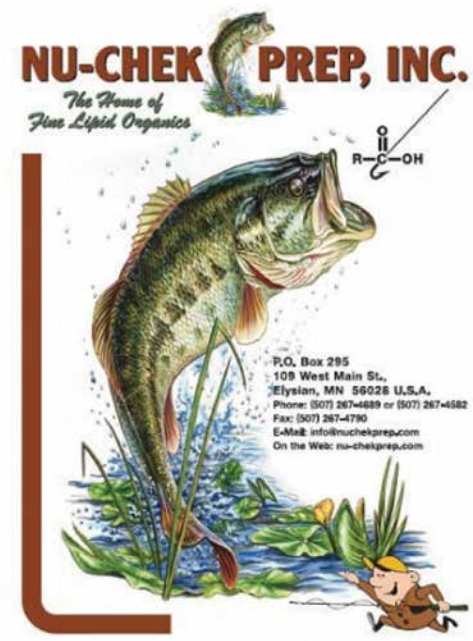
After graduating in 1959, Lowell spent five years teaching science and math in Pine Island Minnesota. While teaching, he met Hilda (Lou) Koehler, and the couple married on May 30, 1964, in a little country church near Madison Lake, Minnesota. Lowell and Hilda had one son, Brian, who is Nu-Chek's current president, and a daughter, Christina. Years later, they were blessed with five grandchildren who kept Lowell and Hilda busy in their retirement.

Following his teaching career, Lowell worked as a research chemist at the Hormel Institute, a research branch of the University of Minnesota located in Austin. While there, Lowell authored and co-authored many publications on lipid analysis with Dr. Orville S. Privett.

In 1970, following his tenure at the Hormel Institute, Lowell and John Nadenicek founded Nu-Chek-Prep Inc. in an old service station in Elysian, Minnesota. Nutter and Nadenicek had worked together at the Hormel Institute where Nadenicek ran the fatty acid production lab and Nutter performed metabolic tests with the purified fatty acids. With a limited staff and budget, Nutter and Nadenicek were able to isolate, extract, and purify fatty acids that no one else was capable of producing at the time. The availability of highly pure fatty acid standards was of considerable interest to many groups then.

The original customers for Nu-Chek Prep's fatty acids were universities, colleges, and pharmaceutical companies. Today, about half of the company's sales are still to researchers at colleges and universities, with the balance being sold to distributors and biological supply houses. The company currently offers approximately 1,500 products in its catalog. Most are exactly the same products that the company began producing in 1970.

Lowell's main hobby in life was golf, and although he never obtained that elusive hole in one, he enjoyed the friendship of



many while golfing. His favorite part of the game was a four-man scramble pitting one twosome against another. He also enjoyed monthly poker games with his friends of many years, most of which were held at Ed Atherton's hideaway overlooking Lake Francis. Lowell lived, loved, and embraced life in many ways.

I first met Lowell at one of my first AOCS annual meetings back in the early 1990s. I was very familiar with Nu-Chek Prep's fatty acid methyl ester standards that were my guide to learning and understanding fatty acid analysis at the time. As a fisherman too, I was also drawn to the '70s-era artwork of a jumping bass on the face page of their catalog, a standard that continues today.

Lowell was an embracing figure, warm and genuine. During my time at the Hormel Institute, Dr. Holman spoke fondly of Mr. Nutter and was proud that he and, subsequently, the Hormel Institute were able to offer such pure standards early in their history.

Lowell was also a passionate member and supporter of AOCS. His enthusiasm for our great society was one of my first lessons about the comradery of AOCS members. My early experiences with members like Lowell emphasized the close family nature of AOCS for many of its members. Lowell was one of the first members of my AOCS "family," and his passion, efforts, and products have been a significant part of my career. I am reminded of Lowell's legacy each day when I open my laboratory freezer and am greeted by a sea of blue-labeled Nu-Chek Prep standard vials that guide our analytical output and remind me of the great man who gave us this treasure.

AOCS Treasurer Doug Bibus founded and directs Lipid Technologies, LLC., an analytical and consulting group in Austin, Minnesota, that focuses on fatty acid and lipid analysis and integration of lipid nutrition in biotech and food applications. Bibus is an expert in the area of omega-3 fatty acids and their analysis, and once worked in the lab of Ralph Holman, who who invented the term "omega 3," and discovered the metabolism and essential nature of omega 3. He can be contacted at doug@lipidlab.com.

Some material was drawn from a feature article that originally appeared in Connect Business Magazine *in 2006.*

AOCS MEETING WATCH

May 5–8, 2019. AOCS Annual Meeting & Expo, America's Center Convention Complex, St. Louis, Missouri, USA.

April 26–29, 2020. AOCS Annual Meeting & Expo, Palais des congrès de Montréal, Montréal, Québec, Canada.

May 2–5, 2021. AOCS Annual Meeting & Expo, Oregon Convention Center, Portland, Oregon, USA.

October 8–11, 2019. 18th AOCS Latin American Congress and Exhibition on Fats, Oils and Lipids, Bourbon Cataratas Convention & Spa Resort, Foz do Iguaçu, Brazil.

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: +1 217-693-4843).

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The nuance of CLA: how a mix of isomers determine its future

Olio is an Inform *column that highlights research, issues, trends, and technologies of interest to the oils and fats community.*

Rebecca Guenard

Three decades of research indicate that conjugated linoleic acid (CLA) has positive effects on human health. Since the 1990s, when scientists identified CLA as an anticarcinogenic component of beef (https://tinyurl.com/ydxthd8b), researchers have sought a way to utilize those benefits for humans. Seeing no feasible treatment option, many in the field of CLA research have moved on, but the bioactive lipid continues to exhibit the ability to reduce inflammation (https://doi.org/10.1007/s11745-016-4228-8, https://doi.org/10.1007/s11745-017-4241-6). Although, a recently published meta-analysis questions these findings by concluding that inflammatory biomarkers in human blood actually increase with CLA intake (https://doi.org/10.1038/s41430-017-0048-z). Scientists have only begun to appreciate the complexity of CLA, and they are realizing that this complexity makes it difficult to survey the body of research on this important fatty acid.

A variety of geometric arrangements are synthesized naturally from the dehydrogenation of linoleic acid by different bacterial strains in the gut of ruminate animals. Each strain relies on different enzymes to convert linoleic acid into CLA (https://doi.org/10.2323/jgam.51.105, https://doi.org/10.1194/jlr.M700271-JLR200) resulting in over a dozen isomers (https://doi.org/10.3945/jn.111.138396). The two isomers prominent in bioactivity research are *trans*-10, *cis*-12 and *cis*-9, *trans*-11 (https://doi.org/10.1016/S0163-7827(01)00008-X). Interest in these specific isomers is likely because chemical synthesis to produce a commercial supplement from vegetable oil results in a CLA yield with a 50:50 mixture of *trans*-10, *cis*-12 and *cis*-9, *trans*-11. In nature, the stomachs of ruminant animals produce less *trans*-10, *cis*-12. The prevailing isomer is *cis*-9, *trans*-11 which then ends up in the ruminant's milk and muscle.

Multiple studies show that both CLA isomers boost lipid metabolism and decrease the risk of cardiovascular disease (https://doi.org/10.1079/BJN2002615, https://doi.org/10.1093/ajcn/79.6.1169S, https://doi.org/10.1007/BF03179915), but secondary effects on adipose and insulin systems in these studies lead to questions about CLA's potential to reduce inflammation.

Jake Olson, a research scientist at the University of Wisconsin–Madison, received his Ph.D. under Professor Mark Cook, who was one of the first scientists to investigate the health benefits of CLA. Cook passed away last year, and now Olson oversees the group's experiments on rheumatoid arthritis, a chronic inflammatory disorder (https://doi.org/10.1007/s11745-017-4241-6, https://doi.org/10.1007/s11745-016-4228-8). As part of that work, Olson has used animal models to distinguish the effects of the *trans*-10, *cis*-12 and *cis*-9, *trans*-11 isomers.

"The 9,11 isomer has a strong potential to act as an anti-inflammatory," he says. Although *in vitro* and animal models have regularly demonstrated anti-inflammatory outcomes, there are few human studies that provide definitive results (https://doi.org/10.1016/j.jfca.2008.12.002).

Fatemeh Nobakht, at Isfahan University of Medical Sciences, Isfahan, Iran, along with B.Fatemeh Nobakht M. Gh at Neyshabur University of Medical Sciences, Neyshabur, Iran, performed a meta-analysis on controlled clinical trials to assess the effect of CLA supplements on inflammatory biomarkers in human blood. They analyzed C-reactive protein and interleukin levels to determine if CLA lowered their concentrations

and found instead that they were slightly elevated. Their analysis concluded that CLA supplementation is cause for concern (https://doi.org/10.1038/s41430-017-0048-z).

Eric Murphy, associate professor of biomedical sciences at the University of North Dakota, Grand Forks, cautions that evaluating and comparing outcomes of CLA experiments needs to be done carefully. "Until people understood that the different isomers of CLA had radically different effects, human studies used the 50:50 mixture where really only one of the two was biologically active," he says. "Looking at these studies through that lens is important for a meta-analysis, because if you have a study that uses a much less bioactive isomer it may not have the same effect." He also points out that many dietary choices can increase or decrease the biomarkers mentioned in the paper.

Murphy suggests that the authors of the review were misguided in determining the exclusion criteria for their meta-analysis, bringing the paper's merit into question. "You can't compare a recent study to a study from twelve years ago, before we understood that the isomers had different biological activity," he says. "Not all CLA is the same."

Olson's arthritis results only reiterate that point. He found that the *trans*-10, *cis*-12 isomer resulted in an increase in inflammation, while the *cis*-9, *trans*-11 isomer acted as an anti-inflammatory agent. "The *trans*-10, *cis*-12 isomer appears to be responsible for promoting immune function," says Olson. "It tends to push the adaptive immune response to promote antibody production."

Olson has since shifted his research focus to study just the *cis*-9, *trans*-11 isomer. He no longer uses supplements which contain a mixture of isomers. He now relies on dairy as his CLA source, since the majority is in the form of the *cis*-9, *trans*-11 isomer. His group wants to determine if the isomer can be incorporated as a whole food into the human diet at a valuable concentration.

In September, *The Lancet* published a study on the dairy intake of over 13,000 participants across 21 countries that concluded there is no association between dairy and major cardiovascular disease. In addition, the authors determined that two or more servings of dairy a day decreases mortality (cardiovascular or non-cardiovascular) and stroke (https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31812-9/fulltext). Researchers now understand the health benefits of dairy fat and are optimizing those benefits by tailoring the animals' feed. Olson hopes that CLA-enriched dairy could provide the added advantage of decreasing inflammation.

Adam Lock, associate professor at Michigan State University, East Lansing, studies dairy production and human nutrition. He says that dairy is part of the human diet that is a uniquely rich source of saturated fatty acids, including CLA. "CLA is certainly a key component of what makes dairy products and milk, as the data is increasingly showing, a good component of the diet," says Lock.

However, the body of research on CLA prevents him from predicting that humans will see CLA-enriched foods any time soon. Although so many promising experiments lead to high hopes for the fatty acid, they were mostly performed on animals. "The point where it breaks down is it's hard to replicate that into a human study," says Lock.

Olson is undeterred. "We were the first group to try and drop the bottom out as far as dose requirements for anti-inflammatory affects," he says. "In both of our studies with pure isomers we found that 3 grams a day is the predicted minimal level. Based on our experiments, 3 grams a day would translate similarly from our mouse studies to humans."

According to Olson, a glass of conventional milk from corn silage-fed cows contains less than 100 milligrams of CLA. Grass feeding increases the concentration, but as CLA goes up, the overall dairy fat content goes down. "It is a challenge for a dairy producer to enrich CLA while maintaining the dairy volume that they would normally be dealing with," says Olson. He understands the economic challenge of enriching dairy fat. He also believes the health benefits are worth the effort since most major diseases in developed countries stem from chronic inflammation and currently available anti-inflammatories have side effects that limit long term use.

In 2017, Olson conducted a study of the *cis*-9, *trans*-11 isomer's anti-inflammatory capabilities compared to the prescription anti-inflammatory Celebrex® (https://onlinelibrary.wiley.com/doi/abs/10.1007/s11745-016-4228-8). The study showed that the potency of the CLA isomer was not sufficient to match the pharmaceutical anti-inflammatory. To achieve a practical anti-inflammatory effect, Olson concluded that CLA will need to work in conjunction with other fatty acids. Olson is currently investigating a *trans*-fat called vaccenic acid that is converted to CLA by the liver. He sees the possibility of enriching milk with multiple fatty acids to optimize anti-inflammation. "Our idea is that through a few of these compounds acting in concert we might be able to get to an anti-inflammatory level that is practical in the diet for humans," he says. "There need to be new innovations to drive a whole food like that."

Purifying the *cis*-9, *trans*-11 isomer is prohibitively expensive, so Olson says we are stuck with the 50:50 mix in supplements. Since scrutiny surrounds the *trans*-10, *cis*-12 isomer, Olson believes enriching CLA in milk is the sensible way for consumers to benefit from it, though he does admit that those consumers would be limited to people who eat and drink dairy.

Lock prefers concentrating on the general health benefits of dairy instead of singling out any one fatty acid to enrich—although he does acknowledge that the potential benefits of the *cis*-9, *trans*-11 isomer make it worth further study. "It is going to be interesting to see where this goes in the next decade," says Lock. "Maybe it will take an upswing again."

With more clinical trials occurring, Olson is confident that the health benefits of CLA will soon be realized by humans. "It is slowly getting there and it is taking the path of omega-3 fish oils in a sense," he says. "There are a lot of layers to this CLA story that are important and have to be peeled away."

Olio is produced by Inform*'s associate editor, Rebecca Guenard. She can be contacted at rebecca.guenard@aocs.org.*

Argentina 2018: Supply and demand of biodiesel

Leslie Kleiner

Latin America Update is a regular Inform *column that features information about fats, oils, and related materials in that region.*

To learn about biodiesel production, supply, and demand in Argentina, I reached out to ASAGA (Asociación Argentina de Grasas y Aceites—Argentinean Association of Fats and Oils).

The following article was written by *A&G* (monthly publication from ASAGA) in collaboration with the BCR (Bolsa de Comercio de Rosario—Stock Exchange of Rosario, Santa Fe Province, Argentina).

The article presents a series of projections and perspectives by the BCR. The organization analyzed the supply and demand of Argentine biodiesel for 2018, considering different local and international scenarios. In a regional and globalized context of instability in terms of exports and consumption, three different scenarios have been formulated. Table 1 summarizes the three scenarios for biodiesel production and consumption in Argentina during 2018.

TABLE 1. Biodiesel in Argentina: production and consumption

		2014	2015	2016	2017	A - Conserv. 2018 P	B - Medium 2018 P	C - Optimistic 2018 P
Initial stock	Thousand tons	82.9	94.0	102.1	98.7	145.8	145.8	145.8
Production	Thousand tons	2,584.0	1,810.7	2,659.3	2,871.0	2,290.0	2,550.0	2,850.0
	Thousand tons					-20.2%	-11.2%	-0.7%
Total offer	Thousand tons	**2,666.9**	**1,904.7**	**2,761.4**	**2,969.7**	**2,435.8**	**2,695.8**	**2,995.8**
Domestic consumption	Thousand tons	970.1	1,014.4	1,036.4	1,173.5	1,190.0	1,300.0	1,350.0
Closing sales	Thousand tons	969.5	1,013.0	1,033.3	1,173.3	1.4%	10.8%	15.1%
Other internal sales	Thousand tons	0.7	1.4	3.1	0.2			
Exports	Thousand tons	1,602.7	788.2	1,626.3	1,650.3	1,130.0	1,280.0	1,530.0
	Thousand tons					-31.5%	-22.4%	-7.3%
Total demand	Thousand tons	**2,572.9**	**1,802.6**	**2,662.7**	**2,823.8**	**2,320.0**	**2,580.0**	**2,880.0**
Final stock	Thousand tons	94.0	102.1	98.7	145.8	115.8	115.8	115.8
Ratio stock/ consumption	(%)	10%	10%	10%	12%			

Source: Bolsa de Comercio de Rosario - (Stock Exchange of Rosario, Santa Fe Province, Argentina), based on Ministry of Energy and Mining from Argentina, INDEC, OILWORLD; Claudio Molina, President of Argentinean Association of Biofuels and Hydrogen Fuels

The biodiesel market presents high levels of uncertainty due to unclear commercial policies worldwide, and local governmental policies in Argentina. Based on this, three scenarios have been estimated for 2018: a conservative, a medium, and an optimistic one (according to how different policies could impact production and exports of Argentine biodiesel). The main variables projected were domestic consumption, exports, and production.

DOMESTIC CONSUMPTION

Conservative scenario: This scenario coincides with the vision of the US Department of Agriculture (USDA) in its GAIN report of July 2017, as well as the view presented in the March issue of *Oil World Magazine*. The domestic consumption of biodiesel in Argentina during 2018 was estimated at 1.19 MT. This is approximately 1,350 million liters of soybean-based biodiesel incorporated into diesel as a mandatory cut, and it represents an increase of 1.4% over last year.

Medium scenario: Considering additional variables, we project a domestic consumption of 1.3 MT. This would be a result of an increase in diesel consumption for higher levels of economic activity (the cutting of biodiesel for local fuel destined to automobiles is above 10% biodiesel, or B10). The current levels of biodiesel consumption by the electricity sector are zero (0%). In addition, tax relief on soybean-based biofuel could increase consumption through the Argentine law 27,430 on "taxes on liquid fuels and carbon dioxide."

Optimistic scenario: A much more optimistic projection would bring the consumption closer to 1.4 MT if the uses of transportation increase. This growth could result from the implementation of the mandatory use of B20 (20% biodiesel) in some important cities of the country. Mandatory use of B20 could also increase consumption due to an increase in voluntary use in captive fleets.

A decision by the National Government to increase the cut to B12 (12% biodiesel) could help achieve this optimistic scenario, which is extremely necessary for the local biodiesel industry.

The medium and optimistic scenarios become more difficult to achieve because of the loss of soybean and corn production (of approximately 26 MT) from the drought. This climatic contingency generated fewer trips in trucking and rail transportation of grains and less use of agricultural producers and gas oil contractors in the harvest.

EXPORTS

The level of exports of biodiesel from Argentina will be mostly determined by the commercial and trading policies of each region or country; mainly Europe, the United States, and others.

Conservative scenario: Given that foreign sales to Perú are similar to those in 2017 and additional exports from Canada and exports to the European Union are similar to those in 2014 (almost 1.1 MT), we can estimate an external demand for the Argentine biofuel in 1,13 MT.

Medium Scenario: It is estimated at 1,280 MT.

Optimistic scenario: According to the Consulting Agency Strategic Grains, imports of Argentine biodiesel could reach 1.5 MT in 2018. This volume of shipments is possible if the European Union does not apply restrictions affecting the commercialization of Argentine biodiesel. If total exports remain stable at 1.53 MT in 2018, they would still be 7% below to the exported in 2017 and 2016.

TABLE 2. Soybean oil in Argentina: production and consumption

		2014	2015	2016	2017	A - Conserv. 2018 P	B - Regular 2018 P	C - Optimistic 2018 P
Initial stock	Thousand tons	0.15	0.27	0.32	0.25	0.17	0.17	0.17
Production	Thousand tons	7.09	7.89	8.66	8.07	7.41	7.41	7.41
Total offer	Thousand tons	**7.24**	**8.16**	**8.98**	**8.31**	**7.58**	**7.58**	**7.58**
Exports	Thousand tons	4.06	5.60	5.76	4.97	4.70	4.50	4.20
Domestic consumption	Thousand tons	2.91	2.25	2.97	3.16	2.63	2.89	3.19
For biodiesel	Thousand tons	2.58	1.81	2.66	2.87	2.29	2.55	2.85
Other uses	Thousand tons	0.32	0.44	0.31	0.29	0.34	0.34	0.34
Total demand	Thousand tons	**6.97**	**7.85**	**8.74**	**8.14**	**7.33**	**7.39**	**7.39**
Final stock	Thousand tons	0.27	0.32	0.25	0.17	0.25	0.19	0.19
Ratio stock/ consumption	(%)	4%	4%	3%	2%	3%	3%	3%

Source : Bolsa de Comercio de Rosario (BCR)

PRODUCTION

Argentina's biodiesel production exhibited good performance in the first two months of 2018: a historical record at more than 400,000 tons. Maintaining the mandatory cut and the domestic consumption estimations, production will come from the greater or lesser external demand for Argentine biodiesel.

What happens in terms of consumption and exports will define the level of final production in 2018.

Conservative scenario: estimated at 2.29 MT for the current year

Medium scenario: estimated at 2.55 MT

Optimist scenario: estimated at 2.85 MT

SOYBEAN OIL WITH LOWER PROSPECTS

Soybean oil is the main input of the biodiesel industry in Argentina. A greater demand for vegetable oils is expected from India. However, this country has been imposing high taxes on imports since 2017, to promote local industrialization of oilseeds and their subsequent transformation into biodiesel.

Argentina, among other countries, suffered from this trade policy measure, decreasing shipments of oil to India. The lower export forecasts for Argentine soybean oil will be effective as a result of lower volumes of production for the drought, and for the lower demand abroad.

India is the main buyer of Argentine soybean oil. While India's import taxes on soybean oil have not changed recently, it is important to note that tax has increased from almost 13% to 33% in recent years. While the intent to apply these taxes is to support domestic prices for oilseeds and the "Made in India" movement, it has logically attenuated the prospects for Indian vegetable oil imports in the current marketing year.

Consequently, we estimate that the exports of soybean oil from Argentina in 2018 are 4.20 to 4.70 MT. In this scenario, the production of soybean oil in Argentina can range between 7.4 and 7.5 MT. Table 2 illustrates the soybean oil supply and demand.

Latin America Update is produced by Leslie Kleiner, R&D Project Coordinator in Confectionery Applications at Roquette America, Geneva, Illinois, USA, and a contributing editor of *Inform*. She can be reached at LESLIE.KLEINER@roquette.com.

Amazon focuses on phthalates, preservatives, NP/NPE surfactants

Regulatory Review is a regular column featuring updates on regulatory matters concerning oils- and fats-related industries.

Kelly Franklin

Online retail giant Amazon has announced a chemicals management policy which includes its first restricted substance list (RSL) and plans for new transparency efforts.

The policy, made public on Amazon's responsible sourcing page, states that part of the company's commitment to quality is avoiding chemicals of concern in products. It defines these as chemicals that meet carcinogenic, mutagenic, or toxic for reproduction (CMR) criteria, or that are persistent, bioaccumulative, and toxic (PBT).

"We strategically prioritize which chemicals of concern to focus on based on product type, customer concerns, and the availability of safer alternatives," the company adds.

News of the approach comes nearly two years after Amazon ranked poorly in a 2016 "retailer report card" by a US NGO campaign.

The company—one of the world's largest retailers—signaled last year that it would become the first solely e-commerce business to develop a chemical policy. But as *Chemical Watch* reported earlier this year, Amazon's online sales model presents challenges for getting its third-party sellers to conform.

RSL

As part of the policy, the company has introduced an RSL that identifies 54 chemicals it is seeking to avoid in Amazon-owned private brand baby, household cleaning, personal care, and beauty products sold in the United States. It aims to expand the product categories, brands, and geographies covered over time, it says.

The RSL was developed based on science and customer feedback, says Amazon, and will be reviewed and updated periodically.

The RSL focuses in particular on:

- phthalates;
- nonylphenol (NP) and nonylphenol ethoxylate (NPE) surfactants;
- parabens;
- formaldehyde-releasing preservatives; as well as
- toluene and triclosan.

Amazon says that it began its reformulation efforts with its own brand products because it has "the most control over how these products are developed."

But according to the company, the RSL represents "a baseline list of chemicals of concern that all brands should work to phase out and eliminate."

And, more broadly, the company's policy encourages manufacturers to "phase out potentially hazardous chemistries and adopt green chemistry alternatives," such as those identified in the US Environmental Protection Agency's (EPA's) Safer Chemicals Ingredients List (Scil).

TRANSPARENCY

With regards to transparency, the policy sets a goal of making health and sustainability data "as easy for customers to access and interpret as price and customer reviews" for products.

To further this aim, the company says, in 2019 it will "work to achieve fuller ingredient disclosure" for its own brands.

And it is looking to add website features to make it easier for customers to access information about product ingredients and third-party certifications, such as Safer Choice, Made Safe, Green Seal and Cradle to Cradle.

"We hope that making this information more readily available for customers will encourage additional brands to move away from potentially hazardous chemistries in their products and adopt safer chemistries," it adds.

Kelly Franklin is North America editor for Chemical Watch.

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Making an impact: AOCS members are authors of top-cited articles

There is no better way to advance the science and technology of oils, fats, proteins, surfactants, and related materials than to publish your influential work in an AOCS journal. Top-cited articles published in 2017–2018 include many AOCS members as authors. Publishing in the *Journal of AOCS* (*JAOCS*), *Lipids*, or the *Journal of Surfactants and Detergents* (*JSD*), allowed these member authors the chance to influence their fields while enhancing the excellence of our journals. These articles by AOCS members are among the list of the 10 top-cited articles for each of our journals in 2017–2018.

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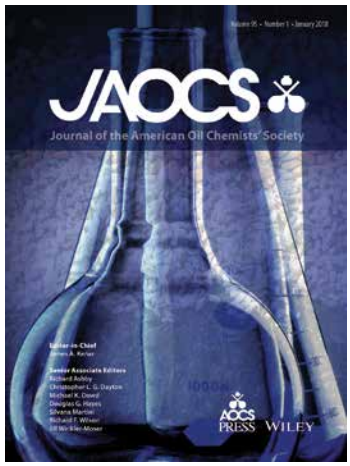


Cocoa butter substitute (CBS) produced from palm mid-fraction/palm kernel oil/ palm stearin for confectionery fillings
Nirupam Biswas, Yuen Lin Cheow, Chin Ping Tan, Sivaruby Kanagaratnam, and Lee Fong Slo
https://onlinelibrary.wiley.com/doi/10.1007/s11746-016-2940-4

Biological implications of lipid oxidation products
Samantha A. Viera, Gudodong Zhang, and Eric A. Decker
https://onlinelibrary.wiley.com/doi/10.1007/s11746-017-2958-2

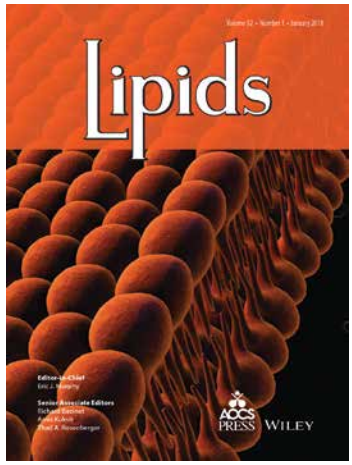
Influence of soybean oil blending with polylactic acid (PLA) films: *In vitro* and *in vivo* evaluation
R. Seda Tiğli Aydin, Elvan Akyo,l and Baki Hazer
https://onlinelibrary.wiley.com/doi/10.1007/s11746-017-2954-6

Sonocrystallization of interesterified fats with 20 and 30% C16:0 at sn-2 position
Jeta V. Kadamne, Ebenezer A. Ifeduba, Casimir C. Akoh, and Silvana Martini
https://onlinelibrary.wiley.com/doi/10.1007/s11746-016-2914-6

Effect of fatty acid unsaturation on phytosteryl ester degradation
Marianna Raczyk, Dominik Kmiecik, Roman Przybylski, and Magdalena Rudzińska
https://onlinelibrary.wiley.com/doi/10.1007/s11746-017-2979-x

Bioactives, aromatics and sensory properties of cold-pressed and hexane-extracted lemon (*Citrus Limon* L.) seed oils
Buket Aydeni Guneser, and Emin Yilmaz
https://onlinelibrary.wiley.com/doi/10.1007/s11746-017-2977-z

Lipids



TGF- β down-regulates apolipoprotein M expression through the TAK-1- JNK-c-Jun pathway in HepG2 cells
Zhong-Cheng Mo, Xing Liu, Zhen-Li Tang, Yue Jiang, Xiao-Shan Pegn, Qing-Hai Zhang, Jin-Feng Shi, and Guang-Hui Yi
https://onlinelibrary.wiley.com/doi/10.1007/s11745-016-4227-9

Trans fatty acids suppress TNF alpha-induced inflammatory gene expression in endothelial (HUVEC) and hepatocellular carcinoma (HepG2) cells
Pierre Julien, Jean-Francois Bilodeau, Olivier Barbier, and Iwona Rudkowska
https://onlinelibrary.wiley.com/doi/10.1007/s11745-017-4243-4.

Hepatic BSCL2 (seipin) deficiency disrupts lipid droplet homeostasis and increases lipid metabolism via SCD1 activity
Simon Lalonde, Sabri Ahmed Rial, Karl-F Bergeron, Jessica C. Ralston, David M. Mutch, and Catherine Mounier
https://onlinelibrary.wiley.com/doi/10.1007/s11745-016-4210-5

Serum n-3 tetracosapentaenoic acid and tetracosahexaenoic acid increase following higher dietary alpha-linolenic acid but not docosahexaenoic acid
Adah M. Metherel, Anthony F. Domenichiello, Alex P. Kitson, Yu-Hong Lin, and Richard P. Bazinet
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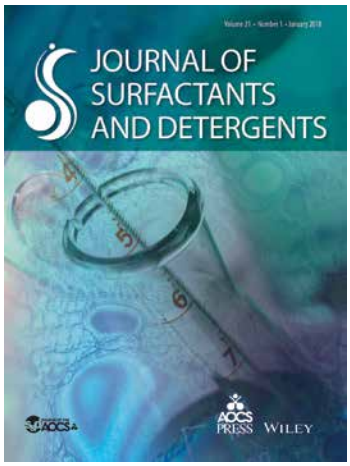

Bio-/environment-friendly cationic gemini surfactant as novel corrosion inhibitor for mild steel in 1 M HCl solution
Ruby Aslam, Saman Zehra, and Musheer Ahmad
https://onlinelibrary.wiley.com/doi/10.1007/s11743-016-1904-x

Acidic heavy oil recovery using a new formulated surfactant accompanying alkali-polymer in high salinity brines
Ali Akbar Dehghan, Adel Jadaly, Shahab Ayatollahi, and Mohsen Masihi
https://onlinelibrary.wiley.com/doi/10.1007/s11743-017-1945-9

How to attain ultralow interfacial tension and three-phase behavior with a surfactant formulation for enhanced oil recovery: a review-part 3.
Practical procedures to optimize the laboratory research according to the current state of the art in surfactant mixing
Jean-Louis Salager, Ana M. Forgiarini, and Miguel J. Rondón
https://onlinelibrary.wiley.com/doi/10.1007/s11743-016-1883-y

Application of silicone surfactant along with hydrocarbon surfactants to textile washing for the removal of different complex stains
Dipak D. Pukale, Archana S. Bansode, Dipak V. Pinjari, Rahul R. Kulkarni, and Usha Sayed
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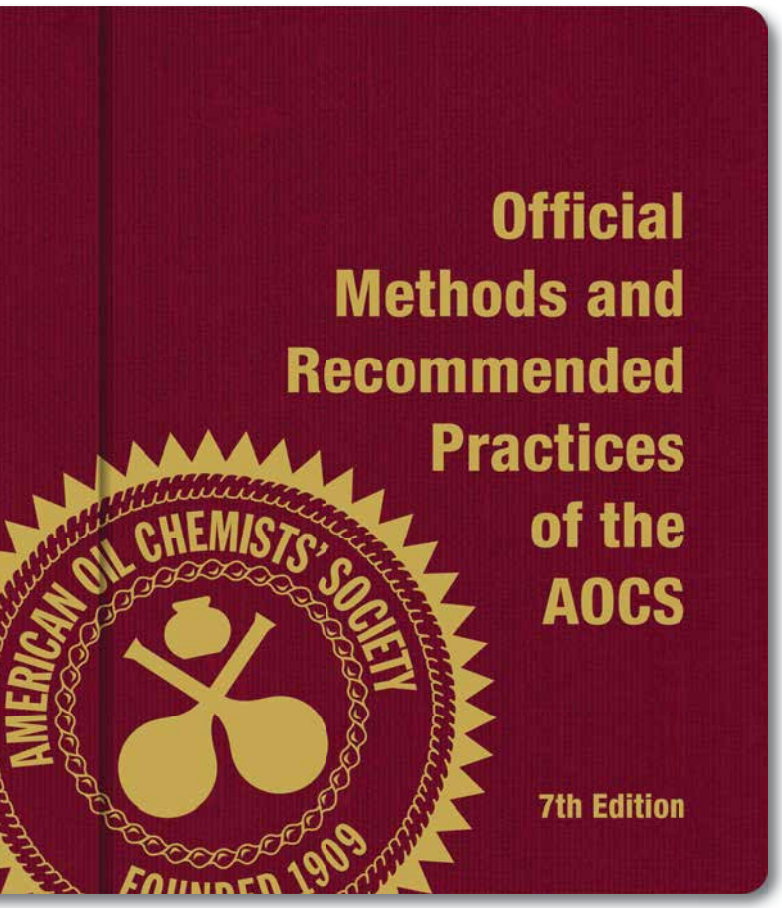

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TECHNICAL SERVICES AOCS

A focus on the future

Member Spotlight is a regular column that features members who play critical roles in AOCS.

"AOCS has done so much for me in my career," says Rick Theiner, "that it motivates me to give back."

And give back he does. As chairperson of the AOCS Annual Meeting Program Committee, Theiner leads the efforts to plan and implement the technical program so that it has the broadest possible appeal to "members and their bosses, business folks, and students." The time he spends varies with the season, but he stresses that AOCS staff and member volunteers "are great about working together to ensure that it's not an onerous amount."

Theiner, who joined AOCS in 1998, began his involvement by joining the Surfactants and Detergents Division, becoming vice chair in 2012. Division vice chairs automatically serve on the Annual Meeting Program Committee; at that point, Dilip Nakhasi of Stratas Foods was the chair.

"I was lucky to work with a chairperson who was passionate about programming, and that passion was contagious," Theiner notes.

The challenges of the committee are manifold and include working to help AOCS stay relevant and up to date with technology and research as well as building bridges between industry and academia.

"We pay attention to what sessions and presentations draw an audience and what draws a crowd," he says. "This helps to shape future programming, but it also helps in identifying areas that we, as an organization or division, want to highlight. Our goal is to encourage session and division chairs to look at what happens during their technical sessions and report back what would make a good *Inform* or journal article."

When asked why his volunteer work is worthwhile to him, Theiner grows serious. "The bottom line is that I have benefitted personally through my membership more than I ever would have expected. My first meeting in 1996 was eye-opening. I often think about how many people don't know that AOCS is here to help them. They get out of school and think they are done. Given how the organization has enabled me to excel at a job that I love, it only seems right to try and pay some of that back by doing my own small part to help continue the development of this organization and its membership."

Fast facts

Name	Eric (Rick) Theiner (pronounced THINE-er)
Joined AOCS	1998
Education	M.S., physical chemistry, Lehigh University (2012)
Job title	Applied Technology Manager
Employer	Evonik Corp. (Richmond, Virginia, USA)
Role in AOCS	Chair, Annual Meeting Program Committee
High-fat indulgence	Ice cream
Favorite social media	LinkedIn, YouTube webinars
Most memorable AOCS experience	Sitting next to Prof. Milton J. Rosen at a Surfactants & Detergents Division luncheon. "It took me 20 minutes to get up the nerve to talk to him, but when I finally did, he was incredibly forthcoming and helpful."
Other involvement	Annual Meeting session chair, Books and Special Publications Committee, Division Council, S&D Division Executive Steering Committee

PATENTS

Method for treating neurotrauma

De Wilde, M.C., *et al.*, N.V. Nutricia, US10071072, September 11, 2018

The invention relates to a composition comprising: i) one or more of uridine and cytidine or salts, phosphates, acyl derivatives, or esters thereof; ii) a lipid fraction comprising at least one of docosahexaenoic acid (22:6; DHA), eicosapentaenoic acid (20:5; EPA) and docosapentaenoic acid (22:5; DPA), or esters thereof, in which the lipid fraction comprises less than 2 weight percent of alpha.-linolenic acid (ALA), calculated on the weight of all fatty acids; iii) choline, or salts or esters thereof; for use in the prevention or treatment of neurotrauma, traumatic brain injury, cerebral palsy, and spinal cord injury.

Method of baking

Borch, K., *et al.*, Novozymes A/S, US10076121, September 11, 2018

Disclosed is the making of baked products, more particularly making of baked products using polypeptides having lipolytic activity and at least one emulsifier. The invention also relates to compositions comprising polypeptides having lipolytic activity and at least one emulsifier.

Cyclic cationic lipids and methods of use

Heyes, J., et al., Arbutus Biopharma Corp., US10077232, September 18, 2018

The present invention provides compositions and methods for the delivery of therapeutic agents to cells. In particular, these include novel cationic lipids and nucleic acid-lipid particles that provide efficient encapsulation of nucleic acids and efficient delivery of the encapsulated nucleic acid to cells *in vivo*. The compositions of the present invention are highly potent, thereby allowing effective knockdown of a specific target protein at relatively low doses. In addition, the compositions and methods of the present invention are less toxic and provide a greater therapeutic index compared to compositions and methods previously known in the art.

Water-soluble compositions incorporating enzymes, and method of making same

Lee, D.M., *et al.*, Monosol, LLC, US10087401, October 2, 2018

Disclosed herein are water-soluble compositions, such as films, including a mixture of a first water-soluble resin, an enzyme, and an enzyme stabilizer which comprises a functional substrate for the enzyme; methods of making such compositions; and methods of using such compositions, e.g., to make packets containing functional ingredients. The enzymes can include proteases and mixtures of proteases with other enzymes, and the compositions provide good retention of enzyme function following film processing and storage.

Detergent composition

Brooker, A.T., *et al.*, The Procter & Gamble Co., US10081782, September 25, 2018

Low-pH automatic dishwashing detergent composition comprising an endoprotease having an isoelectric point from about 4 to about 9 and wherein the composition has a pH as measured in 1% weight aqueous solution at 25°C of from about 5 to about 7.5.

Protective effect of DMPC, DMPG, DMPC/DMPG, LYSOPG, and LYSOPC against drugs that cause channelopathies

Helson, L., Signpath Pharma, Inc., US10117881, November 6, 2018

The present invention includes compositions and methods for preventing one or more cardiac channelopathies or conditions resulting from irregularities or alterations in cardiac patterns caused by an active agent or a drug in a human or animal subject comprising: an amount of a lysophosphatidylglycerol adapted for oral administration effective to reduce or prevent one or more cardiac channelopathies or conditions resulting from irregularities or alterations in cardiac patterns caused by the active agent or drug.

Method of minimizing enzyme-based aerosol mist using a pressure spray system

Peitersen, N.D., *et al.*, Ecolab USA Inc., US10119101, November 6, 2018

Disclosed herein are methods for improving safety and delivery of commercial application of cleaning compositions that include enzymes and other protein irritants. The methods reduce the mist and aerosolization of proteins so that inhalation and exposure to the same are reduced. According to the invention, when commercial pressurized sprayers are used to apply protein containing use cleaning compositions of up to 5 ppm protein, aerosolization is decreased to below 60 ng active protein per meter cubed. Applicants have also identified a specific metering tip/nozzle, dispense rate, and low pressure application of not more than 100 psi are critical to achieving the benefits of the invention.

Patent information was compiled by Scott Bloomer, a registered US patent agent and Director, Technical Services at AOCS. Contact him at scott.bloomer@aocs.org.

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Flaxseed oil attenuates hepatic steatosis and insulin resistance in mice by rescuing the adaption to ER stress

Yu, X., *et al.*, *J. Agric. Food Chem. 66*: 10729–10740, 2018, https://doi.org/10.1021/acs.jafc.8b03906.

Increasing evidence has demonstrated the benefits of alpha-linolenic acid-rich flaxseed oil (ALA-FO) against lipid metabolism abnormality in both rodent models and humans. However, the metabolic response of FO to insulin resistance and type 2 diabetes is still inconsistent. This study aimed to explore the effect of FO on chronic high fat diet (HFD)-induced hepatic steatosis, insulin resistance, and inflammation, mainly focusing on hepatic n-3 fatty acid remodeling and endoplasmic reticulum (ER) unfolded protein response. The results showed that lard-based HFD feeding for 16 weeks (60% fat-derived calories) induced whole-body insulin resistance, lipid profile abnormality, and inflammation in mice, which was alleviated by FO in a dose-dependent manner. Moreover, FO effectively improved hepatic steatosis and insulin resistance in mice by modulating the specific location of ALA and its long-chain n-3 fatty acids across hepatic lipid fractions and enhancing insulin-stimulated phosphorylation of hepatic insulin receptor subtract-1 (IRS-1) tyrosine 632 and protein kinase B (AKT) ($p < 0.05$). Importantly, the differential depositions of ALA and its long-chain n-3 fatty acids in plasma and ER membranes were observed, concomitant with the rescued ER unfolded protein response and Jun N-terminal kinase (JNK) signaling in mice liver.

Influences of light intensity and beta-carotene on polycyclic aromatic hydrocarbons and aldehydes in vegetable oil: a case study using palm oil

Gong, G., *et al.*, *J. Agric. Food Chem. 66*: 11124–11132, 2018, https://doi.org/10.1021/acs.jafc.8b04096.

This study investigated the effects of three light intensities on four types of palm oils during consecutive storage for 12 months at 4°C. The concentrations of 4-hydroxy-2-*trans*-hexenal (4-HHE), 4-hydroxy-2-*trans*-nonenal (4-HNE), polycyclic aromatic hydrocarbon (PAH)4, and PAH8 in the oils significantly increased with the increasing light intensity after storage. The red palm oil had the lowest rate of increase of 4-HNE, while 5°C palm oil had the highest rate of increase of the PAH, OPAH, 4-HNE, and peroxide values during storage. For the same type of oil, OPAHs increased significantly under a light intensity of 6000 lx (lx) after storage. The increasing concentrations of 9FO, ATQ, and BaPO in the oils stored at 6000 lx showed a positive relation to their corresponding parent PAHs, indicating that PAH oxidation occurred at 6000 lx. The results suggest that light intensity and beta-carotene may control PAHs, OPAHs, and 4-hydroxy-*trans*-alkenals for vegetable oil storage, transportation, and retail.

Characterization and quantitation of steryl glycosides in *Solanum melongena*

Heinz, P. and M.A. Glomb, *J. Agric. Food Chem. 66* (43), pp 11398–11406, 2018, https://doi.org/10.1021/acs.jafc.8b04045.

Glycosylated plant sterols or steryl glycosides (SGs) are a small group of glycolipids occurring ubiquitously in plants. In contrast to free sterols, they are insufficiently characterized concerning structural variety, quantity, and biological function. In particular, the type of sugar usually attached to the C-3 hydroxy function of the respective sterol is poorly studied. Eggplants (*Solanum melongena*) are rich in phytochemicals including SGs. In the present work, the unique glycosylation pattern was investigated by a highly selective LC-MS/MS method that allowed quantitation of the glucosides and galactosides of the most common sterols: cholesterol, beta-sitosterol, campesterol, and stigmasterol. The quantitatively most important structure was beta-sitosteryl beta-D-glucopyranoside, with 54.5 mg/kg fresh weight of total fruit (365.3 mg/kg dry weight) followed by stigmasteryl beta-D-glucopyranoside and campesteryl beta-D-glucopyranoside. Analyses were performed in different tissues of eggplants (i.e., exocarp and outer mesocarp vs the remaining inner part). Steryl galactosides were determined in eggplants for the first time at significantly lower concentrations by a factor of 100. Furthermore, the rare SG beta-sitosteryl beta-D-cellobioside (3-beta-sitosteryl beta-D-glucopyranosyl-(1→4)-beta-D-glucopyranoside) was detected in eggplants for the first time. Finally, UV irradiation induced the formation of the vitamin D glucosides 7-dehydrocholesteryl beta-D-glucopyranoside and cholecalciferyl beta-D-glucopyranoside at very low levels.

Quick changes of milk fatty acids after inclusion or suppression of linseed oil in the diet of goats

Blanco, F.P. and A.L.M. Marín, *J. Sci. Food Agric. 98*: 5269–5277, 2018, https://doi.org/10.1002/jsfa.9065.

Lipid supplementation of ruminant diet is an excellent tool to improve the nutritional quality of dairy fat. The purpose of this research was to monitor in detail the goat milk fatty acid (FA) profile during the first 24 h after linseed oil (LO) supplementation or sup-

pression in the diet. Particular emphasis was placed in the changes of FA with bioactive properties. Milk fat was analyzed by gas chromatography from milkings at 0, 1, 3, 6, 12, and 24 h after diet shift. The alpha-linolenic acid levels increased 12 h after LO incorporation in the diet and decreased 3 h after oil suppression. Most of the milk 10:0 to 16:0 saturated FA decreased 24 h after LO supplementation, whereas oil suppression raised their levels after 6 h. Similarly, raising of mono- and polyunsaturated trans-FA after LO inclusion was delayed in comparison with their decrease after oil suppression. This study supports that ruminal bacteria and mammary glands would exhibit a fast responsiveness after the inclusion or suppression of LO in ruminant rations. Milk with an improved FA profile could be collected between 12 h after LO supplementation and the last milking before LO suppression in the diet.

Effect of thermal processing toward lipid oxidation and non-enzymatic browning reactions of Antarctic krill (*Euphausia superba*) meal

Liu, Y., *et al.*, *J. Sci. Food Agric. 98*: 5257–5268, 2018, https://doi.org/10.1002/jsfa.9064.

Antarctic krill is a huge source of biomass and prospective high-quality lipid source. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), nutritionally important lipid components with poor oxidative stability, were used as markers of oxidation during thermal processing of Antarctic krill (*Euphausia superba*) meal by evaluating the lipolysis, lipid oxidation, and non-enzymatic browning reactions. Liquid chromatography–mass spectrometry of the phospholipids and the main oxidation products of free fatty acids and phosphatidylcholine (PC) was effective for evaluating the oxidation of EPA and DHA. During boiling, oxidation of EPA and DHA in the free fatty acid and PC fractions and hydrolysis of the fatty acids at the *sn*-2 position of the phospholipids were predominant. The changes in PC during drying were mainly attributed to the oxidation of EPA and DHA. Heat treatment increased the oxidation products and concentration of hydrophobic pyrrole owing to pyrrolization between phosphatidylethanolamine and the lipid oxidation products. The lipid oxidation level of Antarctic krill increased after drying, owing to prolonged heating under the severe conditions.

Improving the lipid profile of ready-to-cook meat products by addition of omega-3 microcapsules: effect on oxidation and sensory analysis

Pérez-Palacios, T., *et al.*, *J. Sci. Food Agric. 14*: 5302–5312, 2018, https://doi.org/10.1002/jsfa.9069.

The omega-3 enrichment of ready-to-cook meat products by microencapsulated fish oil (MFO) addition was analyzed. Accordingly, three batches of chicken nuggets were prepared:

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The award consists of a US $10,000 Fellowship and up to US $5,000 for travel and research related expenditures related to the student's graduate program.

Eligibility

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(i) control (C); (ii) enriched in bulk fish oil (BFO); and (iii) with added MFO. Sensory features, acceptability, oxidative stability, and volatile compounds were analyzed. MFO nuggets did not differ from C ones with respect to any sensory trait. BFO showed increased juiciness and saltiness but decreased meat flavor. Acceptability was not affected by enrichment. Consumers were not able to differentiate between C and MFO in a triangle test, although they could clearly identify BFO nuggets. Higher levels of lipid and protein oxidation indicators and of volatile compounds from fatty acid oxidation were found in BFO nuggets compared to C and MFO nuggets. Enrichment of ready-to-cook meat products in omega-3 fatty acids with MFO provides both lipid and protein oxidative protection without changes in sensory quality

Recovery of tocopherols, amygdalin, and fatty acids from apricot kernel oil: cold pressing versus supercritical carbon dioxide

Pavlović, N., *et al.*, *Eur. J. Lipids Sci. Technol. 120*: 800043, 2018, https://doi.org/10.1002/ejlt.201800043.

Fatty acid, tocopherol, and amygdalin concentrations are determined in apricot kernel oils obtained by two techniques: cold pressing and supercritical CO_2 (SC-CO_2) extraction. During the SC-CO_2 extraction, oil is collected over 5 h at 300 bar and 40°C until all oil is completely extracted from the raw material. The total tocopherol concentration in cold pressed oil is significantly lower (94 mg 100 g^{-1} of oil) compared to SC-CO_2 oil. beta + γ-tocopherols are the most dominant, while alpha-tocopherol is not detected in cold pressed oil. The concentration of total tocopherols during SC-CO_2 extraction decreases from the first collection (after 1 h) to the last (after 5 h), from 252 to 50 mg 100 g^{-1} of oil. The analysis of fatty acid composition shows a prevalence of palmitic, oleic, and linoleic acid, specifically 5.93, 57.33, and 33.81%, respectively, in SC-CO_2 extracts, which are similar to the values of cold pressed oil (5.48, 62.73, 29.18%, respectively). Small amount of amygdalin content is determined in cold pressed oil (0.40 mg g^{-1} of oil), as well as in oil obtained by SC-CO_2 (0.20 mg g^{-1} of oil). According to official methods and requirements, oils produced by both techniques are of satisfactory quality (low values of peroxide number, FFA, insoluble impurities, and moisture content).

Isolation, purification of DPAn-3 from the seal oil ethyl ester

Zheng, Z., *et al.*, *Eur. J. Lipid Sci. Technol. 120*: 1800225, https://doi.org/10.1002/ejlt.201800225.

DPA (docosapentaenoic acid)n-3 is an important ingredient in seal oil and has many potential functions. Yet, it has not been studied systematically for the pure form is difficult to obtain. In this paper, DPAn-3 with purity of ~99% and total yield of 44.80% is obtained through the following process. First, eicosapentaenoic acid (EPA), DPAn-3, and docosahexaenoic acid (DHA) are enriched by urea adduction and the content of them increased from 22.05 to 62.52%. Then, DPA and DPA are concentrated by molecular distillation with a content of them increase from 37.08 to 75.59%. Next, DPAn-3 is enriched through $AgNO_3$ complexation, and a product with 37.92% of DPA is obtained under the optimal conditions. Finally, DPAn-3 in the product is purified by preparative HPLC. The process proposed in this paper is specific for the purification of DPA and this work provides important reference for the future studies of DPAn-3.

Lipid extraction from oleaginous microorganism with electrochemical method

Zhang, G., *et al.*, *Eur. J. Lipid Sci. Technol. 120*: 1800215, 2018, https://doi.org/10.1002/ejlt.201800215.

In this study, electro-treatment is used to disrupt the microbe cells for facilitating the lipid extraction from oleaginous yeast. Two types of the electrochemical assisted lipid extraction are performed. One is that an electrochemical method is used as pre-treatment to break cells, and thereafter solvents (hexane, methanol, and mixture of chloroform:methanol) are used to dissolve the lipid, defined as electrochemical pre-treatment followed extraction. The extraction efficiency reaches 43 and 92% in the electrochemical involved treatment with hexane and chloroform:methanol, respectively. In addition, simultaneous electrochemical treatment and lipid extraction is also conducted. In the process, the biomass dispersed in the solvents is subjected to the electrochemical treatment for extraction, defined as simultaneous electrochemical treatment and lipid extraction. The highest lipid extraction efficiency is 92.17% w/w dry biomass obtained at 48 h extraction time with chloroform:methanol:water as solvents. Electrochemical treatment shows great potential in lipid extraction as it somewhat reduces the toxic chloroform utilization. Increase of current of electro-treatment leads to the increase of saturation degree of the biodiesel converted from lipid extracted with electro-treatment. It is found that the current of electro-treatment should be kept below 0.4 A in order to avoid the impact on biodiesel property.

Development of novel microparticles for effective delivery of thymol and lauric acid to pig intestinal tract

Omonijo, F.A., *et al.*, *J. Agric. Food Chem. 66*: 9608–9615, 2018, https://doi.org/10.1021/acs.jafc.8b02808.

This technology, capable of delivering active ingredients directly to intestinal tract without metabolism in the stomach, can deliver unique nutrition directly where it is needed.

Antibiotics have been widely supplemented in feeds at sub-therapeutic concentrations to prevent post-weaning diarrhea and increase the overall productivity of pigs. However, the emergence of antimicrobial-resistant bacteria worldwide has made it urgent to minimize the use of in-feed antibiotics. The development of promising alternatives to in-feed antibiotics is crucial for maintaining the sustainability of swine production. Both medium-chain fatty acids (MCFA) and essential oils exhibit great potential to post-weaning diarrhea; however, their direct inclusion has compromised efficacy


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because of several factors including low stability, poor palatability, and low availability in the lower gut. Therefore, the objective of this study was to develop a formulation of microparticles to deliver a model of essential oil (thymol) and MCFA (lauric acid). The composite microparticles were produced by the incorporation of starch and alginate through a melt-granulation process. The release of thymol and lauric acid from the microparticles was determined *in vitro* using simulated salivary fluid (SSF), simulated gastric fluid (SGF), and simulated intestinal fluid (SIF), consecutively. The microparticles prepared with 2% alginate solution displayed a slow release of thymol and lauric acid in the SSF (21.2 ± 2.3%; 36 ± 1.1%), SGF (73.7 ± 6.9%; 54.8 ± 1.7%), and SIF (99.1 ± 1.2%; 99.1 ± 0.6%), respectively, whereas, the microparticles without alginate showed a rapid release of thymol and lauric acid from the SSF (79.9 ± 11.8%; 84.9 ± 9.4%), SGF (92.5 ± 3.5%; 75.8 ± 5.9%), and SIF (93.3 ± 9.4%; 93.3 ± 4.6%), respectively. The thymol and lauric acid in the developed microparticles with or without alginate both exhibited excellent stabilities (>90%) during being stored at 4°C for 12 weeks and after being stored at room temperature for 2 weeks. These results evidenced that the approach developed in the present study could be potentially employed to deliver thymol and lauric acid to the lower gut of pigs, although further *in vivo* investigations are necessary to validate the efficacy of the microparticles.

Metabolomics and transcriptomics analyses reveal nitrogen influences on the accumulation of flavonoids and amino acids in young shoots of tea plant (*Camellia sinensis* L.) associated with tea flavor

Huang, H., *et al., J. Agric. Food Chem. 66*: 9828–9838, 2018, https://doi.org/10.1021/acs.jafc.8b01995.

This article looks at how nitrogen levels effect the levels of amino acids associated with the flavor of tea.

Tea-specialized metabolites contribute to rich flavors and healthy function of tea. Their accumulation patterns and underlying regulatory mechanism are significantly different under different nitrogen (N) conditions during adaptation stage. Here, we find that flavonoids associated with tea flavor are dominated by different metabolic and transcriptional responses among the four N conditions (N-deficiency, nitrate, ammonia, and nitric oxide). Nitrogen-deficiency tea plants accumulate diverse flavonoids, corresponding with higher expression of hub genes including F3H, FNS, UFGT, bHLH35, and bHLH36. Compared with N-deficiency, N-supply tea plants significantly increase proline, glutamine, and theanine, which are also associated with tea flavor, especially under NH4+-supply. As NH4+-tolerant species, tea plant exploits the adaptive strategy by substantial accumulation of amino acids including theanine to adapt excess NH4+, which attributes to, at least in part, efficient N transport and assimilation, and active protein degradation. A distinct divergence of N reallocation in young shoots of tea plant under different N sources contributes to diverse tea flavor.

Effects of natural flavonoid isoorientin on growth performance and gut microbiota of mice

Yuan, L., *et al., J. Agric. Food Chem.* 66: 9777–9784, 2018, https://doi.org/10.1021/acs.jafc.8b03568.

Isoorientin (ISO) is a glucoside of luteolin found naturally in foods such as celery, thyme, green peppers, and chamomile tea—common food items that we already know express flavonoids with health benefits.

ISO is a natural flavonoid, which is a 6-C-glucoside of luteolin, and has been demonstrated to possess multiple biological properties. In this study, the effects of ISO on the growth performance and gut microbiota of BALB/c mice were investigated. The results showed that ISO could promote food intake and body weight gain, increase the digestibility of crude proteins and utilization of the gross energy, and strengthen antioxidant capacity of mice. We also demonstrated it has no side effects on hepatic and renal functions. Moreover, ISO inhibited the growth of most bacteria in gut microbiota, especially the pathogenic genera of *Alistipes*, *Helicobacter*, and *Oscillibacter*, which could lead to inflammation. Metabolisms of epithelial cell signaling in *Helicobacter pylori* infection, lipopolysaccharide (LPS) biosynthesis, and LPS biosynthesis proteins in gut microbiota of the control group were more abundant than those in the ISO group, while lipid metabolism and vitamin B6 metabolism were enriched in the ISO group. We found the changes in enrichments of metabolic pathways of the gut microbiota along with the ISO application were positively correlated with the antioxidation, anti-inflammation, and antibiosis. This work provided a fundamental basis for the future development of ISO-functional foods used for resistance to oxidation, inflammation, and pathogens.

Influence of dairy emulsifier type and lipid droplet size on gastrointestinal fate of model emulsions: *in vitro* digestion study

Liang, L., *et al., J. Agric. Food Chem. 66*: 9761–9769, 2018, https://doi.org/10.1021/acs.jafc.8b02959.

Human breast milk is a natural emulsion containing relatively large triacylglycerol droplets coated by a distinct interfacial layer known as the milk fat globule membrane (MFGM). The unique properties of the MFGM impact the release of nutrients from breast milk in an infant's gastrointestinal tract (GIT), but the membrane architecture is susceptible to disruption by industrial processes. To formulate infant formula that simulates the gastrointestinal behavior of breast milk, food manufacturers require knowledge of the impact of the interfacial properties on the gastrointestinal fate of fat globules. In this study, a simulated GIT was utilized to monitor the gastrointestinal fate of emulsified corn oil with different dairy emulsifiers, including sodium caseinate, lactoferrin (LF), whey protein isolate (WPI), and milk phospholipids (MPL) isolated from MFGM. The influence of droplet size on the gastrointestinal fate of the MPL-stabilized emulsions was also examined. Our findings

provide valuable information for the optimization of infant formula and dairy-based nutritional beverages.

Exopolysaccharides from *Lactobacillus plantarum* NCU116 regulate intestinal barrier function via STAT3 signaling pathway

Zhou, X., *et al., J. Agric. Food Chem. 66*: 9719–9727, 2018, https://doi.org/10.1021/acs.jafc.8b03340.

Strengthening of the intestinal barrier is a desirable endpoint in irritated bowl syndrome (IBS symptoms). Identification of a new mechanism regulating intestinal barrier function—particularly if it is modulated by natural chemical entities—could be helpful in determining a positive outcome.

Lactic acid bacteria (LAB) and their exopolysaccharides (EPS) are recognized to promote intestinal barrier function by mechanisms that remain incompletely understood. Herein, we sought to identify the roles of exopolysaccharides from *Lactobacillus plantarum* NCU116 (EPS116) in intestinal barrier function. Our data showed that EPS116 attenuated dextran sodium sulfate (DSS) induced colitis and promoted epithelial barrier function and the expression of tight junction (TJ) proteins *in vivo* and *in vitro*. Moreover, chromatin immunoprecipitation data showed that EPS116 facilitated STAT3 (signal transducer and activator of transcription 3) binding to the promoter of occludin and ZO-1. Furthermore, knockdown of STAT3 in Caco-2 cell with EPS116 treatment led to decreased expression of occludin and ZO-1 and increased intestinal permeability, suggesting that the regulation of epithelial barrier function by EPS116 should be STAT3 dependent. Thus, our data revealed a novel mechanism that EPS116 inhibited intestinal inflammation via regulating intestinal epithelial barrier function.

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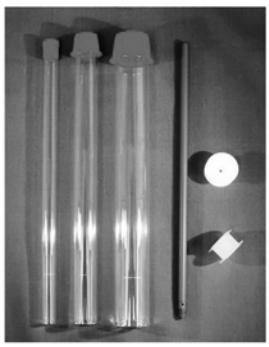

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Protein or no protein? Opportunities for DNA-based detection of allergenic foods

Holzhauser, T., *J. Agric. Food Chem. 66*: 9889–9894, 2018, https://doi.org/10.1021/acs.jafc.8b03657.

Identifying trace amounts of allergenic components in various food and consumer products is highly desirable, especially in products for children. The application DNA-based methods could be an opportunity to increase the sensitivities of detection.

In food allergy, a common immunological disease with a potentially severe outcome, a causative cure is not available. Correct ingredient labeling and risk assessment of unlabeled allergen cross-contact is a prerequisite for effective allergen avoidance. Specific and sensitive analytical methods, which allow for unequivocal identification and accurate quantification of allergenic components, are important tools in allergen risk management. Both protein- and DNA-based methods are in place and reveal pros and cons depending upon the application and individual analytical question. This perspective highlights relevant molecular aspects and discusses, especially, opportunities for the application of DNA-based methods for the detection of allergenic foods.

Effect of roasting on oligosaccharide abundance in arabica coffee beans

Tian, T., *et al., J. Agric. Food Chem. 66*: 10067–10076, 2018, https://doi.org/10.1021/acs.jafc.8b02641.

Very interesting to see evidence that roasting coffee bean increased the levels of beneficial saccharides in coffee. No wonder our ancestors started roasting the beans.

Emerging research into the bioactivities of indigestible carbohydrates is illuminating the potential of various foods and food streams to serve as novel sources of health-promoting compounds. Oligosaccharides (OS) are widely present in milks and some plants. Our previous research demonstrated the presence of OS in brewed coffee and spent coffee grounds. Armed with this new knowledge, the next step toward improving the utilization of these valuable components involved investigating the effect of roasting on the formation and abundance of coffee OS. In the present study, we used advanced mass spectrometry to analyze a variety of coffee samples and demonstrated that a great structural diversity and increased abundance of OS is associated with higher roasting intensity. The present investigation also evaluated methods for OS extraction and fractionation. A preparative-scale chromatographic method, based on activated carbon, was developed to isolate enough amounts of OS from coffee to enable future confirmation of prebiotic and other *in vitro* activities.

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Nutritional potential, chemical profile, and antioxidant activity of Chichá (*Sterculia striata*) nuts and their by-products

de Britto Policarpi, P., *et al.*, *Food Res. Int. 106*: 736–744, 201, https://doi.org/10.1016/j.foodres.2017.12.069.

The *Sterculia striata* nut commonly known as chichá is consumed raw or toasted in Brazil, but information on its chemical composition and antioxidant activity are scarce in the literature. In this work, the nutritional composition, minerals profile, lipid composition, and phenolic compounds profile of chichá nuts and its by-products (pellicle and shell) were determined. The results showed that the nuts and the cake contain considerable amount of fibers and proteins and are rich in minerals (Fe, Mn, and Cu). Oleic acid was the main fatty acid (37.8%), and PPO (36.0%) and POP (15.6%) were the main triacylglycerides present in the chichá oil. The phytosterols beta-sitosterol, stigmasteroland campesterol (1848.5 microgram g^{-1}, 542. 2microgram g^{-1}, and 186.3 microgram^{-1}, respectively), and the gamma-, delta-, alpha- and beta-tocopherol (8.85; 2.10; 1.64, and 0.11 mg 100 g–1, respectively) were identified in the oil. The antioxidant activity (ABTS and FRAP assays) followed the order pellicle > shell > nuts (13.25 and 84.65; 8.71 and 64.3; 5.85 and 36.79 μmol TEACg^{-1}, respectively). The main phenolic compounds identified in the extracts were ellagic and ferulic acids; ellagic and protocatechuic acids; and protocatechuic, ellagic and methoxyphenylacetic acids for the nuts, shells, and pellicle, respectively. A strong positive correlation was observed between total phenolic content and antioxidant activity determined by ABTS and FRAP assays ($r= 0.9067$, $p < 0.01$; and $r=0.9584$, $p < 0.01$; respectively). Collectively, the results showed that the chichá is a nut of high nutritional value, rich in bioactive compounds.

Composition and properties of virgin pistachio oils and their by-products from different cultivars

Ojeda-Amador, R.M., *et al.*, *Food Chem.240*: 123–130, 2018, http://dx.doi.org/10.1016/j.foodchem.2017.07.087.

Pistachios (*Pistacia vera*) exhibit an interesting nutritional value due to the high content of oleic acid and minor components with antioxidant and bioactive properties. This work aimed to characterize pistachio virgin oils and their partially defatted residual cakes, obtained from eight cultivars (Aegina, Avdat, Kastel, Kerman, Larnaka, Mateur, Napoletana, and Sirora). Interesting results on phenolics, tocopherols and antioxidant activity were observed, which were greatly affected by variety. Pistachio virgin oils are rich in healthy oleic acid (55–74%), phytosterols (3200–7600 mg/kg) and gamma-tocopherol (550–720 mg/kg). A high content of phenolic compounds (8600–15000 mg/kg gallic acid equivalents) and the corresponding antioxidant activities (12–46 and 155–496 mmol/kg for DPPH and ORAC) of the residual cakes demonstrate their potential applications as functional ingredients and as rich sources of bioactive compounds. Moreover, virgin pistachio oils possess peculiar and pleasant sensory characteristics, contributing greater added value to the consumers compared to refined vegetable oils.

Chemical characterization of a variety of cold-pressed gourmet oils available on the Brazilian market

Cicero, N., *et al.*, *Food Res. Int.109*: 517–525, 2018, https://doi.org/10.1016/j.foodres.2018.04.064.

Different specialty extra virgin oils, produced by cold-pressing fruits/nuts (olive, pequi, palm, avocado, coconut, macadamia, and Brazil nut and seeds (grapeseed and canola) and retailed in the Brazilian region of Minas Gerais, were chemically characterized. Specifically, for each type of oil, the fatty acid composition was elucidated by GC-FID, the contents of selected polyphenols and squalene were determined respectively by UHPLC-MS and UHPLC-PDA, whereas minerals were explored by means of ICP-MS. Olive oil was confirmed to have the highest MUFA content due to a valuable level of oleic acid, while oils from grapeseed, Brazil nut and canola were marked by nutritionally important PUFA levels. The highest SFA content found in coconut oil was mainly due to the high levels of lauric acid, known for its advantageous HDL-raising effects. As for polyphenols, gourmet oils from palm, coconut, and canola showed higher levels of phenolic acids (e.g. p-hydroxybenzoic, ferulic, syringic, acids) than olive oil, which was though characterized by peculiar antioxidants, such as tyrosol and hydroxytyrosol. Also, olive oil had the highest amount of squalene, followed by the oil from Brazil nut. Finally, all the investigated oils had very low levels (order of microgram/kg) of pro-oxidant elements, such as Cu, Fe, and Mn. Overall, these findings may fill the gaps still present in literature on certain compositional aspects of commercially available gourmet oils.

Perspectives on processing of high-value lipids using supercritical fluids

Catchpole, O., *et al.*, *J. Supercrit. Fluids 134*: 260–268, 2018, https://doi.org/10.1016/j.supflu.2017.12.001.

Opinions regarding the state-of the-art, issues, and future perspectives for the processing and production of high-value lipids using supercritical fluids are discussed including examples from New Zealand. The categories of high-value lipids discussed are seed oils, marine neutral lipid extracts, and polyunsaturated omega-3 fatty acid concentrates, carotenoid-rich extracts, and phospholipid-rich extracts. Commercial production of carotenoid-rich extracts has been a growth area, particularly astaxanthin-rich oleoresin produced from the micro-algae *Haematococcus pluvialis*. The main research and development trends observed in the processing of feed streams to produce these high-value lipid products are the use of ultra-high pressures for CO_2 extraction, the use of propane and dimethyl ether as alternative extraction solvent, and semi-preparative supercritical chromatography to produce omega-3 concentrates. New product opportunities include phospholipid concentrates from marine and dairy materials, EPA and/or DHA-rich oils and concentrates from GM-modified seeds, and a broader range of carotenoid-rich extracts obtained from microalgae.

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