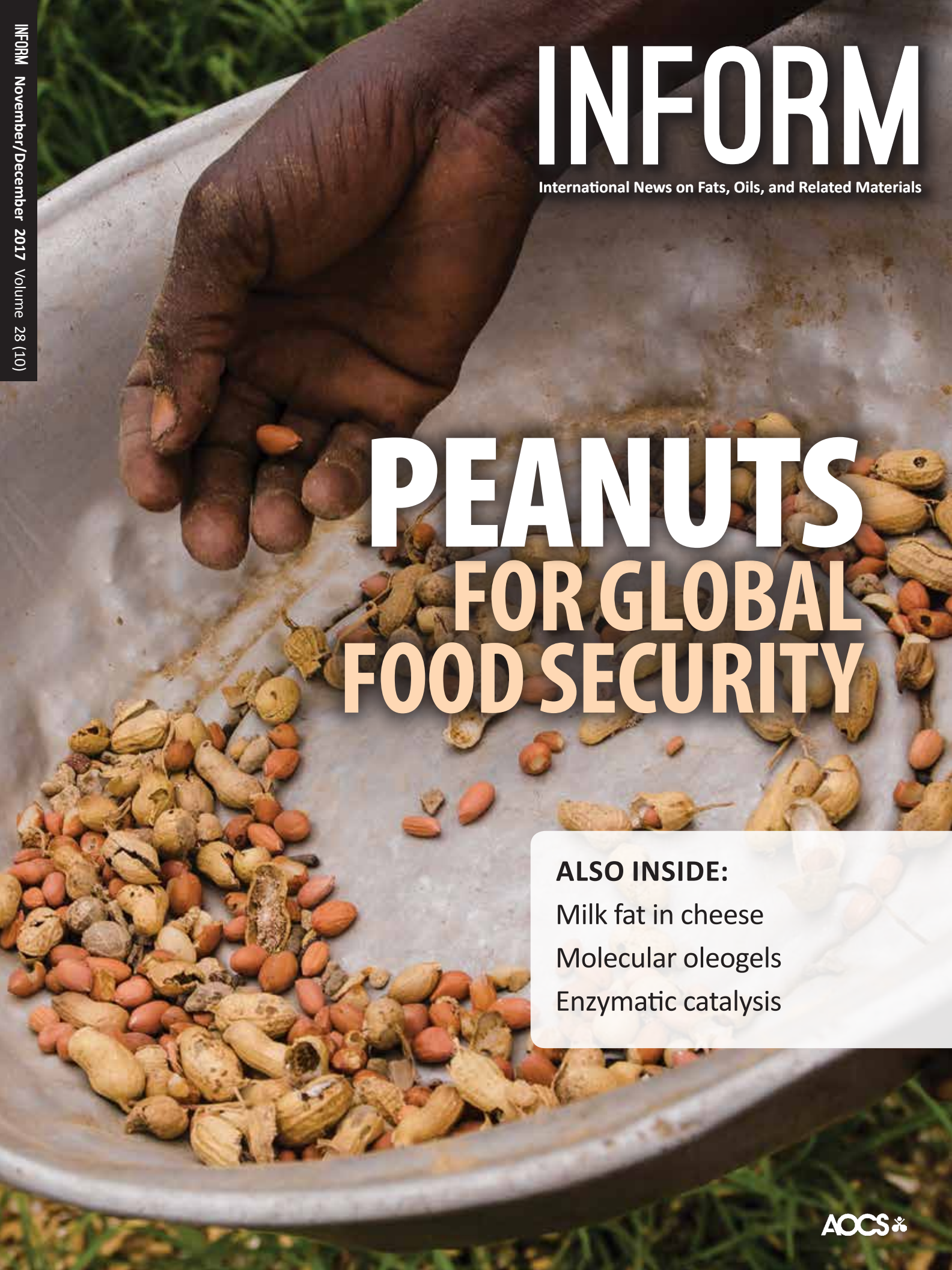
INFORM November/December 2017 Volume 28 (10)



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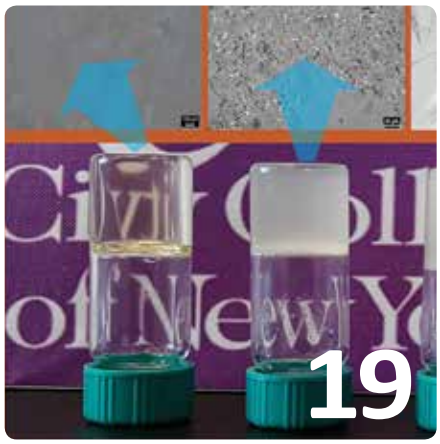

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Strategic role of peanuts in sustainable global food security

Richard F. Wilson

The World Health Organization, the US Food and Drug Administration, and various health authorities throughout the world recommend a minimum consumption of about 2,100 food calories per day, as part of a nutritionally balanced diet, to ensure a healthy and active life (1). A country's ability to produce or purchase sufficient food to effectively satisfy that nutritional dietary threshold defines, in part, a nation's food security status. Interactive computational models such as the Global Food Security Index (GFSI) provide analytical tools for estimating the level of food security among countries or regions (2). The current index lists 28 countries in severe need of improvement, primarily in Sub-Saharan Africa (SSA) and Indonesia. The situation is endemic in SSA, which may be the most food insecure region in the world (3).

- **We are extremely fortunate to live in a time when technology is expanding at an exponential pace. Opportunities abound to make proper exercise of advances in technology for human good.**
- **United Nations estimates predict that the world population will reach 9.3 billion, and the number of people living in Sub-Saharan Africa may double to 1.1 billion by 2050. (www.photius.com).**
- **Given the anticipated impact of genome-sequence-guided peanut breeding, this article explores the global market situation for oilseed peanuts and evaluates the role superior oilseed peanut varieties may play in targeted strategies for improving global food security, with an emphasis on countries in Sub-Saharan Africa.**

Immediate and longer-term food and nutrition security needs in SSA are being addressed on a massive scale under a comprehensive action plan developed by a "High-Level Task Force on Global Food Security" led by the United Nations (UN) Secretary-General and the Director-General of the Food and Agriculture Organization (FAO) (4). A principle tenet of the international plan recognizes the priority of investing in agricultural research "to improve the productivity of local foods so that they (the countries) are more competitive and contribute to make improvements in nutrition." Current US Department of Agriculture-Foreign Agricultural Service (5) estimates of the market situation for food and feed crops in SSA show that cereal crops, principally corn, sorghum, and millet, dominate domestic production; rice, wheat, barley, oats, rye also contribute to the total food supply (Table 1).

Collectively, cereal grains account for nearly 95% of domestic food consumption in SSA. Meat and poultry products are a rare dietary option in all SSA countries, with the exception of South Africa (5). Limited sources of protein-rich foods condition symptoms of dietary protein deficiency in about 60% of Sub-Saharan Africans. Thus, the nature of local food production in SSA presents a formidable constraint on humanitarian efforts to improve human health through nutritionally balanced diets.

TABLE 1. Overview of the market situation for food and feed grains in Sub-Saharan Africa

Commodity	Harvested Area (MHa)	Total Supply (MMT)	Domestic Food Consumption (MMT)	Domestic Feed Consumption (MMT)	Domestic Production % total supply
Corn	30.80	63.36	44.34	10.48	85.9
Sorghum	26.36	26.82	23.54	1.54	92.1
Millet	20.67	14.77	14.75	0.01	99.9
Oilseed Peanut	**10.71**	**10.33**	**7.43**	**1.24**	**96.2**
Rice, Milled	9.54	23.94	22.15	0.00	51.8
Wheat	2.84	25.48	21.95	0.48	24.8
Barley	1.22	2.50	2.08	0.11	85.0
Oats	0.03	0.09	0.04	0.03	51.4
Rye	0.02	0.01	0.01	0.00	100.0
Total	102.19	167.31	136.29	13.88	

USDA-FAS (2016)
Data in each category represent the average of USDA-FAS estimates for all Sub Sahran countries from 2005 to 2016.

TABLE 2. Oilseed market situation in Sub-Saharan Africa

Commodity	Total Oil seed Supply (1000 MT)	Domestic Food Consumption (1000 MT)				Domestic Feed Consumption (1000 MT)
		Oil seed	Oil	Peanut Butter and Pastes	Sum	
Peanut	**10,333.8**	**5,595.9**	**919.2**	**911.1**	**7,426.2**	**1,239.1**
Cottonseed	2,005.6	0.0	225.0	546.7	771.7	380.9
Soybean	1,925.7	276.2	568.1	29.1	873.3	509.4
Palm Kernel	1,204.4	0.1	337.3	18.2	355.6	28.0
Sunflowerseed	759.8	1.2	347.6	110.6	459.3	11.3
Coconut	95.8	0.0	42.2	3.8	45.9	9.0
Rapeseed	50.3	0.0	18.0	1.5	19.5	3.7
Palm	0.0	0.0	4,740.3	0.0	4,740.3	0.0
Total	16,375.4	5,873.3	7,197.7	1,620.8	14,691.8	2,181.4

USDA-FAS (2016)
Data: Mean + s tandard deviation of annual USDA-FAS estimates from 2005 to 2016

Given that a nutritionally balanced daily diet should at a minimum contain 53 g protein and 47 g oil and/or fat (6), strategic agricultural policies that foster sustainable oilseed markets in food insecure regions should help enhance dietary protein-energy quality. For example, oilseed peanut is a major source of domestically produced edible and feed-grade protein and vegetable oil in SSA. Peanut-producing countries in SSA include: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, The Gambia, Ghana, Guinea, Malawi, Mali, Mozambique, Niger, Nigeria, Senegal, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe, where peanuts and peanut products account for about half of domestic consumption of oilseed-derived foods and feed (Table 2).

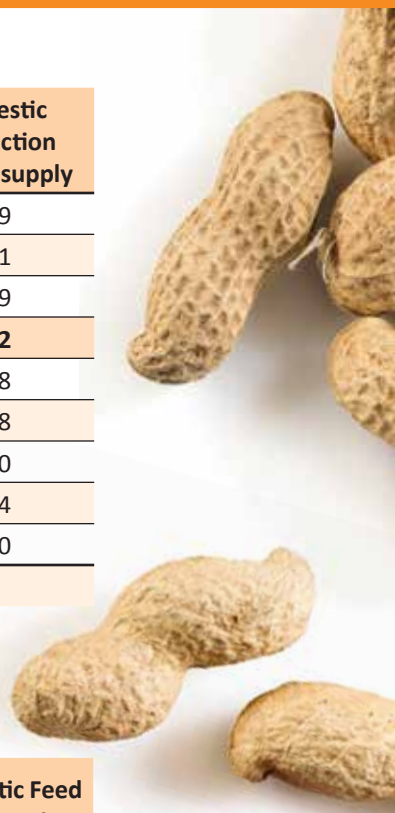

TABLE 3(a). Contribution of peanut-derived foods to dietary nutrition among countries of Sub-Saharan Africa

Country	Population		Domestic Food Consumption (calories /day/capita)					Peanut % Total dietary intake	Dietary protein intake (grams /day/capita)				Peanut % Total Protein
	(1,000)	(%)	Oil seed Peanut	Peanut Oil	Peanut Butter	Sum	Total Dietary Intake		Peanut Protein	Total Protein	Minimal Protein Requirement	Protein Balance	
Congo	4,730	0.8	706	209	133	1,048	2,570	40.8	38.1	53.0	64.3	-11.3	71.8
Gambia	1,781	0.3	358	176	154	688	2,330	29.5	21.3	55.0	58.3	-3.3	38.7
Chad	12,376	2.1	326	62	34	423	2,010	21.0	16.6	62.0	50.3	11.8	26.8
Guinea	11,300	1.9	355	107	68	530	2,550	20.8	19.2	54.0	63.8	-9.8	5.5
Central African Rep	4,877	0.8	191	139	73	402	1,960	20.5	12.6	46.0	49.0	-3.0	27.5
Cameroon	20,226	3.4	238	66	50	354	2,240	15.8	12.7	58.0	56.0	2.0	21.9
Sudan	42,433	7.1	146	124	83	354	2,280	15.5	10.2	73.0	57.0	16.0	13.9
Senegal	13,516	2.3	299	7	36	342	2,280	15.0	13.8	59.0	57.0	2.0	23.4
Ghana	26,378	4.4	253	101	52	406	2,900	14.0	14.4	59.0	72.5	-13.5	22.4
Malawi	15,656	2.6	154	63	44	261	2,150	12.2	8.8	55.0	53.8	1.3	16.0
Niger	18,482	3.1	151	60	44	255	2,390	10.7	8.6	74.0	59.8	14.3	11.6
Nigeria	165,313	27.6	189	38	23	251	2,710	9.3	9.7	62.0	67.8	-5.8	15.6
Tanzania	49,343	8.2	94	65	35	194	2,150	9.0	6.1	50.0	53.8	-3.8	12.3
Burkina	18,509	3.1	80	99	60	239	2,690	8.9	6.4	80.0	67.3	12.8	8.1
Mali	17,657	3.0	150	29	32	210	2,590	8.1	7.6	71.0	64.8	6.3	10.7
Benin	9,448	1.6	109	54	32	195	2,510	7.8	6.5	59.0	62.8	-3.8	10.9
Zambia	14,796	2.5	115	3	2	121	1,880	6.4	5.3	48.0	47.0	1.0	11.1
Zimbabwe	16,368	2.7	92	27	16	134	2,210	6.1	4.9	55.0	55.3	-0.3	9.0
Uganda	38,739	6.5	52	22	13	87	2,020	4.3	3.0	49.0	50.5	-1.5	6.1
Togo	6,576	1.1	73	11	7	92	2,220	4.1	3.6	49.0	55.5	-6.5	7.4
Mozambique	23,526	3.9	44	21	10	74	2,070	3.6	2.6	38.0	51.8	-13.8	6.8
Cote d'Ivoire	21,529	3.6	45	11	6	62	2,500	2.5	2.4	50.0	62.5	-12.5	4.7
South Africa	44,616	7.5	25	3	1	29	3,000	1.0	1.2	81.0	75.0	6.0	1.5
Sub-Saharan Africa	598,175	100.0	150	43	28	221	2,357	9.4	8.1	55.0	58.9	-3.9	14.7

SSA Country Population: Based on 2015 census, http://data.worldbank.org/region/sub-saharan-africa
Domestic Food Consumption of peanuts and peanut oil: USDA-FAS estimates each country in 2016; https://apps.fas.usda.gov/psdonl ine/app/index.html #/app/advQuery
Peanut Butter Production per SSA country: [Oi l seed Peanut Crush-(Peanut Oil + Meal Production)] for 2016; Ibid USDA-FAS (2016)
Calories Per Captia: [(MMT domestic food consumption/country population/365 days) x Calories /MT]
Calories /MT = Oil seed Peanut, 5.7 Mi l l ion, Peanut Oi l , 8.8 mi l l ion, Peanut Butter, 5.9 Mi l l ion: https ://www.fatsecret.com/calories -nutrition/usda/peanuts
Total Dietary Intake: 2016, https://en.wi kipedia.org/wi ki /Sub-Saharan_Africa
Peanut Protein Intake: 2016, [(MMT dietary consumed Peanut and Peanut Butter/country population/365 days) x 15% protein], https://www.fatsecret.com/calories-nutrition/usda/peanuts
Total Dietary Protein Intake: 2016, https ://chartsbin.com/view/1155
Minimum Protein Requirement: FAO Statistics Division 2010, Food Balance Sheets, Food and Agriculture Organization of the United Nations, Rome, Italy, viewed 17th March, 2011, <http://faostat.fao.org/>.
Protein Balance: Minimal Protein Requirement - Total Dietary Protein Intake

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TABLE 3(b). Impact of peanut consumption on dietary nutrition among Sub-Saharan African Countries

GROUP-1		
Congo, Malawi, Cameroon, Gambia, Niger, Sudan, Chad, Ghana, Senegal, Guinea, Central African Republic		
% Total Dietary Caloric Intake from Peanut	**% Total Dietary Protein Intake from Peanut**	**Total Dietary Protein Balance (grams/capita/day)**
3.7	16.2	19.5

GROUP-2		
Nigeria, Benin, Zambia, Tanzania, Mozambique, Zimbabwe, Burkina, Togo, Uganda, Mali, Cote d' Ivoire		
% Total Dietary Caloric Intake from Peanut	**% Total Dietary Protein Intake from Peanut**	**Total Dietary Protein Balance (grams/capita/day)**
6.2	8.8	-2.6

Data: Calculations based on estimates presented in Table 3a
Group-1: SSA conutries where peanut supplies greater than 10% of total daily caloric intake per capita; Group-2: SSA nations where peanut supplies less than 10% of total daily caloric intake per capita (Group-2 excludes South Africa)
Weighted Mean % total dietary caloric intake from peanut: Σ(individual Group-1 or Group-2 country population x corresponding % of total caloric intake from peanut)/(total population of Group 1 or Group 2 nations)
Weighted Mean % total dietary protein intake from peanut: Σ(individual Group-1 or Group-2 country population x corresponding % of total protein intake from peanut)/(total population of Group-1 or Group-2 nations)
Weighted Mean total dietary protein balance: Σ(individual Group-1 or Group-2 country population x corresponding protein balance)/(total population of Group-1 or Group-2 nations)

Estimates of the nutritional impact of peanut consumption on dietary protein quality show that SSA nations may be divided into two groups of 11 countries, where peanut accounts for greater or less than 10% of total daily caloric intake, a threshold that correlates with estimates of total peanut protein consumption (Table 3a). Within group averages weighted by country population, the group of SSA nations that consume a higher level of peanut foods per capita on a daily basis exhibit a positive total dietary protein balance; unfortunately, those countries account for only about 30% of the total SSA population (Table 3b).

Worldwide, SSA ranks second in global oilseed peanut production, first in harvested area, and second in total demand for oilseed peanut (Table 4, page 10). What then is the major constraint on wider implementation of the UN's endorsement of peanut consumption as a treatment for acute malnutrition in SSA? The answer appears to be the low-yielding ability of peanut varieties grown in SSA. Technological advances in

TABLE 4. Global market situation for oilseed peanut (2005–2016)

Country	Total Demand	Harvested Area	Production	Yield
	MMT	Mha	MMT	MT/Ha
China	15.5 ± 1.6	4.5 ± 0.3	15.4 ± 1.5	3.4 ± 0.2
India	5.5 ± 0.7	5.5 ± 0.8	5.5 ± 0.9	1.0 ± 0.1
Sub-Saharan Africa	9.9 ± 1.1	10.7 ± 1.5	9.9 ± 1.1	0.9 ± 0.1
South America	1.2 ± 0.2	0.4 ± 0.1	1.2 ± 0.1	3.1 ± 0.3
USA	2.1 ± 0.3	0.5 ± 0.1	2.2 ± 0.5	4.0 ± 0.5
World	40.3 ± 3.0	23.8 ± 1.3	38.0 ± 2.8	1.6 ± 0.1

Data: Mean + standard deviation of annual USDA-FAS e timates from 2005 to 2016

Total Demand: Σ(Oi l seed Peanut exports , crush, domestic food consumption, feed & industrial use)

peanut breeding have improved average yields in the United States (4.0 MT/ha), China (3.4 MT/ha), and South America (3.1 MT/ha); however, from 2005 to 2016, peanut yields in SSA have averaged about 0.9 MT/ha. In effect, SSA produces only about 26% of world peanut production on about 45% of the global harvested area. Thus, developing the peanut as an intervention to help correct acute malnutrition predominately is constrained by an inability to implement cost-effective yield-enhancement technologies.

Fortunately, recent technological breakthroughs made by the International Peanut Genome Initiative offer an opportunity to improve the yielding ability of oilseed peanut varieties in SSA (http://PeanutBase.org). The basis for these breakthroughs (7) is embodied in the ordered chromosome scale assemblies of two wild specie progenitor genomes (*Arachis duranensis, Arachis ipaensis*) and the pending genome assembly of cultivated oilseed peanut (*Arachis hypogaea*). Visualization of annotated chromosomal structures of those genomes accelerates discovery of useful variations in disease-specific resistance genes, construction of genetic markers that pinpoint those alleles, and deployment of advanced breeding methods that mediate transfer and accumulation of disease-resistance genes in agronomic varieties of cultivated peanut.

The international peanut research community has targeted a broad array of bacterial, fungal, viral, and parasitic diseases to control peanut crop damage and economic losses caused by *Aspergillus flavus* (aflatoxin), groundnut rosette disease, *Aspergillus niger*, bud necrosis collar rot, peanut rust, bacterial wilt, and late and early leaf spot (8). Genetic resistance to these diseases will provide a cost-effective means to realize future increases in oilseed peanut supply in SSA. Initial deployment of those varieties near processing plants in Nigeria, Sudan, Senegal, Tanzania, Cameroon, Ghana, and Burkina that account for about 75% of SSA crush capacity (5) also should enhance the supply of peanuts and demand for nutritious foods such as peanut butter.

Richard F. Wilson is Chief Executive Officer at Oilseeds & Biosciences Consulting, Raleigh, North Carolina, USA, and co-editor of Peanuts: Genetics, Processing, and Utilization, *https://tinyurl.com/y6v8z5qh. He can be contacted at Peanut.Bioscience@gmail.com.*

References

1. Rosen, S., Meade, B., Shapouri, S., D'Souza, A., and Rada, N. (2012) International Food Security Assessment, 2012–2022. United States Department of Agriculture, Economic Research Service, GAF-23, July 2012. Washington DC.

2. Global food security index (2016) Economic Intelligence Unit, DuPont Inc. http://foodsecurityindex.eiu.com/.

3. Meade, B. and Rosen, S. (2013a) International Food Security Assessment, 2013–2023. United States Department of Agriculture, Economic Research Service, GAF-24, June 2013. Washington DC.

4. Food and nutritional security: Comprehensive framework for action (2011) Task Force on Global Food Security, United Nations. http://www.un-foodsecurity.org.

5. Oilseeds: World Markets and Trade (2016) United States Department of Agriculture, Foreign Agricultural Service, Washington DC. http://apps.fas.usda.gov/psdonline/circulars/oilseeds.pdf.

6. Meade, B. and Rosen, S. (2013b) Despite improvements in international food security, nutritional adequacy of diets falls short of targets in many countries. Amber Waves. Nov. 18, 2013. http://www.ers.usda.gov/avmber-wars/2013-november/.

7. Bertioli J.D., *et al.*, The genome sequences of *Arachis duranensis* and *Arachis ipaensis*, the diploid ancestors of cultivated peanut, *Nature Genetics 48*: 438–436, 2016, http://dx.doi.org/10.1038/ng.3517.

8. Holbrook, C.C., Burow, M.D., Chen, C., Pandey, M., Liu, L., Chagoya, J.C., Chu, Y., Ozias-Akins, P. (2015). "Recent advances in peanut breeding and genetics." In: H.T. Stalker and R.F. Wilson (Eds.). *Peanuts: Genetics, Processing and Utilization*. Elsevier Academic Press, Inc.

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Milk fat triacylglycerol packing within processed cheese products

Author Pere R. Ramel received the 2017 AOCS Edible Applications Technology Division Student Award at the 2017 AOCS Annual Meeting and Industry Showcases in Orlando, Florida, USA, April 30–May 3.

Pere R. Ramel and Alejandro G. Marangoni

- **The incorporation of milk fat within food affects milk fat polymorphism.**
- **A greater extent of β polymorph formation is observed when milk fat is dispersed as globules within a solid protein matrix.**
- **The most important mechanism for the formation of the β polymorph of milk fat within processed cheese is crystallization in a confined space.**

Milk fat is one of the most studied fats due to the advantages that it provides as an ingredient in many food applications. Besides having a desirable flavor, milk fat triacylglycerols (TAGs) form a crystal network upon cooling, which is important in the structure formation of various food products, such as butter, ice cream, chocolate, and cheese. Furthermore, owing to its complex composition, milk fat provides a characteristic melting profile to food products. The crystallization behavior and crystalline structure of milk fat at various length scales (molecular, nano-, meso- and microscale), and the effects of composition and processing conditions on milk fat crystal structure have been extensively studied throughout the years using various analytical techniques.

Most of these studies were performed on milk fat alone, or in cream or emulsions. However, milk fat is also incorporated in solid food matrixes, such as cheese and pastry, where the incorporation of milk fat and the presence of other ingredients could affect the functionality of the milk fat crystal network formed upon cooling of the finished product. The crystallization behavior of milk fat within such a solid food matrix has not been extensively investigated.

To address this knowledge gap, we studied the polymorphism of milk fat (*i.e.,* how the TAGs pack in a crystalline lattice, especially looking at a subcellular region) within different commercial processed cheese products, namely processed cheese loaf (PCL), cream cheese (CRC), and processed cheese single slices (PCSS), produced in the United States and Canada. As controls, anhydrous milk fat (AMF) and cream were also studied. Microscopy, differential scanning calorimetry (DSC), and x-ray diffraction (XRD) techniques were used to analyze these products.

Figure 1 shows the microstructure of processed cheese loaf. The discernible globular structures are fat globules emulsified in a continuous protein network.

Emulsified fat globules in the protein matrix were also observed in cream cheese and processed cheese single slices. Milk fat in these processed cheese systems can therefore be considered as a dispersed phase in a solid matrix, in contrast with cream, which is milk fat globules dispersed in a liquid phase (milk serum), and with AMF, which is undispersed bulk fat (~ 99% fat).

AMF, cream, and processed cheese products were then melted from 0 to 60 °C in a controlled manner using DSC. The peaks observed in Figure 2 are related to the melting of milk fat crystals, since protein in processed cheese is not expected to exhibit any thermal transitions at the temperatures studied. AMF, due to the complexity of its composition, shows three overlapping peaks. This is characteristic of the melting of the different fractions present in milk fat. Cream and PCSS, on the other hand, show only two separate—not overlapping—melting peaks. This may indicate that the dispersion of milk fat, either in a liquid phase or a solid matrix, allows for the distinction of the melting of the middle-melting and high-melting fractions of milk fat.

To determine whether a difference exists in the polymorphism of bulk milk fat versus milk fat that is dispersed in

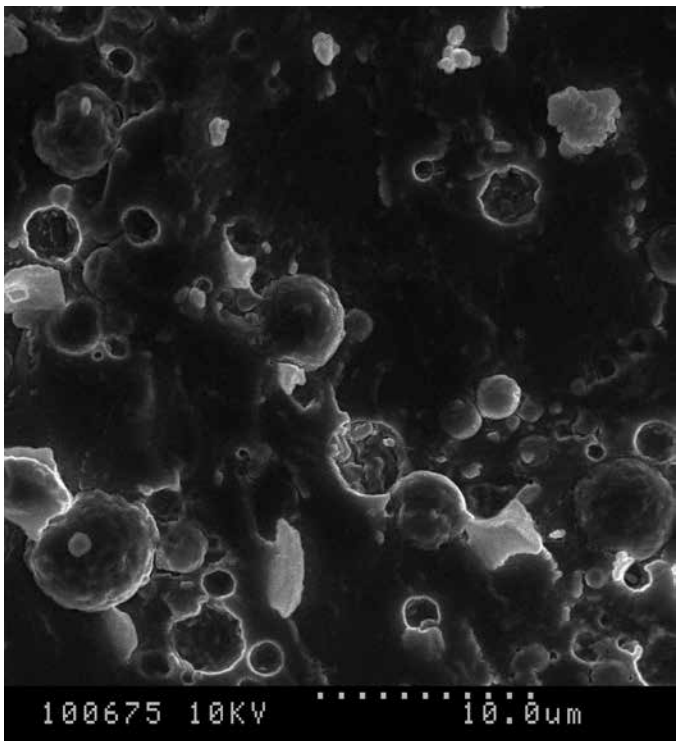

FIG. 1. Cryogenic scanning electron (cryo-SEM) micrograph of processed cheese loaf (PCL) produced in the United States

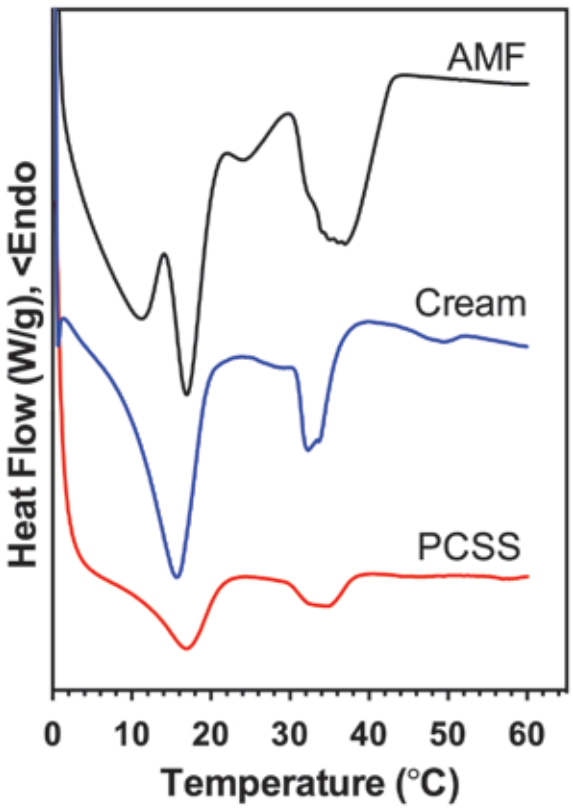

FIG. 2. Differential scanning calorimetry (DSC) melting curves (0–60°C) of anhydrous milk fat (AMF), cream, and processed cheese single slices (PCSS) produced in the United states

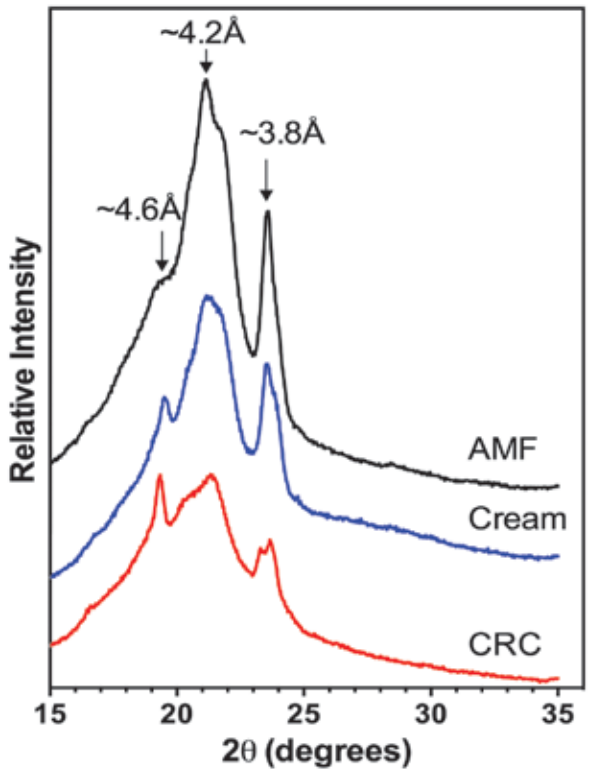

FIG. 3. Wide-angle X-ray diffraction (XRD) patterns of anhydrous milk fat (AMF), cream, and cream cheese (CRC) produced in Canada. Arrows indicate the peaks corresponding to *d*-spacings characteristic of the β' (4.2, 3.8 and 3.7 Å) and β (4.6 Å) polymorphs.

a liquid phase or solid matrix, AMF, cream, and the processed cheese products were analyzed using XRD. Figure 3 shows XRD patterns at the wide-angle region of AMF, cream, and cream cheese. The different peaks observed at various diffraction angles (θ) are labelled according to corresponding *d*-spacings, which are related to the geometrical arrangement of TAG molecules. Three polymorphs have been identified in milk fat, namely alpha, α (*d* = 4.1 Å), beta-prime, β' (*d* = 4.2 and 3.8 Å), and beta, β (*d* = 4.6 Å). The β polymorph is the most compact and stable polymorph of milk fat; however, it is rarely observed because the complex TAG composition of milk fat does not allow TAG molecules to organize into the most compact structure. Therefore, upon cooling, the β' form is usually found in milk fat. The β' form can be observed in AMF (Fig. 3) even after slow cooling and storage for up to eight months. Cream and cream cheese also show the β' peaks; in addition, a peak indicating the presence of the β polymorph (4.6 Å) can be very well observed in these samples. Furthermore, this peak is extremely well defined in cream cheese (Fig. 3). This indicates that the dispersion of milk fat either in liquid or a solid food matrix results in the formation of the most stable crystal form of milk fat. The formation of the β polymorph in cream is observed because of inherent slow crystallization, which can be explained by the limited availability of catalytic impurities in a dispersed system during cooling, which promotes the formation of the β polymorph. However, in processed cheese, other ingredients that could hasten crystallization or complement the structure of TAGs are present; therefore milk fat can form the β polymorph.

To further investigate the mechanisms involved in the formation of milk fat β polymorph in processed cheese, we designed a model cheese system where AMF (β'- tending) was incorporated in a sodium caseinate gel with and without the presence of salts. Furthermore, to determine the effect of protein type, AMF was also incorporated in soy and whey protein isolate gels. As a control, AMF alone was processed in the same way as that of making the model cheese. Results in Figure 4 show that the β polymorph is present in all the samples except for AMF. This indicates that regardless of the presence of other ingredients, such as salts, and the protein type (*i.e.,* surface properties or structure), a greater extent of β polymorph formation can be observed if fat is emulsified as globules or droplets in a solid food matrix. Consequently, the most important mechanism for the formation of the β polymorph in processed cheese products is the physical constrains imposed by a solid food matrix. Due to crystallization in a confined space, TAGs of milk fat are forced to arrange themselves in the most compact or stable form.

The results of our study show that the polymorphism of milk fat, or fats in general, is affected by incorporation within a food matrix. This is important, especially when polymorphism greatly affects the functionality of fats or food products in which fats are added as a main ingredient (*i.e.,* melting profile). The current study can also be used as a template for

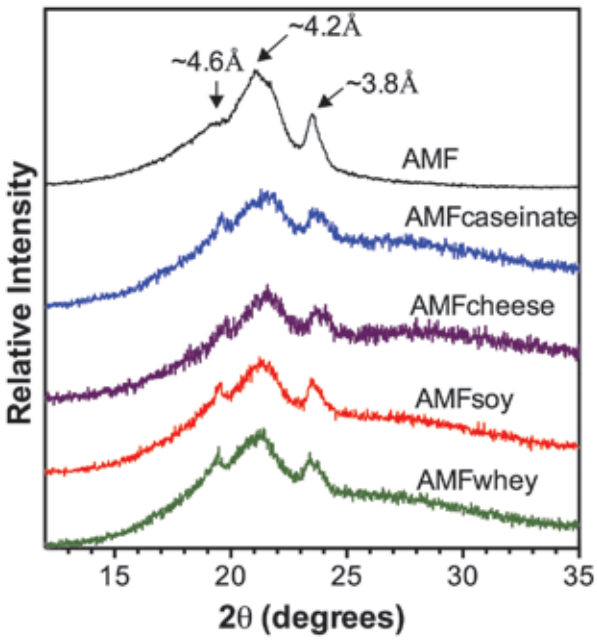

FIG. 4. Wide-angle X-ray diffraction (WAXD) patterns of anhydrous milk fat (AMF); AMF incorporated in sodium caseinate gel (AMF caseinate), sodium caseinate gel with salts (AMF cheese), soy protein (AMF soy), and whey protein isolate (AMF whey) gels. Arrows indicate the peaks corresponding to *d*-spacings characteristic of the β′ (4.2, 3.8 and 3.7 Å) and β (4.6 Å) polymorphs.

studying other products containing milk fat, such as pastries. Furthermore, techniques such as XRD and DSC can be used to profile processed cheese products.

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Alejandro G. Marangoni is a professor and Tier I Canada Research Chair Food, Health and Aging at the University of Guelph. He received the first AOCS Young Scientist Award in 2000, the Timothy L. Mounts Award in 2004, and the Supelco/Nicholas Pelick-AOCS Research Award in 2014. He is currently the Editor-in-Chief of the AOCS Lipid Library®.

References

Ramel, P.R. and A.G. Marangoni, Characterization of the polymorphism of milk fat within processed cheese products, *Food Structure 12*: 15–25, 2017, http://dx.doi.org/10.1016/j.foostr.2017.03.001.

Ramel, P.R. and A.G. Marangoni, Insights into the mechanism of formation of the most stable crystal polymorph of milk fat in model protein matrices. Accepted in *J. Dairy Sci.,* 2017.

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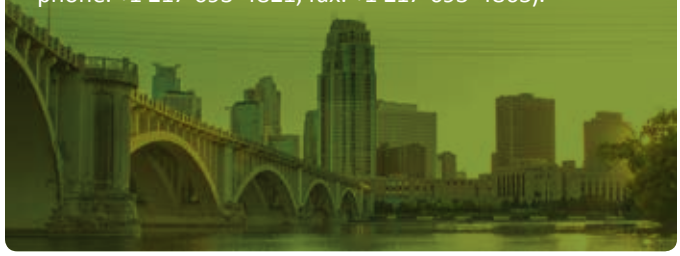

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Mixed alcohol transesterification of mustard oil

Sayeh Sinichi, David G.B. Boocock, and Levente L. Diosady

Transesterification is currently the most widely used method for biodiesel production. Methanol is the most commonly used alcohol for transesterification in the United States and Europe due to its low price, high reactivity, and availability. However, the transesterification reaction using methanol is hampered by mass transfer limitations due to the low solubility of oil in methanol at ambient temperature [4][5]. Oil solubility in isopropyl alcohol (IPA) is much higher, but the reaction has a lower reactivity because IPA has a high pKa value (pKa = 16.5). Transesterification was therefore tested in isopropyl-methyl alcohol mixtures (Fig. 1) in an effort to combine the high oil solubility of IPA with the high reactivity of methanol. Oil was mixed with IPA and methanol, and the effect of IPA:oil:MeOH ratios on transesterification rates were determined. The ratio of IPA to methanol (w/w) was varied from 1:5 to 47:1.

- **Isopropyl alcohol (IPA), as an environmentally friendly replacement for hexane, was used to recover oil suitable for conversion to biodiesel from yellow mustard [1, 2].**

- **This summary of a paper, originally published in the *Journal of the American Oil Chemists' Society* (*JAOCS*), describes how IPA and methanol (MeOH) were used to develop a rapid process for biodiesel production directly from yellow mustard oil +IPA miscella [3].**

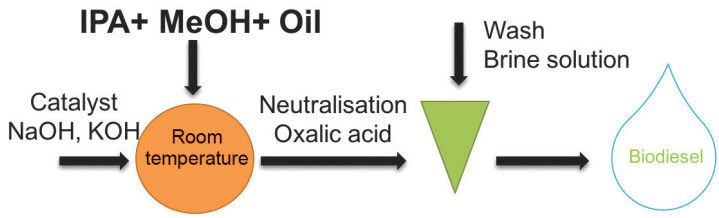
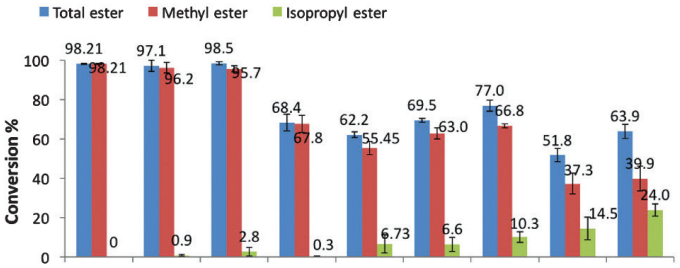


FIG. 1. Transesterification process scheme

The effect of IPA:oil:MeOH concentrations on ester yield after 30 minutes of reaction at room temperature using 1% (w/w) NaOH as a catalyst is shown in Figure 2. Reactions made with lower IPA contents had higher ester yields, even though the reaction did not start in the single-phase region. IPA:oil:MeOH molar ratios of 3:1:25, 10:1:25, and 25:1:25 resulted in ester yields between 97 to 98% (Fig. 2). Optimal results were obtained with an alcohol:oil molar ratio of 25:1. The amount of isopropyl esters formed in the above mixtures was very low, reaching a maximum of 2.8 ± 0.98% at an IPA:oil:MeOH molar ratio of 25:1:25. These reactions started in a bi-phasic region and then coalesced to a single phase due to the production of mono-, di-, and triglycerides. These types of reactions are called progressive pseudo-single-phase transesterifications (D.G.B. Boocock).



IPA:Methanol (w:w)	1:5	1:1	2:1	3:1	4:1	8:1	11:1	16:1	47:1
IPA:oil:methanol (w:w:w)	2:10:10	7:10: 9	17:10: 9	7:10: 2	34:10: 9	17:10: 2	100:10: 9	34:10: 2	100:10: 2
IPA:oil:methanol (Molar ratio)	3:1:25	10:1:25	25:1: 25	10:1:6	50:1:25	25:1:6	150:1:25	50:1:6	150:1:25
Phase separation	Two	Two	Two	Two	Two	Two	One	Two	One

FIG. 2. Total ester, isopropyl ester, and methyl ester content after 30 minutes of IPA/MeOH transesterification using 1% NaOH at room temperature

In the presence of high concentrations of IPA, ester yields were lower. The highest isopropyl ester yield (~ 24 %) was achieved with an IPA:oil:MeOH molar ratio of 150:1:6. This indicates that high concentrations of IPA resulting in single phase reaction conditions favored isopropyl ester formation, while reducing the methyl ester yield and reducing total ester yield. Excess IPA in the system also resulted in the dilution of the catalyst which decreased the ester yield.

Four-stage extraction using an IPA: mustard flour ratio (v:w) of only 1.5:1 resulted in ~86% oil recovery. IPA extracted some water and carbohydrates in addition to the oil. The miscella was used directly as feedstock for biodiesel production. The miscella obtained by combining the miscellae from the 4 stages with 146:1 molar ratio, contained 2.13 ± 0.1%, water, which is greater than the maximum acceptable level for transesterification, as the water will hydrolyze some fatty acid methyl esters to form free fatty acids that further react with the catalyst to produce soap [6]. Dehydration by absorption was used to reduce the water content of the miscella from 2.1% to <0.3%. Base-catalyzed transesterification of the mustard miscellae was ineffective (29%) due to low catalyst ionization (low reactivity) in IPA, and due to interference by other oil impurities such as FFAs and phospholipids. As a result, IPA did not seem to be a suitable reactant.

The addition of methanol to the dehydrated miscellae increased the reactivity, thus using IPA as a co-solvent rather than as a reagent. This improved the ester yield dramatically. Excess IPA in the system (more than 25:1 IPA:oil molar ratio) hindered the production of the methyl ester by competing with methanol during ester formation, and decreased total ester yield. The IPA/MeOH one-phase transesterification of the dehydrated miscella with an IPA:oil:MeOH molar ratio of 146:1:30 using 1.2 mass % KOH resulted in a high (89%) ester yield at room temperature (Fig. 3). Increasing KOH to 3% increased the conversion rate to 94%.

Aqueous sulfuric acid 5–20 wt% was added to the combined miscella before transesterification. The treated miscella was separated into three phases: a water-rich phase, an oil-rich phase, and an impurity phase. The addition of water to the miscella

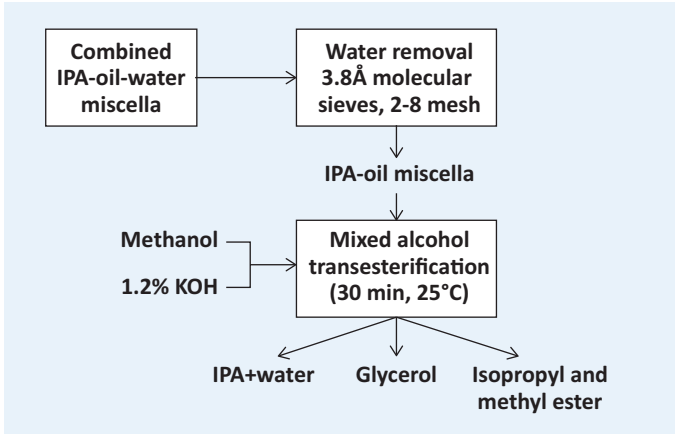


FIG. 3. Mixed alcohol transesterification of dehydrated mustard miscella with high level of IPA

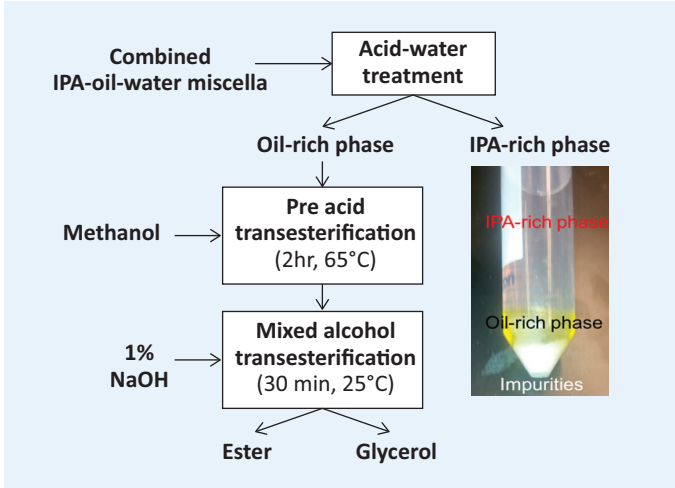


FIG. 4. Mixed alcohol transesterification of treated mustard miscella with low level of IPA

resulted in the separation of the impurities that were collected from the bottom of the centrifuge bottle and analyzed. Addition of some 20% by weight 50% sulfuric acid solution to the miscella induced phase separation, which resulted in transferring 92 ± 1% of the oil into the oil-rich phase. This oil-rich phase had an IPA:oil molar ratio of 3:1 and was therefore suitable for the mixed alcohol transesterification. The acid-catalyzed pretreatment converted the free fatty acids present in the system to esters. Although the use of IPA as a co-solvent improved the methanolysis process considerably, it seems that lower IPA:oil:MeOH 3:1:24 molar ratios achieved higher ester yields (>99%) and improved the quality of the biodiesel produced(Fig. 4, page 17).

The reaction kinetics of the transesterification process at various IPA:oil:MeOH molar ratios and using different catalyst levels are presented in Figure 5. The IPA:oil:MeOH molar ratio of 146:1:0; i.e., without the presence of methanol, was very slow. Using an IPA:oil:MeOH molar ratio of 0:1:30; i.e., without IPA, the reaction proceeded slightly faster in comparison to an IPA-only system. In methanolysis, the solubility of the oil in the methanol is low; therefore the reaction which occurs only in the catalyst-containing phase proceeded very slowly until the oil reached saturation levels in the methanol, and even consistent stirring did not overcome the mass transfer limitations. Using an IPA:oil:MeOH molar ratio of 146:1:30 gave a cloudy two-phase mixture prior to the beginning of the reaction, but it formed a single phase within the first three minutes of the reaction, as there was an abundance of IPA and thus only a small amount of ester was needed to completely dissolve the oil in the IPA/MeOH mixture. Some 60% conversion was obtained within the first 10 minutes under these conditions. This increased to 89 % within the first hour of reaction. Using

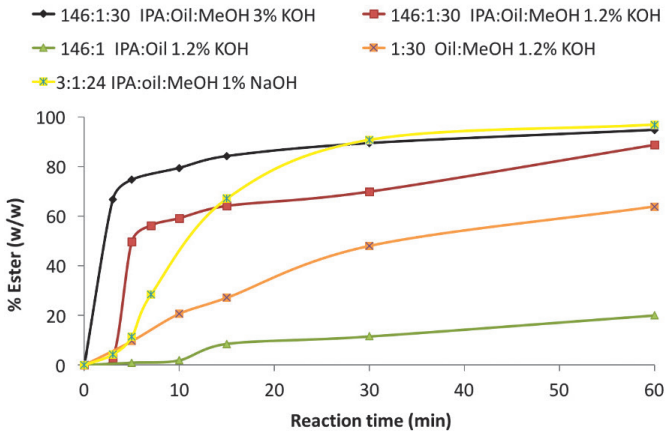


FIG. 5. Transesterification kinetics at various IPA: Mustard oil: MeOH molar ratios

an IPA:oil:MeOH molar ratio of 146:1:30 and 3 mass % KOH, a single phase was achieved within the first minute, and approximately 57% conversion was obtained within the first three minutes of reaction. Furthermore, the conversion increased to 94% in the first hour of reaction time. The best ester conversion in reactions with lower levels of alcohol in the system was 99.66%, obtained using an IPA:oil:MeOH molar ratio of 3:1:24 with 0.07 GT%, which complies with the ASTM biodiesel standard. The kinetic study indicated a slow but steadily increasing ester formation unlike the sharp increase observed when higher levels of mixed alcohols were present in the reaction. After 30 minutes more than 98% ester production was achieved, and this increased to more than 99% after one hour.

WHAT WAS LEARNED

The following three conclusions can be drawn from this work.

- Yellow mustard oil can be considered as a renewable feedstock for biodiesel production.
- A combination of IPA extraction process and an additional refining step followed by mixed alcohol transesterification can be used for direct recovery of the oil as standard biodiesel.
- This is a highly attractive and economically viable process since an underutilized Canadian crop (yellow mustard) is used to produce food-grade protein products as well as high-grade biodiesel.
- Future investigations into the recovery and recycling of IPA could further refine this process and thereby make it even more economically attractive.

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Information

1. Sinichi, S. and L.L. Diosady, Isopropyl alcohol extraction of dehulled yellow mustard flour, *J. Am. Oil Chem. Soc*. *91*: 2143–2153, 2014.

2. Sinichi, S. and L.L Diosady, Isopropyl alcohol extraction of mustard oil, *Inform 26*: 178–182, March 2015.

3. Sinichi, S. and L. Diosady, Production of isopropyl and methyl esters from yellow mustard oil-IPA miscella, *J. Am. Oil Chem. Soc*. *94*: 485–495, 2017.

4. Boocock, D.G.B., S.K. Konar, V. Mao, and H. Sidi, Fast one-phase oil-rich processes for the preparation of vegetable oil methyl esters, *Biomass Bioenerg*. *11*: *43*–50, 1996.

5. Boocock, D.G.B., S.K. Konar, and H. Sidi, Phase diagrams for oil/methanol/ether mixtures, *J. Am. Oil Chem. Soc*. *73*: 1247–1251, 1996.

6. Sharma, Y.C., B. Singh, and S.N. Upadhyay, Advancements in development and characterization of biodiesel: a review, *Fuel 87*: 2355–2373, 2008.

Fat for the future: designing multifunctional molecular oleogels

Sai Sateesh Sagiri, Malick Samateh, and George John

- **Oleogels from low-molecular-weight gelators are a potential alternative to traditional vegetable oil structuring methods.**
- **Such gelators are synthesized from bioderived raw materials including sugars, sugar alcohols, glycosides, and fatty acids using a one-step GRAS (Generally Recognized as Safe) protocol.**
- **The thermal, rheological, textural, and aesthetic properties of vegetable oils structured with these gelators can be fine-tuned using functional molecular gelators, opening the door to future fat substitutes.**

With the deadline for replacing partially hydrogenated oils less than a year away, there is a compelling need to develop functional, healthy, and nutritious materials that can be used to turn liquid oils into semi-solid fats. Toward that end, our research group has successfully demonstrated the design and synthesis of a new family of naturally derived molecular gelators through a simple GRAS (Generally Recognized as Safe) protocol. These gelators can potentially form stable oleogels with a variety of vegetable oils for food and personal care applications.

SOLID OILS FORTIFIED WITH MULTIFUNCTIONAL GELATORS

The quest for alternative vegetable oil solidifying/thickening or structuring strategies has progressed rapidly since the discovery of low-molecular-weight gelators (LMWGs)—a new class of vegetable oil structuring agents that can be distinguished from existing polymeric gelators/waxes. While the majority of research on molecular gelators has focused on the gelation of organic solvents (organogels), few research groups are working on structuring vegetable oils using small molecules. The design, synthesis, and application of a carbohydrate derivative in edible oil structuring was reported by our research group in 2006. Since then, we have been actively involved in designing new amphiphilic molecules and developing technologies for structuring different edible oils.

Based on our expertise in small molecular gelators, we recently aimed to design oil structuring agents with multifunctional properties (eg., low in calories, low glycemic index, antioxidant). Naturally available sugars (e.g., trehalose, sucrose, mannose, amygdalin), sugar alcohols (e.g., sorbitol, mannitol, xylitol), and glycosides (e.g., raspberry ketone glycoside, salicin) were investigated as precursors for the design of multifunctional amphiphilic molecular gelators. The carbohydrate group acts as the hydrophilic head, and the fatty acyl chains act as hydrophobic tail.

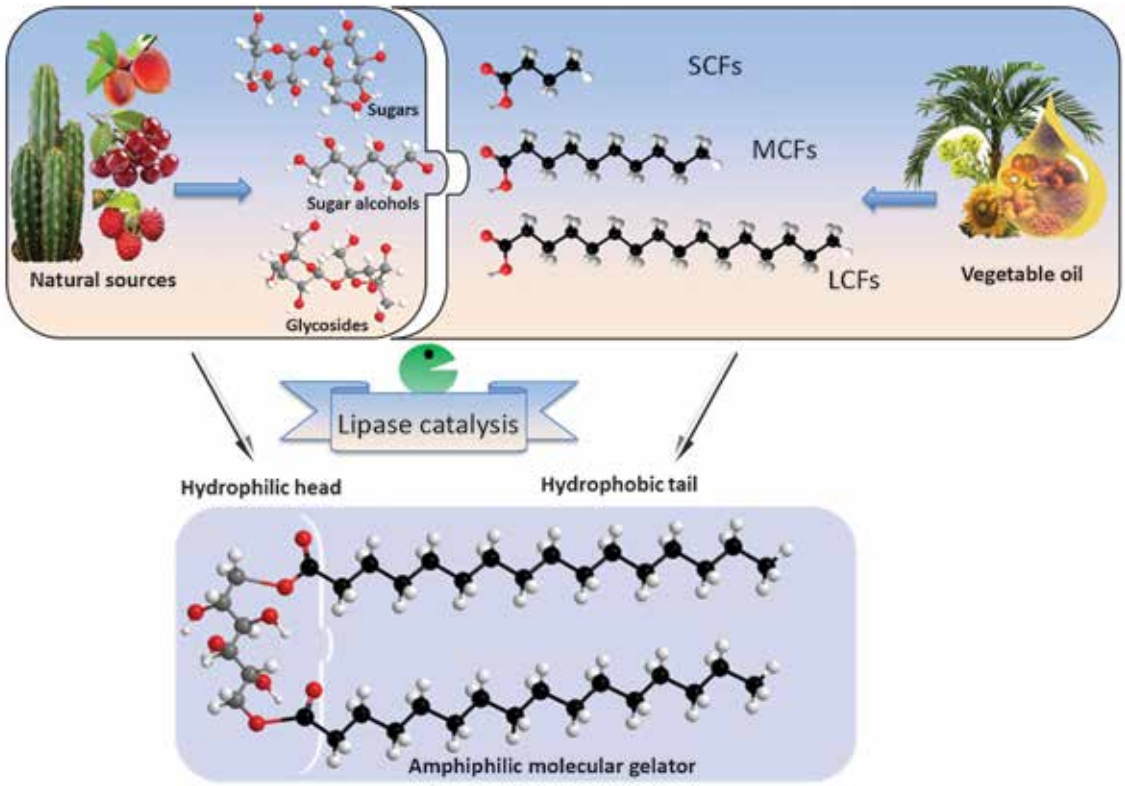

FIG. 1. One-step synthesis of amphiphilc molecular gelators from natural sources (SCFs, MCFs, and LCFs: Short-, medium-, and long-chain fatty acids)

The fatty acids provide the necessary lipophilic nature to balance the hydrophilicity associated with the carbohydrates. Hence, care has to be taken to achieve appropriate hydrophilic-lipophilic balance (HLB) while designing molecular gelators for targeted applications.

SUGAR ALCOHOL DERIVATIVES

Sugar alcohols were esterified with fatty acids having different chain lengths ranging from butyric acid (C4), caprylic acid (C8), capric acid (C10), lauric acid (C12), myristic acid (C14), palmitic acid (C16), and stearic acid (C18). By following a simple one-step enzymatic reaction (regiospecific esterification), high yields (> 90 %) of molecular gelators were synthesized. We synthesized these molecular gelators in kilogram scale as well. Based on the simplicity, yield, and cost effectiveness, synthesis of sugar alcohol derivatives using regiospecific esterification seems to be plausible at the industrial level. The sugar alcohol derivatives have shown excellent gelation ability at exceedingly low amounts (Fig. 2), often less than 5%, in canola oil, grape seed oil, olive oil, sesame oil, soybean oil, and sunflower oil [1]. Sorbitol and mannitol dialkanoates have proven to be efficient in the molecular gelation of vegetable oils. The amphiphiles self-assemble to form supramolecular hierarchical structures, notably called self-assembled fibrillar networks (SAFINs). During gelation, sugar alcohol derivatives self-assemble as inverse bilayers which extend unidirectionally as fibrils, and further aggregate to form supramolecular structures such as fibers and microcrystals.

FIG. 2. Structured vegetable oils (oleogels) using sorbitol and mannitol dialkanoates

The three-dimensional entanglement of supramolecular structures arrests the free flow of vegetable oil and results in a semi-solid oleogel. Sorbitol and mannitol derivatives respectively form microcrystalline and fibrous micro-architectures in vegetable oils (Fig. 3). The molecular level stereochemical differences in the chemical structure of sugar alcohols are responsible for the microscopic morphological orientation of the gelators in the oleogels. These microstructural differences have yielded translucent and opaque oleogels when sorbitol and mannitol derivatives were used respectively with medium-chain vegetable oils. Transparent oleogels were obtained using raspberry ketone glucoside-based oleogels (Fig. 3). The microstructural differences have, in turn, affected the textural and rheological properties of oleogels. Thus, the aesthetics, texture, rheology, and solid phase content (generally referred to as the solid fat content) of the oleogels can be fine-tuned by formulating with appropriate sugar alcohol dialkanoates.

FIG. 3. Stable oleogels and their microstructure (from left to right): Oleogels showed increase in opacity when prepared using RKG, sorbitol, and mannitol dialkanoates.

The multifunctionality of sugar alcohol derivatives can also be measured by their lower glycemic index, in addition to their structuring ability. Sugar alcohols such as sorbitol and mannitol possess low glycemic indices compared to sugars. Sorbitol and mannitol are currently used as sugar substitutes, as their calorific values are 2.6 and 1.6 cal/g, respectively, lower than that of glucose (3.35 cal/g). The calorific value of medium-chain fatty acids are reported to be in the range of ~7.95-9.5 cal/g, thus the glycemic index of sugar alcohol-dialkanoates are expected to be minimal and within the proposed limit (~10 cal/g). The non-hypercholesterolemic nature of medium-chain fatty acids also may add value to the multifunctionality of the structuring agents. For example, caprylic acid has been used as food contact surface sanitizer in dairy, food, and beverage processing plants; the use of caprylic acid does not illicit immunological response when ingested. High cell viability of human liver carcinoma cells (HepG2 cell line) was observed during cytotoxicity tests of molecular gelators, supporting the suitability of the molecules toward food applications.

SUGAR AND GLYCOSIDE DERIVATIVES

The design of multifunctional oleogelators is also possible with trehalose and raspberry ketone glucoside (RKG). Trehalsoe, a disaccharide, has demonstrated anti-aging, neuroprotective, cardiovascular, and gastrointestinal benefits. RKG is a sugar glucoside primarily used in cosmetics that is also used in weight management and therapy. Trehalose and RKG diesters are synthesized by enzymatic catalysis in a similar fashion as with sugar alcohol dialkanoates. Trehalose and RKG diesters have demonstrated excellent gelation ability in olive oil, and particularly with medium-chain triglycerides such as coconut oil, respectively [2]. The inherent nutritional qualities of precursors complement the structuring ability of these derivatives for use as multifunctional oleogelators.

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WHAT WE LEARNED

Low- or non-calorific sugar/sugar alcohol/glucoside derivatives have shown excellent results and promise in structuring vegetable oils. The functionality of such bioderived gelators can be tuned by employing the appropriate structure and stereochemistry of carbohydrates and fatty acid components. The acquired microstructural and physico-chemical differences facilitate the use of structured oils (oleogels) in food materials, personal care, cosmetics, and medicinal applications. We envision that the design, synthesis and self-assembly of bioderived, multifunctional small molecules can be tailored to meet future niche market needs.

Sai Sateesh Sagiri is a postdoctoral fellow in the Department of Chemistry and Biochemistry at The City College of New York, New York, USA. He earned his Ph.D. from the Department of Biotechnology and Medical Engineering, National Institute of Technology, Rourkela, India in 2015. His research expertise is on the self-assembly of small molecular gelators, formulation of oleogels, and their applications in food and pharmaceutics

Malick Samateh is a candidate in the Ph.D. Program in Chemistry at the Graduate Center of the City University of New York, where he works on the design and synthesis of amphiphilic molecules from sugar-based precursors. His research includes studying the assembly of small molecular gelators, mainly in vegetable oils, and analyzing the resulting structured oils for properties such as gelation efficiency, thermal stability, and mechanical strength using different physicochemical techniques.

George John is recognized for his active research in the field of functional molecular materials from renewable resources and their potential utility in food materials. After receiving his Ph.D. from NIIST-CSIR (India) in Chemistry in 1993, he held research positions in the Netherlands, Japan, and the United States before joining the City College of New York (CCNY). Currently he is a Professor of Chemistry and Biochemistry at CCNY. The research in John's laboratory is highly interdisciplinary, and is focused on molecular design of synthetic lipids (biobased), membrane mimics, soft materials, trans fat alternatives, food materials and food chemistry, and organic materials chemistry. His group has successfully developed environmentally benign antibacterial paints, oil spill recovery materials, molecular gel technologies, vegetable oil thickening agents, and trans-fat alternatives. He is a Fellow of the Royal Society of Chemistry, a senior Fulbright Scholar to India, and was a recipient of the Tokyo University of Sciences (TUS) President Award, the Pfizer Visiting Professorship at (IISc) Bangalore, and the Kerala Center Award. He can be contacted at gjohn@ccny.cuny.edu.

References

1. Jadhav, S.R., H. Hwang, Q. Huang, and G. John, Medium-chain sugar amphiphiles: a new family of healthy vegetable oil structuring agents, *J. Agric. Food Chem. 61*: 12005–12011, 2013.

2. (a) John, G., G. Zhu, J. Li, and J.S. Dordick, Enzymatically derived sugar-containing self-assembled organogels with nanostructured morphologies, *Angewandte Chemie International Edition 45*: 4772–4775, 2006; (b) Silverman, J.R. and G. John, G., Biobased fat-mimicking molecular structuring agents for medium-chain triglycerides (MCTs) and other edible oils, *J. Agric. Food Chem. 63*: 10536–10542, 2015.

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Biodiesel from low-quality feed stocks

P.M. Nielsen and C.C. Akoh

The 2017 AOCS Annual Meeting and Industry Showcases held in Orlando, Florida, USA, April 30–May 3, included a joint technical session (BIO 3.1/PRO 3.1) on biodiesel from low-cost feed stocks that illustrated the level of technology now available for producing biodiesel with enzymatic catalysis. From the discussion, it became clear that the technology was in daily operation at several plants represented by the speakers, and that it can now be considered as one of the alternative methods for biodiesel production.

- **Enzymatic biodiesel has been developed during the last 15 years, starting with research in Japan and China.**
- **A paradigm shift was introduced when liquid-formulated lipases were launched for processing low-cost feed stocks.**
- **This article summarizes the documentation presented by biodiesel entrepreneurs and producers during the 2017 AOCS Annual Meeting and Industry Showcases held in Orlando, Florida, USA, April 30–May 3.**

EARLY RESEARCH

The first publication on enzymatic biodiesel research addressing enzymatic biodiesel from waste oils was made by the R&D group at Osaka Municipal Technical Research Institute headed by Yuji Shimada [1]. The group started their work with enzymatic biodiesel production a few years earlier, and published many articles during a 10-year period. Since then, a large number of articles as well as conference presentations have discussed results related to the development of the enzymatic technology—some of which involved the discovery of new lipases that optimize the process and a shift from immobilized to liquid-formulated enzymes as a partial solution to lowering the cost of production.

ONE OF THE FIRST FULL-SCALE PRODUCTION UNITS

The R&D group at Tsinghua University, Beijing, China, started their research in 2005. Their work has since progressed from the laboratory to pilot- and full-scale production. During the AOCS technical session, Professor D. Liu explained that the plant in Hunan province, China, with a 50,000 throughput yield (TPY) capacity was in production from 2008, but has not been in constant production since then due to changes in production technology and/or availability of raw materials (Fig. 1, page 24).

The main challenges in the enzymatic process are:

- Purity of raw material (impacts enzyme stability and yield);
- Methanol concentration in reactor (impacts enzyme stability); and
- Equilibrium end-point of the reaction (impacts the amount of free fatty acids in the biodiesel)

FIG. 1. The first large-scale unit for production of enzymatic biodiesel (Hunan province, China). Initially, it was expected that the process had to be based upon immobilized enzymes to enable easy recovery and re-use of the enzyme. Due to high enzyme prices many re-uses were required. This, together with limited access to high-purity feedstock and process design challenges, inspired the development of a process catalyzed by liquid-formulated lipase.

CLEANING THE FEEDSTOCK

Cleaning of the oil feedstock is an "art" of its own, and a part of the process some presenters covered in great detail. The method of controlling the at-all-times concentration of methanol in the reactor determines the lifetime of the immobilized enzyme. A good methanol dosage strategy is now relatively easy to establish with the use of liquid-formulated enzymes, which for the past five years has been the way to operate. The plant in Hunan has a system for recovering the liquid enzyme for re-use, so that enzyme costs can be kept as low as possible. The equilibrium after reaction is what keeps the biodiesel within specifications, except for the free fatty acids (FFA) content, which must be converted to fatty acid methyl esters (FAME) by a separate technology. Three different technologies for this will be described later in this article.

Liu explained why they used immobilized *C. antarctica* lipase B in an air-mixed reactor with the enzyme fluidized. The air consists of a methanol vapor that is pumped to the bottom of the reactor. This vapor picks up the water formed by the esterification reaction and carries it out from the head-space and into a molecular sieve drier before it is returned. A larger production unit with 200,000 TPY capacity is now under construction in China.

FIG. 2. The 4-CSTR Viesel pilot plant used for perfecting the process before scaling up.

LESSONS IN PRODUCTION

B. Chabras, a pioneer in process development from Viesel Fuel LLC in Stuart, Florida, USA, shared the history of how a full-scale operation with a continuous stirred tank reactor (CSTR) system was developed. The pilot plant for CSTR is seen in Figure 2. Viesel arrived at this configuration after a lot of experimental work in batch operation, from which they used the bound glycerin data from the batch reaction to establish

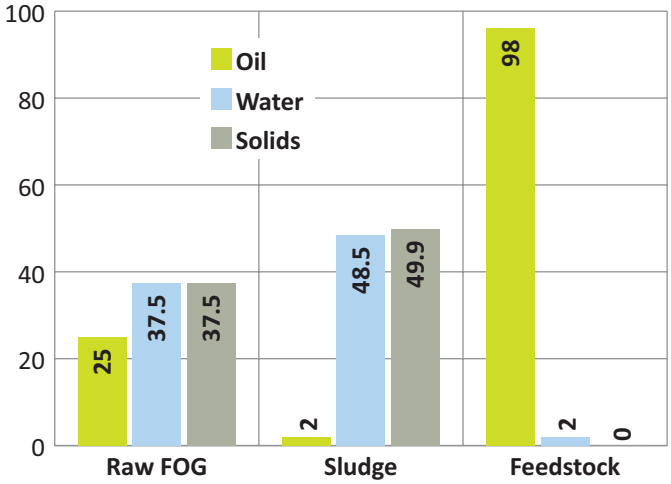

FIG. 3. Example of FOG purification by Tactical technology on material from a sewage plant in New Orleans, Louisiana, USA

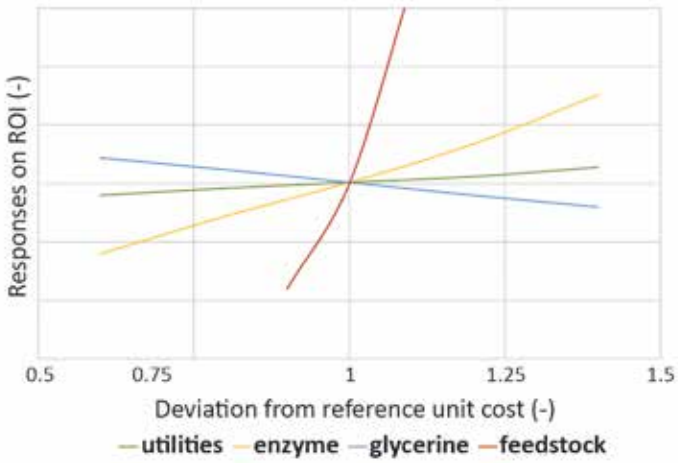

FIG. 4. Perturbation plot showing the relative significance of selected operational costs on the enzymatic biodiesel process profitability

a scientific base for changing to a CSTR operation. The kinetic data from the reaction can be used to calculate the dimensioning of the reactors and the parameters of operation [2]. The liquid lipase is used only once, which secures a steady daily operation by avoiding accumulation of impurities. It was emphasized that the process's success depends in part on good pre-treatment to prepare the used cooking oil, brown grease, or even fats and oils from sewage plants.

The team from Tactical Fabrication LLC, in Dublin Georgia, USA—F. Mathis and B. Munk—focused their presentation on their development of a decanter system that pulls the fats, oils, and grease (FOG) out of the sewage plant to be converted into in-spec biodiesel. One problem with this feedstock is the high amount of sulfur that originates from the raw material and must be distilled off at the end. A small-scale unit has produced the first amount of biodiesel, and the team has estab-

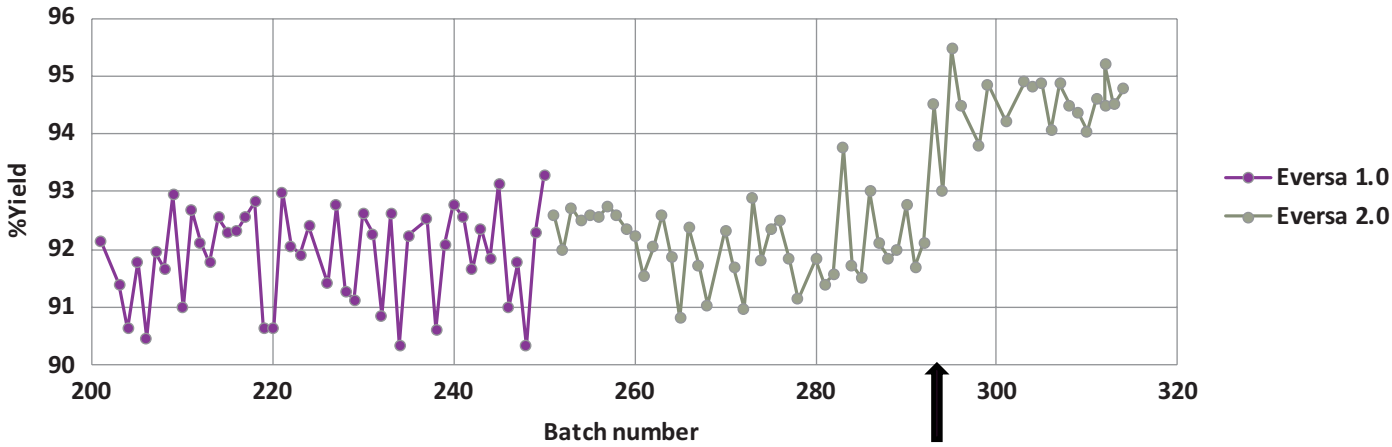

FIG. 5. Process data from Adkins Energy Ethanol plant illustrating the change of enzyme from Eversa Transform from 1.0 to 2.0, and the change of NaOH dosage in the polishing step from 1.7 equivalents to 1.15.

lished collaboration with the US Department of Agriculture to validate the full process, starting with the lowest quality oils from sewage systems to final biodiesel product [3]. In addition to the technological breakthrough in collecting and cleaning the FOG, the presenters discussed the downstream cleaning in which a resin-catalyzed FFA esterification process and a distillation technology are used to reduce the sulfur to less than 15ppm.

M. Cantele relayed the experience of Transfertech Gestão de Inovaçõs LTDA, Florianópolis, Brazil, in establishing enzyme-catalyzed biodiesel production. Transfertec specializes in innovation management and engineering that has converted a former chemical biodiesel plant to an enzymatic catalyst plant. The most important factor for a successful reaction is the pretreatment of the feedstock. Transfertec now has a simple method which includes an addition of a component that secures uniform performance of the enzyme reaction and which separates off impurities with the heavy phase at the end of reaction. By eliminating the use of water for up-stream washing/purification of the feedstock, they have reduced overall costs and complications. The production of biodiesel per the new process was on-stream in April 2017.

The large engineering company, Desmet Ballestra, was represented by G. Calliauw, who described the company's modular design of an enzymatic biodiesel plant. By modular, each plant is considered as a specific array of different "known" process unit operations and equipment (e.g., distillation, water washing, soap stock splitting, and so on.). This modular engineering approach is not only useful in designing specific customized production processes, but also makes it easier to integrate unit operations during retrofitting or additions at existing biodiesel plants. It also makes it possible to evaluate the contribution of each separate process module to the overall efficiency, performance, and cost of the overall enzymatic biodiesel process.

The operational cost sensitivity analysis shown in Figure 4 (page 25) is an example of this type of modular evaluation. The graph, called "a perturbation plot," visually demonstrates how

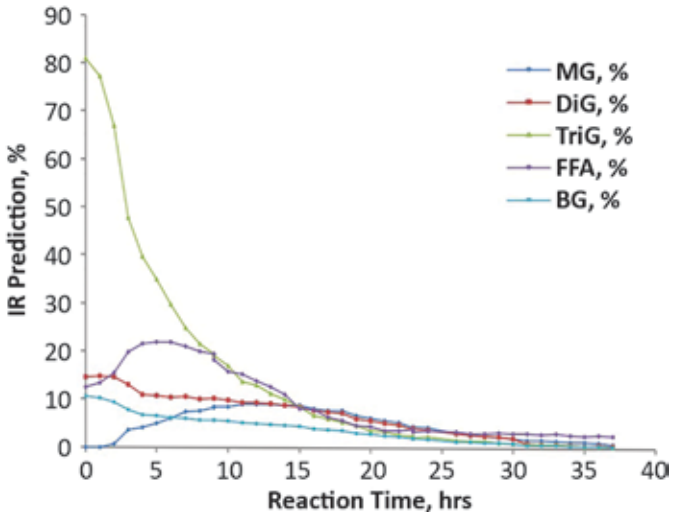

FIG. 6. Data from an enzymatic biodiesel reaction monitored by QTA FT-NIR showing the development over time for monoacylglycerol (MG), diacylglycerol (DiG), triacylglycerol (TriG), free fatty acids (FFA), and bound glycerin (BG)

a deviation of various operational costs (e.g., a 20% reduction in the steam unit price) affects the overall profitability of the plant. For the case-study that was presented, it was clear that the price of steam, electricity, and glycerol considerably less impact on the overall return-on-investment than the enzyme price. The most crucial parameter, however, is the cost differential between feedstock and finished biodiesel: Just a small variation can have a huge impact on a project's total balance sheet.

Process data from the large-scale operation of corn oil transesterification at a plant where corn oil is a by-product of bioethanol production was presented by A. Rancke-Madsen, Novozymes, Bagsværd, Denmark. Figure 5 shows how the yield increased from 92% to 94.5% when the NaOH dosage in the polishing step was lowered from 1.7 molar equivalent to the FFA content to 1.15 equivalents. The process data showed

no change in yield when changing the lipase from Eversa Transform from 1.0 to 2.0. It was mentioned that the total yield could be even higher if the soap stock from the polishing is neutralized and used as feedstock for the biodiesel reaction.

OBTAINING PROCESS DATA

One of the main challenges in the enzymatic biodiesel development has been to get reliable process data.

A very useful tool has been the use of the Fourier Transform Near Infrared (FT-NIR) instrumentation, which was discussed by K. Ma from Eurofins Analytical USA. The sample preparation for monitoring the process is simple. Centrifugation in a laboratory centrifuge enable drops of oils samples to be obtained and added to the instrument. The composition of glycerides/acylglycerols, FFA, and methanol content of each sample can be obtained in about one minute. Eurofins has developed calibrations curves for both the oil and the glycerol phase. The progression of the fats conversion into FAME can be tracked, so that the methanol concentration does not exceed the critical level that would prevent enzyme inactivation (Fig. 6). The methodology has been approved by AOCS as a standard method: Ck2-09 Solution for quality and process control in enzymatic biodiesel production.

The productions of biodiesel from low cost-feed stocks was documented as feasible during the session. The enzyme reaction seems very robust, provided pre-treatment has been done to prevent low pH and impurities in the reactors. The enzyme reaction must be followed by a process step to reduce the percent FFA in the crude biodiesel. Possibilities suggested by the speakers included an efficient caustic or resin wash, or enzyme-catalyzed esterification. The session revealed that process control has been established by a range of biodiesel producers.

References

1. Watanabe, Y., Y. Shimada, A. Sugihara, and Y. Tominaga, Enzymatic conversion of waste edible oil to biodiesel fuel in a fixed bed bioreactor, *J. Amer. Oil Chem. Soc.78*: 703–707, 2001.

2. Price, J., M. Nordblad, H.H. Martel, B. Chrabas, H. Wang, P.M. Nielsen, and J.M. Woodley, Scale-up of industrial biodiesel production to 40m3 using a liquid lipase formulation. *Biotech and Bioeng. 113*: 1719–1729, 2015.

3. Kotrba, R. http://biodieselmagazine.com/articles/2513233/enzymatic-biodiesel-project-under-development-in-georgia.

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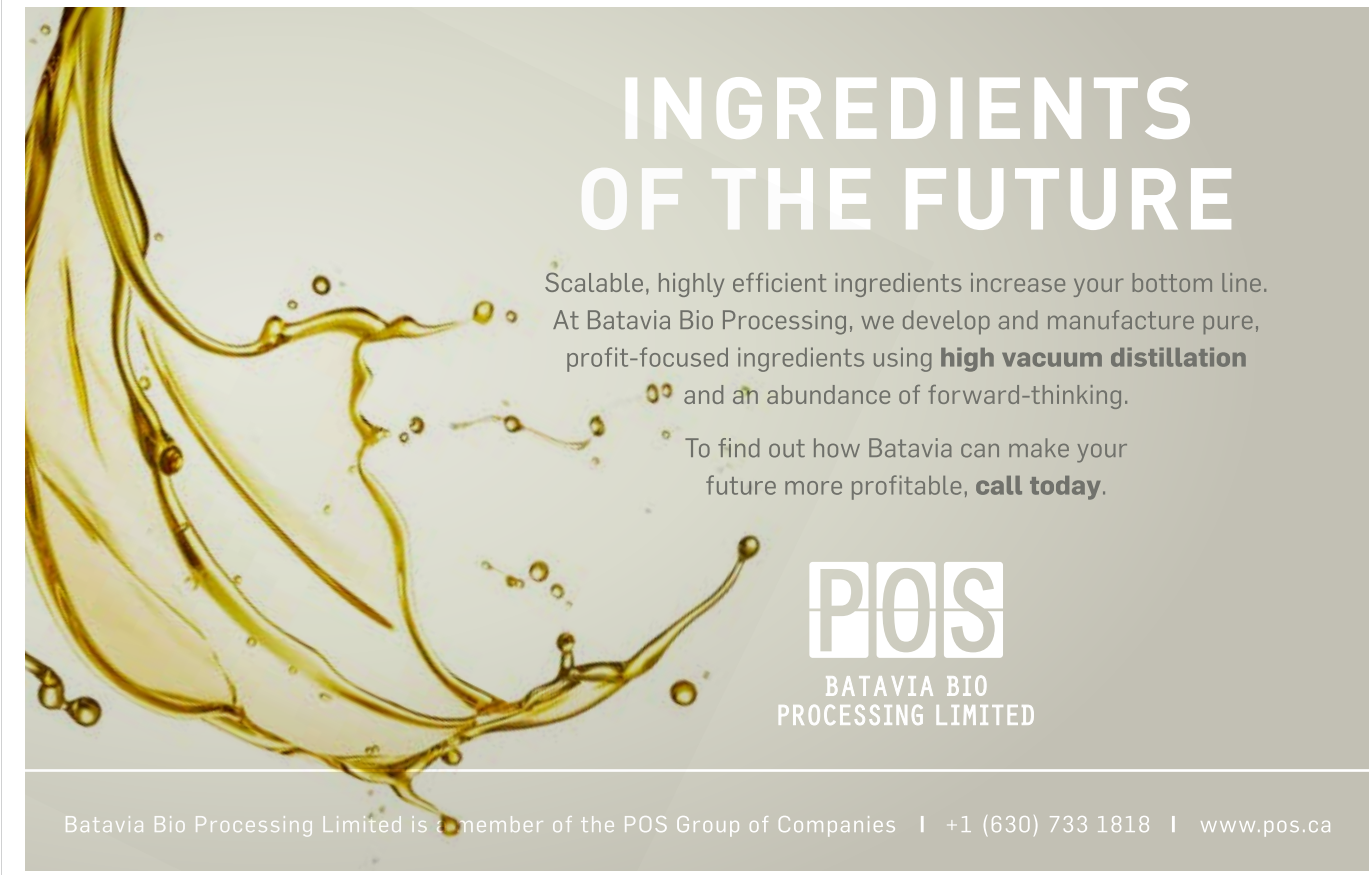

A *dulce de leche*-like product with the lipid profile of pecan oil

Natalia Ranalli, Silvina C. Andrés, and Alicia N. Califano

- *Dulce de leche* **is a concentrated sweetened milk product consumed widely throughout Latin America.**
- **Unfortunately, it is high in saturated fatty acids.**
- **This article describes a substitute made with emulsified pecan oil that tastes like the traditional milk-based confection but is low in saturated fatty acids and high in oleic and linoleic unsaturated fatty acids.**

Dulce de leche (DL), a concentrated sweetened milk product, is highly consumed in Latin America and exported to other countries, such as USA and Spain. DL is traditionally prepared by concentrating 3% w/v fat milk with sucrose and vanilla until ~70% total soluble solids is reached, obtaining a minimum fat content of 6% w/w. As DL is the most-consumed sweet spread in Argentina, particularly by children, it was an obvious candidate for substitution with respect to saturated fats.

The objective of this work was to improve the lipid profile of DL by replacing milk fat, which is high in saturated fatty acids (SFA), with pecan oil, which is high in unsaturated fatty acids (UFA), particularly 18:1 (52%), 18:2 (36%), y 18:3 (1.5%), leading to a DL-like product (pecan oil DL) with quality characteristics that resemble commercial DL.

Skim milk (0% fat) was first incubated with lactase at 4°C for 24 hours to reduce lactose content and subsequent crystal formation during storage. Afterward, adequate amounts of sucrose, glucose, and potassium sorbate were dissolved in the milk. At the same time, xanthan gum (0.1%) was dissolved in a milk aliquot, and enough pecan oil to reach a level of ~5% w/w in the final product was added, along with added tocopherols (1000 ppm) that had been pre-emulsified in another skim milk aliquot. The pecan oil DL was prepared at a La Plata University pilot plant and kept in 500g glass jars at 20ºC for 6 months.

DL with pre-emulsified pecan oil presented 65 °Brix of soluble solids, 33.6 (0.3) % w/w moisture content, and 0.845 (0.003) water activity, while color parameters were 38.7 (1.2), 8.9 (0.1), and 19.4 (0.6) for L*, a*, and b*, respectively. These results were in the range of com-

mercial products. The process yield was 30.4%, and according to the formula, its lipid content was 6.56% w/w, within the range of Argentinean and Brazilian commercial DL. However, as expected, the UFA level (89–90% w/w)—mainly consisting of oleic (C18:1 n-9 cis) and linoleic (C18:2 n-6 cis) acids—was higher, and the SFA level lower in the pecan oil DL lipid phase as compared to the FA profile of milk fat (Fig. 1). Therefore, the product presented a lower SFA/UFA ratio (0.1) with respect to the traditional product obtained with whole milk (2.1).

Pecan oil DL quality characteristics, such as physicochemical properties (aw, color, water content, crystal formation), lipid oxidation (TBARS), rheological behavior (steady state flow curves and linear oscillatory assays), typical lactose crystal formation, and microbial characterization were evaluated monthly during storage at 20°C. TBARS values remained constant for 138 days, showing an increase afterwards (Fig. 2). However, they were not associated with sensorial changes.

In spite of the high UFA content and its high oxidation susceptibility, UFA levels did not show significant differences ($P>0.05$) throughout storage, reflecting the antioxidant effect of the tocopherols and other natural compounds that were added to the product. Visual inspections showed that the pecan oil DL remained stable, with no oil phase separation. Moreover, in microscopic observations, no tomahawk-like shape crystals typical of **α**-lactose were detected, avoiding a characteristic defect that occurs in DL. This was probably due to a ~60% of reduction in milk lactose content after lactase activity.

The pecan oil DL obtained in the pilot-plant presented the pseudoplastic flow behavior typical of DL prepared with regular milk, and within the ranges of commercial DL (Ranalli, *et al*. 2012). Its rheological characteristics improved during storage due to small variations, which produced a firmer structure that favored oil/water (o/w) emulsion stability. Structure development is thought to involve not only casein micelles but also

whey proteins (especially if these have suffered a high degree of denaturation during thermal processing) and fat globules. Such changes could be associated with several modifications in the continuous phase (mainly hydration of milk proteins, carbohydrates, and xanthan gum) that could happen during storage and would increase the volume fraction of dispersed components.

Molds, yeast, and coagulase positive *Staphylococci* counts were lower than the detection limits of the methods (2 logCFUg^{-1}), indicating that thermal treatment and aseptic packaging were adequate to obtain a 6-month shelf-life.

Sensory analysis showed that more than 90% of panelists assigned more than seven points to all attributes, resulting in good product acceptability. The average scores were: 8.5 (0.1), 8.7 (0.1), 9.1 (0.1), and 8.4 (0.2) for general acceptability, texture, color, and taste, respectively. The pecan oil DL's caloric value was similar to traditional commercial DL. Taking the FA

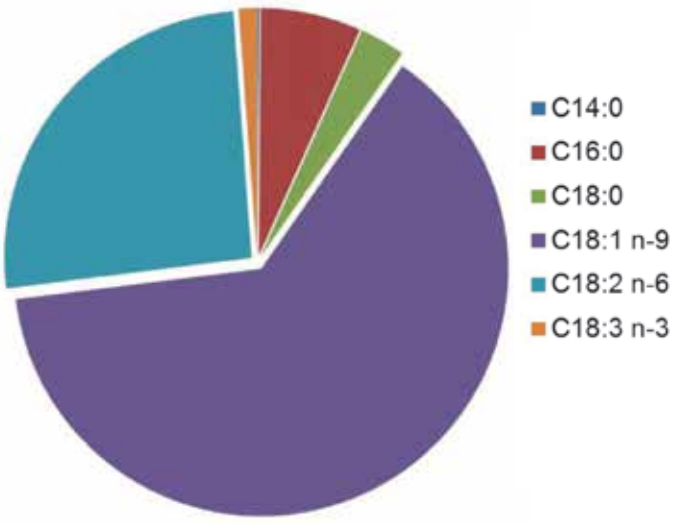

FIG. 1. Main fatty acids in pecan oil DL lipid phase

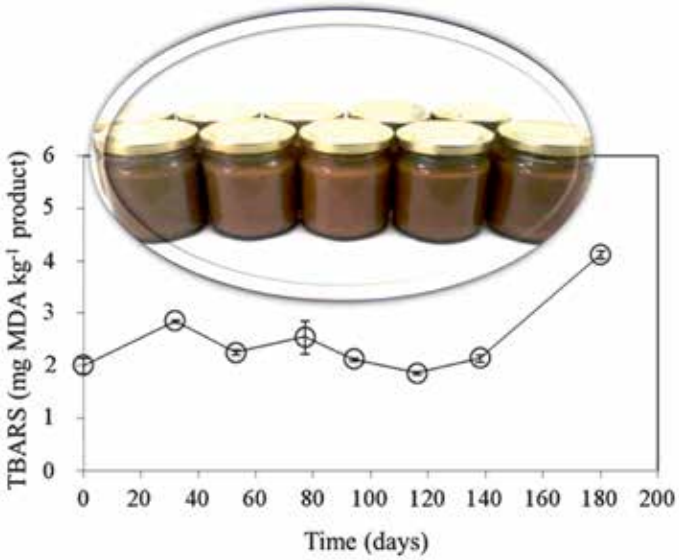

FIG. 2. TBARS evolution of pecan oil DL with added tocopherols (1000 ppm) during storage at 20 °C

profiles of Argentinean milk fat and pecan oil into account, it could be concluded that 100 g of pecan oil DL would have a 82.6% lower SFA and a 200% higher UFA content than a traditional product, and it was cholesterol free.

Natalia Ranalli received her PhD degree in 2105 from La Plata National University, La Plata, Argentina, where she currently works as an assistant in the College of Engineering. For eight years before earning her doctoral degree, she worked at CIDCA (Research and Development Center on Food Cryotechnology) on healthy and nutritious processed foods development through the modification and improvement of formulations and processes involved in traditionally consumed products. She has published over four peer-reviewed international papers and two book chapters, and presented at about a dozen national and international scientific meetings. Ranalli can be contacted at nataliaranalli@gmail.com.

Silvina C. Andrés is an adjunct professor in the College of Exact Science, Department of Chemistry, La Plata National University, where she earned her Ph.D. in biochemistry in 2001. In 2005, she joined the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET, Argentina) as a research scientist. Since 1994, she has worked in Food Chemistry and Technology at CIDCA, where she currently focuses on the physicochemical, nutritional, and sensorial quality of healthy food matrices over their shelf life. She has published over 20 peer-reviewed international papers, 5 book chapters, and 2 patents. Andrés has participated in 70 scientific meetings, presenting about 100 works.

Alicia N. Califano obtained her Ph.D. in Chemical Science in 1982 from the College of Exact Science, La Plata National University, La Plata, Argentina. That same year she became a research scientist at CONICET. Since 1989, she has worked as a full-time adjunct professor in the College of Exact Science, Department of Chemistry, La Plata National University. She has worked in Food Chemistry and Technology at CIDCA since 1977, and currently coordinates a food hydrocolloids group there. Her research focuses on design, processing, and preservation of food matrices with special nutritional characteristics, and the relationship between microstructural properties and food quality, food rheology, and food emulsions. During the last 15 years, Califano has directed or co-directed more than 15 scientific projects funded by the Ministry of Science and Technology of Argentina (MINCyT), National Council of Scientific and Technical Research (CONICET), and La Plata National University. She has published over 70 peer-reviewed international papers, 18 book chapters, and 2 patents, and has presented about 200 works at scientific meetings.

References

Ranalli, N., S.C. Andrés, and A.N. Califano, "Physicochemical and rheological characterization of "*dulce de leche*," *J. Texture Studies 43*: 115–123, 2012.

Dermal BPA: Study questions practice of combining oral and dermal exposures

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

Kelly Franklin

Risk assessors may need to revisit how they combine dermal and oral BPA exposure estimates, following a human study led by Jonathan Martin, professor of toxicological environmental chemistry at Stockholm University in Sweden.

"Some agencies consider both dermal and oral absorption together in risk assessments, by simply summing the estimated daily dose by each route. However, the data in our study raise potential deficiencies in that approach," Martin says.

BPA absorbed through the skin takes far longer to show up in blood and urine than dietary BPA, the study suggests.

Diet is the main human exposure route, but dermal exposure is also important. It is still not understood exactly how the body deals with BPA from this route.

Martin and his colleague Jiaying Liu from the University of Alberta, Canada, asked six volunteers to handle thermal paper receipts containing BPA labelled with deuterium. The volunteers later returned to eat a biscuit laced with BPA, at a level around ten times below that of the European Food Safety Authority's (Efsa's) temporary tolerable daily intake (TDI) of 4 micrograms/kg body weight/day.

Urinary BPA levels peaked within five hours after eating the biscuit and had completely cleared within 24 hours, while total BPA in the blood peaked within four hours. Following dermal exposure, however, total BPA was not detectable in blood until 22 hours later and could still be detected in urine after nine days.

Martin suggests that the time lag between dermal exposure and BPA detection may mean that levels are commonly underestimated, using current techniques. The differences in the way the body deals with dietary and dermal exposure also raise problems with summing exposures.

"The study appears to be well done, and provides useful data on a topic that has not been exhaustively studied," says

Steve Hentges, senior director of the American Chemistry Council's polycarbonate/BPA global group.

"BPA from dermal exposure is detoxified in essentially the same way as from oral exposure," he adds. "What's different is the pharmacokinetics that result from each route … The differences are important for an in-depth understanding of risk, but the differences by themselves are not an indication of risk. This also depends on exposure and, as indicated by this study, blood levels of BPA are very low."

In January, BPA was added to the REACH candidate list on the grounds that it has properties that are toxic to reproduction.

In June, Echa's Member State Committee agreed with a French proposal that BPA is also a substance of very high concern due to its endocrine disrupting properties.

Last year, the European Union banned BPA in thermal paper. At the European Commission's request, Echa is carrying out a survey on an alternative bisphenol, BPS, in thermal paper.

The study was published in *Environmental Science and* Technology (*Liu, J. and Martin, J.W., Environ. Sci. Technol. 51*: 9940–9949, 2017, http://dx.doi.org/ 10.1021/acs.est.7b03093).

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Coconut oil debate heats up

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

Laura Cassiday

In June 2017, the American Heart Association (AHA) issued a dire warning about saturated fat and the risk of cardiovascular disease (CVD). In an advisory published in the journal *Circulation*, the group reaffirmed decades-long advice to reduce the risk of CVD by replacing saturated fats (such as butter, lard, coconut oil, and palm oil) with unsaturated ones (for example, soybean, corn, and canola oils) (Sacks, F. M., ***et al.***, http://dx.doi.org/10.1161/CIR.0000000000000510). In the same report, the AHA issued a caution against the growing popularity of coconut oil, saying "because coconut oil increases LDL cholesterol, a cause of CVD, and has no known offsetting favorable effects, we advise against the use of coconut oil." But even if one accepts the premise that saturated fat is harmful and should be avoided (which is still up for debate; Cassiday, L., http://tinyurl.com/inform-fat-controversy, 2015), did the AHA unfairly target coconut oil?

Fabian M. Dayrit, professor of chemistry at Ateneo de Manila University, in the Philippines, and chairman of the Scientific Advisory Committee for Health in the Asian and Pacific Coconut Community, thinks so. Dayrit recently authored a response to the 2017 AHA advisory, entitled "How the wrong science is making people sick: the truth about saturated fat, animal fat, and coconut oil" (aocs.org/coconutoil, 2017). In this article, Dayrit notes that the AHA has lumped coconut oil together with animal fats in its warning against "saturated fat," although they have very different fatty acid profiles and cholesterol contents.

According to Dayrit, coconut oil is unique among saturated fats in its composition, containing about 63% medium-chain fatty acids (MCFAs)—fatty acids with chains of 6 to 12 carbon atoms (C6-C12). In contrast, the saturated fats in animal fats are mostly long-chain fatty acids (LCFAs), which have 14 to 18 carbon atoms (C14-C18). Beef fat and lard do not contain any MCFAs, whereas butter contains 9%. MCFAs are metabolized differently from LCFAs (Cassiday, L., http://tinyurl.com/coconut-oil-boom, 2016). LCFAs are typically assembled into complexes called chylomicrons, which circulate in the blood stream and accumulate as fat deposits in tissues. However, most MCFAs are not packaged into chylomicrons, but instead pass through the portal vein to the liver, where they are converted to ketone bodies and other metabolites.

Moreover, coconut oil contains very little cholesterol (0–3 mg/kg) compared with butter (2,150 mg/kg), beef fat (1,090 mg/kg), and lard (950 mg/kg) (Dayrit, F. M., aocs.org/coconutoil, 2017). Despite their classification as saturated fats, beef fat and lard contain about 60% unsaturated fatty acids, and butter about 33%, compared with coconut oil's 9% unsaturated fat. All of these properties place coconut oil in a distinct metabolic group from saturated animal fats, Dayrit contends.

Dayrit and others, including well-known science writer Gary Taubes (http://garytaubes.com/blog/, June 17, 2017), have accused the AHA of cherry-picking studies that support its anti-saturated-fat agenda, while ignoring those unfavorable to its position. In their advisory, the AHA researchers identified four clinical trials that satisfied their requirements of study design, execution, and adherence. They performed a meta-analysis of these four trials, concluding that replacing saturated fat from dairy and meat with polyunsaturated vegetable oil (primarily soybean) reduced CVD events by 30% (Sacks, F. M., *et al.*, http://dx.doi.org/10.1161/CIR.0000000000000510). The

AHA rejected several other studies, including the Minnesota Coronary Survey, that reached contrary conclusions. Dayrit notes that none of the four core studies selected by the AHA examined the effects of replacing coconut oil with unsaturated vegetable oils—they all dealt with animal fats. Nevertheless, the AHA extrapolated these findings on other saturated fats to coconut oil.

A surprising aspect of the AHA advisory is its complete dismissal of high-density lipoprotein (HDL) cholesterol as a cardioprotective factor. The advisory states that "changes in HDL cholesterol caused by diet or drug treatments can no longer be directly linked to changes in CVD, and therefore, the LDL cholesterol raising effect [of coconut oil] should be considered on its own" (Sacks, F. M., *et al.*, http://dx.doi.org/10.1161/CIR.0000000000000510). When ingested, coconut oil, like other saturated fats, raises serum levels of both LDL- and HDL-cholesterol. Elevated serum levels of LDL-cholesterol are a risk factor for CVD, while high HDL-cholesterol levels have been correlated with a reduced risk of heart disease. Because of these opposing effects, many cardiologists consider the ratio of total cholesterol to HDL-cholesterol (total:HDL) a more reliable measure of cardiovascular risk than total cholesterol or LDL-cholesterol alone (Cassiday, L., http://tinyurl.com/inform-fat-controversy, 2015). Whereas unsaturated fats lower total:HDL cholesterol, and trans fats raise the ratio, coconut oil and other saturated fats typically have a neutral effect.

On the other hand, drugs that artificially raise HDL-cholesterol levels in an attempt to treat or prevent heart disease have been largely unsuccessful. In addition, rare genetic mutations that cause extremely high serum levels of HDL-cholesterol actually increase the risk of heart disease (Cassiday, L., http://tinyurl.com/inform-HDL, 2016). Although the relationship between HDL-cholesterol and CVD is obviously complex, it seems premature for the AHA to completely dismiss HDL-cholesterol as a cardioprotective factor, despite much observational evidence to the contrary (e.g., the Framingham Study).

Dayrit disputes the AHA's assertion that coconut oil should be viewed only in terms of its LDL-cholesterol-raising properties, and that the oil has "no known offsetting favorable effects." He points toward the overall good cardiovascular health of Pacific Islanders who consume coconut flesh, cream, and oil on a daily basis. "The AHA is obviously unaware of the numerous published studies that document how Pacific island inhabitants shifted from a coconut diet to a Western diet and became more prone to heart disease and obesity," he says. "The AHA wants us to miss the forest for the trees: There is no evidence that coconut oil causes heart disease; instead, they want to focus only on LDL."

Indeed, the AHA admits that clinical trials examining direct effects of coconut oil on CVD have not been reported. A recent literature review of 21 observational and intervention studies concluded that coconut oil raises LDL-cholesterol more than unsaturated plant oils, but less than butter (Eyres, L., http://dx.doi.org/10.1093/nutrit/nuw002, 2016). Effects of coconut oil on HDL-C and total:HDL were inconsistent, and often not reported. The observational studies did not reveal any increased risk of CVD outcomes for people who consume coconut (flesh, cream, milk, or oil) in the context of traditional dietary patterns. "However, due to large differences in dietary and lifestyle patterns, these findings cannot be applied to a typical Western diet," the researchers say.

Eyres and colleagues also dispute the classification of coconut oil as a medium-chain triglyceride oil. Coconut oil is composed of about 50% lauric acid (C12:0), which some researchers view as intermediate between MCFAs and LCFAs (Eyres, L., http://dx.doi.org/10.1093/nutrit/nuw002, 2016). Studies indicate that about 25–30% of lauric acid is absorbed directly into the portal vein, compared with 95% of C6-C10. "In recent years, numerous claims on websites and in the commercial literature have likened coconut oil to medium-chain triglycerides, asserting that it behaves atypically compared with other foods high in saturated fat and is beneficial for human health," the researchers say. However, coconut oil contains neither predominantly C6-C10 MCFAs, nor medium-chain triglycerides, and therefore has similar metabolic effects as other saturated fats, Eyres and colleagues contend.

But Dayrit and others worry that the AHA's recommendation to replace saturated fats such as coconut oil with polyunsaturated, omega-6-rich vegetable oils such as soybean may have negative public health consequences. In the United States, the ratio of omega-6 to omega-3 fatty acid consumption is already 15:1, whereas international health agencies suggest keeping the ratio below 5:1. High ratios of omega-6 to omega-3 fatty acids have been linked with CVD, cancer, and other inflammatory diseases. If Dayrit and others are correct, the AHA may be inadvertently increasing the risk of the very disease they seek to prevent.

Olio is produced by Inform*'s associate editor, Laura Cassiday. She can be contacted at laura.cassiday@aocs.org.*

*Inform*ation

Cassiday, L. (2015) "Big fat controversy: changing opinions about saturated fat." *Inform*, June 2015, 342–349, 377. http://tinyurl.com/inform-fat-controversy.

Cassiday, L. (2017) "Coconut oil boom." *Inform*, May 2016, 6–13. http://tinyurl.com/coconut-oil-boom

Cassiday, L. (2016) "When high HDL cholesterol isn't 'good.'" *Inform*, May 2016, 28–29. http://tinyurl.com/inform-HDL

Eyres, L., *et al.* (2016) "Coconut oil consumption and cardiovascular risk factors in humans." *Nutr. Rev. 74*, 267–280. http://dx.doi.org/10.1093/nutrit/nuw002

Sacks, F. M., *et al.* (2017) "Dietary fats and cardiovascular disease: a presidential advisory from the American Heart Association." *Circulation 136*, e1–e23. http://dx.doi.org/10.1161/CIR.0000000000000510.

Taubes, G. (2017) "Vegetable oils, (Francis) bacon, Bing Crosby, and the American Heart Association." http://garytaubes.com/blog/, June 17, 2017.

Brazil: largest LATAM biscuit market, by volume

Leslie Kleiner

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

Sweet and savory biscuits usually contain fats and/or oils, and are widely consumed in many regions of the world. Sweet biscuits generally include sandwich, meringue, and chocolate covered cookies, among other varieties. Savory biscuits, on the other hand, include butter, soda, cream, and cheese crackers. To learn about the biscuits market segment globally—and more specifically in LATAM—I consulted a recent report from global market intelligence agency Mintel. The report, "Category insight: biscuits, cookies and crackers," was written by Senior Innovation Analyst Amrin I.A Walji. The following Q&A is extracted from this report.

Q: Indulgence is a key driver for the sweet biscuit category, but what does "indulgence" really mean?

In 2017, indulgence has largely been driven by innovative textural and flavor combinations. For example, in the United States, 66% of sweet biscuit consumers described indulgence as biscuits containing dark chocolate, caramel, nuts, and/or biscuits made from artisanal recipes. Between May 2016 and May 2017, the top flavors in global sweet biscuit innovations were chocolate (15%), plain (11%), and butter (5%); these flavors were associated with crunchy (16%), smooth (4%), and soft (3%) textures. The parameter of texture been used to describe indulgence. For example, in the United Kingdom, Mondelez launched Cadbury Roundie, a wafer with chocolate cream and chocolate coating that is said to provide "moments of joy through its unique texture."

In an effort to promote a more luxurious image for their brands, companies may evoke the idea of indulgence by specifying ingredient sources and sophisticated flavors. Claims that brands are "naturally healthy" or made of "real food ingredients" help position such brands as "permissible indulgences," and justify consumer decisions to indulge in products that are traditionally characterized as "not good for you." In this sense, because smaller portion options and "better for you" varieties give consumers permission, they continue to emerge.

Examples of newly launched products in the global market include dessert-flavored cookies, such as Nabisco Oreo

Blueberry Pie Flavor Cream Sandwich Cookie (United States), Nabisco Chips Ahoy! Red Velvet Filled Soft Cookies with Cream Cheese flavored chips (Mexico), and Super Green Me Spirulina Mini Cookies with Cranberry containing spirulina, a green-blue micro-algae naturally rich in proteins, iron, magnesium, and vitamin B12 (France).

Q: Regarding biscuits, what are key points for LATAM markets?

In LATAM biscuit markets, innovation, fortification, and fruit flavors are of most interest.

Innovation is seen in both sweet and savory biscuits, with the savory market segment having more room for new product development and growth in the region. For the May 2016–April 2017 period, 19% of the savory and 81% of the sweet biscuits in LATAM were new product developments.

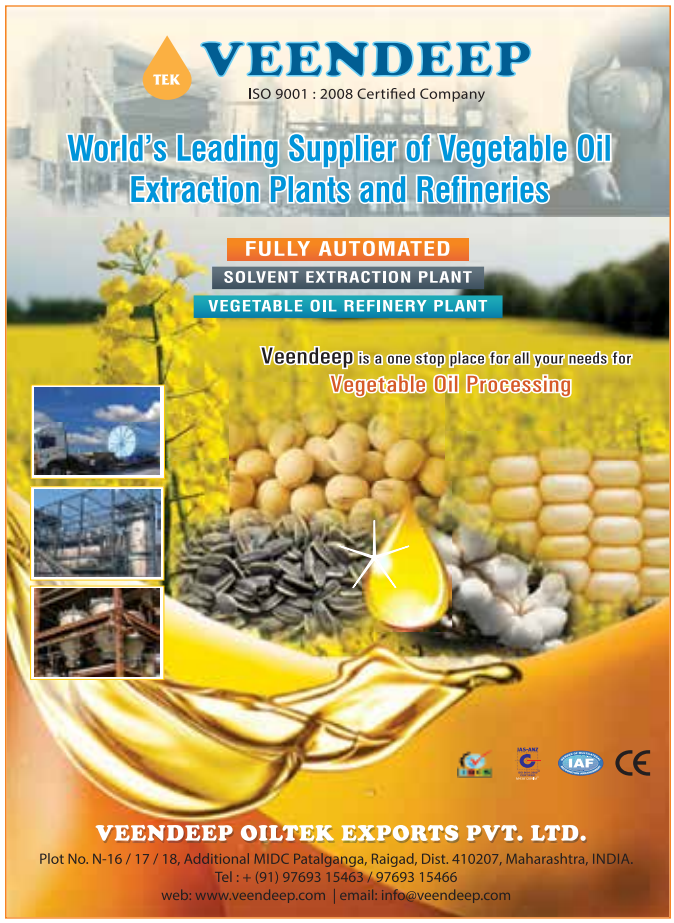
In both sweet and savory biscuits there has been an increase in vitamin and mineral fortification. Due to this increase, the percentage of biscuits with fortification claims in LATAM is twice that of the global average (2% globally, 4% LATAM). Fortification can lead to more growth in this region, since consumers are interested in healthier options. In fact, 44% of Brazilian consumers reported interest in fortification ranging from minerals and vitamins to protein and fibers. Examples of fortified products recently launched in LATAM include Wal-Mart Great Value Orange Flavored Cookies enriched with vitamins B1, B2, niacin, and folic acid, as well as iron (Mexico); Nestlé Passatempo Strawberry Filled Sandwich Biscuits, which are aimed at children, are a source of energy, and contain added calcium and zinc (Brazil); and PepsiCo Quaker Whole Grain Crackers with Seven Grains, which are fortified with iron, folic acid, and vitamin B12 (Colombia).

During this same time period, fruit and citrus were the most popular flavors, comprising 8% of product launches in LATAM, compared to 6% globally. Some popular flavors include: orange, lemon, guava, raisin, apple, banana, and lime, while some products use alternatives such as natural fruit juice, fruit pulp, or dried fruit. Some fruit-flavored products launched recently include Jumbo Oatmeal Cookies with Tropical Fruits, which are made of papaya, glazed orange, and dried banana sandwiched between composed of banana- and vanilla-flavored sweet oat biscuits (Argentina); and Bagley Arcor Cereal Mix Apple Filled Biscuit Bars containing wheat, oat bran, and quince pulp (Argentina). Uniquely sourced ingredients are also of importance in the region. Examples of new launches with unique ingredients are Jasmine Suply Sem Glúten Wholegrain Açai and Chia Cookies made with Açai (purple skin fruit with antioxidants) and chia (Brazil), and CHE Alfajor Artesanal Mini Sandwich Cookies with White Chocolate Coating, which are *dulce-de-leche*-filled alfajores covered in white chocolate and 100% handmade. The recipe for the alfajores are said to be the best recipe from Río de Plata with the best Ecuadorian chocolate (Ecuador).

Q: What is the biscuit consumption, by volume, in LATAM?

By volume, Brazil is the largest biscuit market, with an annual per capita consumption of 8.2kg/person/year. Brazil represents an important market for this category since, based on sales, it has grown at an average rate of 10% in recent years. However, Chile's biscuit market grew at an annual rate of 11.6% over the last five years (volume consumption per capita for the region during this time was 6.0kg/person/year). Following Brazil and Chile are Mexico and Colombia, which also have steady average growth in this segment and offer opportunity for further development.

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.



Earl G. Hammond (1926–2017)

Giants of the Past pays tribute to members who have made a significant impact on AOCS or who have attained considerable stature in the areas of oils, fats, surfactants, proteins, and related materials.

Gary R. List

Earl G. Hammond was born on November, 21, 1926, in Terril, Texas, USA. He received BS and MS degrees in biochemistry from the University of Texas. In 1946, while he was attending the U of Texas, he was called into the US Army and served one year. He returned to Texas and, while working on his MS, met his future wife, Johnie Wright, at the University Baptist Church. After a long courtship, the two were married on September 17,1951.

Earl went on to earn a PhD in biochemistry from the University of Minnesota, where he studied under professor Walter O. Lundberg. The Hammonds then moved to Ames, Iowa, where Earl took a position at Iowa State University. There, Earl began a long and productive career in fats and oils that spanned over 50 years. During that time, he received numerous honors for his research, including the Alton E. Bailey, Stephen S. Chang, and Supelco AOCS Research awards from AOCS, as well as election to the first class of AOCS Fellows in 1998. He was awarded an honorary doctorate from the University of Olsztyn in Poland, as well as an Honorary Medal from the University of Agriculture and Technology in Olsztyn, Poland. In recognition of his research on soybeans, he along with agronomist Walter Fehr were awarded a Utilization Award by the American Soybean Association.

Earl authored about 260 publications and patents. He was a highly cited author with more than 4,000 citations (h index 34, g index 57, publish or perish). His research encompassed virtually every area of lipid science, including glyceride structure, autoxidation, dairy foods, flavor chemistry, edible fats and oils, biofuels, enzymology, and plant biochemistry.

His most important contribution involved changing the fatty acid composition of soybean oil. Soybean oil was considered to be a low-saturate, high-polyunsaturated oil, and desirable from a nutritional point of view. The oil performed well in low-temperature applications, such as salad dressings, mayonnaise, margarines and spreads, and shortening components. However, soybean oil contains 7–8% highly unstable linolenic acid which, upon heating to frying temperatures, imparts disagreeable odors described as “painty” or “fishy.” Thus, many efforts to remove linolenic acid were made, including fractionation, catalytic hydrogenation, and plant breeding—all of which were only partially successful on a commercial scale.

An early publication from the US Department of Agriculture, National Center for Agricultural Utilization Research Laboratory (USDA NCAUR) in Peoria, Illinois, USA, showed that while some reduction in linolenate by plant breeding was possi-

ble, a content of 3% or less was needed for heavy-duty industrial frying. In the early 1980s, Earl Hammond teamed with agronomist Walter Fehr to conduct studies aimed at changing the fatty acid composition of soybean oil. By the late 1980s, their efforts bore fruit, and the target of 3% linolenic acid was reached. Considerable interest was aroused, and by the early 1990s a low-linolenic acid soybean oil reached the market. Despite annual sales of $500 million, the oil was discontinued. The costs of grower premiums and identity preservation during harvesting and processing were a deterrent, and food companies were unwilling to pay the added price for a niche oil. The technology was ahead of its time. By 1999, trans fats had become the target for nutrition labeling, and by 2003 had become federal law. The food industry had about three years to find replacements for trans fats. Accordingly, low-linolenic soybean oil was sought by the food industry. In fact, by 2005, KFC (Kentucky Fried Chicken) had contracted to purchase 100 million pounds to supply 5,600 stores across the nation. While further improvements have been made to trait-modified oils, including low-linolenic mid/high-oleic soybean, canola, and sunflower oils, the pioneering work of Hammond and Fehr was vital. Today, trait-modified oils furnish over 20% of domestic needs.

Hammond's work on trait-modified oils is documented in 23 US Patents. Low- and zero-linolenic soybean oils are only a part of the work carried out at Iowa State. A number of lines with modified saturated acid content were identified, including a high-palmitic, a high-stearic, and a high-palmitic /stearic variety—all of which have shown promise as trans-fat replacements in soft margarines and spreads.

Earl Hammond was a quiet, modest, unassuming person with a dry sense of humor. I first met him in 1967 at the AOCS meeting in Chicago, and he was the first person I was introduced to. Much later I told him about our meeting, and he said, "I'm sure it was a momentous occasion." Earl left a great legacy. A number of his graduate students have become top scientists in industry and academia.

Recognition came late to Earl Hammond. His first major award, the 9th AOCS Stephen S. Chang award for decisive accomplishments in research for the improvement or development of products related to lipids, came in 1992 at the age of 66. He remarked that he wondered if he would ever get an award. However, he was considered to be his own best critic of his work. A year later, he received the 2006 AOCS Alton E. Bailey Award for outstanding research and exceptional service in the field of lipids and associated products. In 2006, he received the prestigious Supelco AOCS Research award for outstanding original research in fats, oils, lipid chemistry, or biochemistry. His address was entitled "Confessions of an unfocused professor," in which he described how his career was shaped by grant money. Dairy chemistry was a favorite research area in which he was recognized with an American Dairy Science Association Pfizer, Inc. award in cultured and fermented foods.

Earl and his wife enjoyed traveling about the world with their many grandchildren. The Hammonds have two sons, two daughters, 11 grandchildren, and six great-grandchildren. Earl shared his passion for science with his family with gifts of chemistry sets and microscopes. Earl was promoted to University Professor and retired officially in January 2003, but he continued to do research and work with students until 2014. He derived much satisfaction from mentoring young students and helping them to succeed. Earl Hammond was a true gentleman and scholar. His willingness to offer advice to many in the fields of fats, oils, and lipids was widely acknowledged by AOCS members. He regularly attended AOCS meetings, in the last few years, with help of a motorized scooter. In 2008, an AOCS symposium was held to honor his many contributions the profession. A number of former students presented papers and personal reflections. All were grateful for his leadership, council, and advice. To say he was held in high esteem would be an understatement.

Earl was passionate about the welfare of the poor, and was actively engaged in finding affordable housing for low-income families. He was a founding member of the Story County and Ames Ecumenical housing foundation, and was active in his church, where he was a teacher for many years. He loved music and played recorder for small groups. His wife, Johnie, was active in politics, serving as a state legislator. Gary R. List, is an AOCS Fellow and associate editor of the AOCS Lipid Library®. He can be contacted at grlist@telestar-online.net.

Notes and Further reading

Summaries of Earl Hammond's career can be found at the AOCS Lipid Library® (www//lipid library.org/history).

Earl Hammond's patents on trait modified soybean oils are listed by number as follows: US 5 516.980, 5 530 183, 5 534 425, 5 557 037, 5 585 535, 5 602 311, 5 684 230, 5 684 231, 5 710 369, 5 714 668, 5 714 669, 5 714 670, 5 714 672, 5 750 844, 5 750 845, 5 570 846, 6 060 647, 5 986 116, 6 025 029, 6 133 509.

Appointments at Iowa State University: 1953–1959 (Assistant Professor), 1959–1966 (Associate Professor) 1985–1990 (Head Food Technology) 1966–1996 (Professor) 1997–2003 (University Professor) 2003–2017 (University Professor Emeritus)

E.G. Hammond, "Confessions of an unfocused research professor," *Inform 17*: 448–450, 2008

AOCS awards: *Inform 3*: 1,288, 1992; *Inform 4*: 426, 1993

Book Chapters:

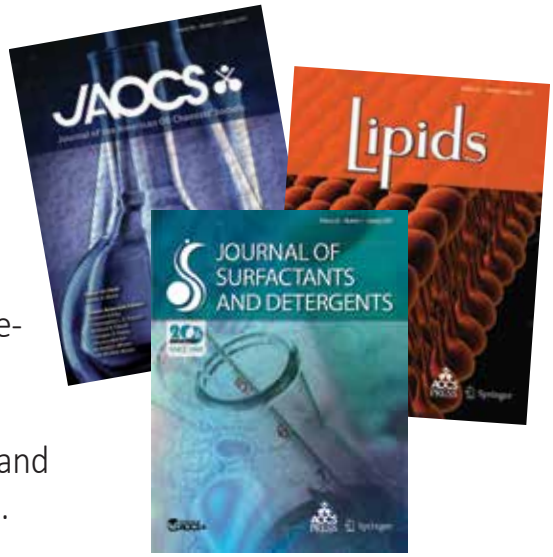
E.G. Hammond, L.A. Johnson, C. Su, T. Wang, and P.J. White, "Soybean Oil" (2005) In *Bailey's Industrial Oil and Fat Products* 6th Ed. (Ed. F. Shahidi)

Earl Hammond, "Filled and artificial and altered milk fats" (2006) In *Modifying Lipids for use in Foods* Ed. F. Gunstone, Woodhead Publishers

E.G. Hammond, "Edible oils from herbaceous crops" (1994) In *Technological Advances in Improved and Alternative Crops* Ed. B.S. Kamel, Blackie and Sons

Publishing advice from journal editors and their counterparts

Beginning in January, AOCS members will receive free online access to the Society's journals as a new benefit of membership. The process for submitting an article will still be done through ScholarOne; however, there will be a few changes to the process. If you have published with *JAOCS, Lipids*, or *JSD* in the past few years, Wiley will be in contact with you via email to explain these changes. Meanwhile, whether you are an experienced, applied, emerging, aspiring, or incidental author, it is always important to improve your peer-review and publishing skills. The following editorials by AOCS journal editors-in-chief and their counterparts will help you optimize your next submission.



Dear authors: We do read your cover letters

James A. Kenar, Editor-in-Chief, *J. Am. Oil Chem. Soc. 93*: 1171–1172, 2016, https://link.springer.com/article/10.1007/s11746-016-2889-3

So you want to publish in *Lipids*

Eric J. Murphy, Editor-in-Chief, *Lipids 52*: 383–384, 2017, https://link.springer.com/article/10.1007/s11745-017-4255-0

Is tweeting important for technical writing? absolutely

Eric J. Murphy, Editor-in-Chief, *Lipids 51*: 653–653, 2016, https://link.springer.com/article/10.1007/s11745-016-4152-y

The importance of ethical peer review

Eric J. Murphy, Editor-in-Chief, *Lipids 50*: 1165–1166, 2015, https://link.springer.com/article/10.1007/s11745-015-4094-9

Are you a good citizen of science?

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Citations: the rules they didn't teach you

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Jonathan V. Sweedler, *Anal. Chem. 89*: 4329–4329, 2017, http://pubs.acs.org/doi/full/10.1021/acs.analchem.7b01206

Is paid peer review a good idea?

Sneha Kulkami, editage.com
https://www.editage.com/insights/is-paid-peer-review-a-good-idea

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Prashant Kamat, *J. Phys. Chem. Lett. 5*: 2118–2120, 2014, http://pubs.acs.org/doi/full/10.1021/jz500997e

The experimental section: the key to longevity of your research

Jillian M. Buriak and Brian Korgel, *Chem. Mater. 26*: 1765–1766, 2014, http://pubs.acs.org/doi/full/10.1021/cm500632c

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PATENTS

Certain dimers as crystallization depressants

Narine, *et al.*, Trent University, US9637698, May 2, 2017

This application relates to certain dimers as crystallization depressants for biodiesel fuels, and methods for making the same. Such dimers, due to their particular structure and conformation, disrupt the regular packing of linear saturated fatty acid methyl esters, thereby delaying nucleation and mitigating crystal growth. In some embodiments, the dimer includes (E)-1-(1-(oleoyloxy)-3-(stearoyloxy)propan-2-yl) 18-(1-(oleoyloxy)-3-(stearoyloxy)propan-2-yl)octadec-9-enedioate.

Feed processing using salts of fatty acids

Mommer, Jr., *et al.*, Uniscope, Inc., US9642380, May 9, 2017

Methods for using water-soluble salts of fatty acids alone, or in chosen combinations with chelating agents, antifreeze compounds, and water for improving the processing of feed materials including whole grains or finely-divided ingredients, which may contain grain, that are mechanically processed, are described. The fatty acid salts may be added to water or to steam prior to application to feed materials, and may be applied directly to the feed materials, or added to grain conditioners known in the art to improve their performance. Treated feed materials have improved lubricity, and thin, strong durable flakes having less bulk density, and durable hard pellets, may be generated with reduced fines. Addition of an anti-freeze material permits the resulting compositions to remain fluid under freezing conditions, while oxidation or spoilage, may be reduced by adding a chelating agent. The solutions are basic and are non-corrosive.

Use of a combination of at least one polyunsaturated fatty acid and at least one carotenoid, for improving the quality of the nails

Piccardi, *et al.*, Nutricos Technologies, US9642786, May 9, 2017

The invention relates to the oral cosmetic use of a combination of active agents comprising at least one polyunsaturated fatty acid and at least one carotenoid, for improving the quality of the nails. More particularly, the present invention relates to the oral cosmetic use of such a combination for improving the solidity of the nails and for reducing and/or preventing their splitting.

Oil-based pesticidal suspension

Sano, *et al.*, Ishihara Sangyo Kaisha, Ltd., US9642357, May 9, 2017

To provide an oil-based pesticidal suspension which suppresses foaming at the time of preparation of a spray liquid by an organic silicone type surfactant, and which has excellent pesticidal activity with a small amount of an agricultural chemical. The present invention provides an oil-based pesticidal suspension comprising (1) flonicamid or its salt, (2) an organic silicone type surfactant, and (3) at least one oil-based diluting agent selected from the group consisting of a vegetable oil and its alkylated oil, and a method for controlling pests, which comprises applying the oil-based pesticidal suspension to the pests or to a place where they grow.

Method for encapsulation of an edible oil, compositions comprising edible oil and the use thereof

van Seeventer, *et al.*, Friesland Brands B.V., US9649611, May 16, 2017

The present invention relates to a method for encapsulation of an edible oil using whey protein and a reducing sugar. The edible oil comprises long-chain polyunsaturated fatty acids. Also compositions comprising an edible oil obtainable by the method of the invention are provided. The compositions of the invention have good stability to oxidation, good taste and/or odor, and limited diffusion from and into the continuous phase when applied in liquids. The compositions of the invention are particularly suitable for food and pharma applications.

Aerated fat-based confectionery

Utsunomiya, *et al.*, Meiji Co., Ltd. US9648893, May 16, 2017

Disclosed is an aerated fat-based confectionery that, unlike a conventional shell-type or tapered shape, has a novel shape, that is, a cubic or rectangular parallelepiped shape having top, bottom, and side surfaces in contact with and perpendicularly to each other, or any shape such as an animal or flower shape having a given thickness, has a light texture and a sharp melt-in-the-mouth sensation, does not require alignment in packaging. The confectionery can be obtained by aerating a fat-based confectionery mass having a fat content of 30 to 60% by weight such as chocolate to a specific gravity of 0.5 to 1.0 and cutting the aerated mass with a heated wire so that the side surface is perpendicularly to the top and bottom surfaces.

Inhibitor of visceral fat loss in Parkinson's disease patients

Terada, *et al.*, The Nisshin Oillio Group, Ltd., US9649288, May 16, 2017

An inhibitor of visceral fat loss is capable of suppressing body weight loss peculiarly found in Parkinson's disease patients. The inhibitor of visceral fat loss in Parkinson's disease patients of the present invention contains a lipid obtained by subjecting a medium-chain triglyceride that includes as a constitutive fatty acid at least one of a saturated fatty acid having 8 carbon atoms and a sat-

urated fatty acid having 10 carbon atoms to a transesterification reaction with a vegetable oil. The lipid is preferably obtained by subjecting the medium-chain triglyceride to a transesterification reaction with the vegetable oil at a ratio of 10:90 to 20:80.

Emulsion whippable at room temperature

Dombree, *et al.*, Puratos N.V., US9648895, May 16, 2017

The present invention relates to an oil-in-water emulsion for whipped cream and to a whipped cream obtained by whipping the emulsion. In particular, the present invention relates to a stabilized whippable oil-in-water emulsion upon increasing the trilaurin triglyceride content of its oily phase, and to the stabilized cream obtained by whipping the emulsion. The present invention further relates to the methods for obtaining this emulsion and this cream, and to the uses of an oil-in-water emulsion according to the invention or of the stabilized cream according to the invention.

Hard butter

Homma, *et al.*, KAO Corp., US9648894,

Provided is a hard butter, comprising 55 mass% or more of diacylglycerols satisfying the following (1) and (2): (1) 70 to 99 mass% of a disaturated diacylglycerol (SS) in the diacylglycerols; and (2) 55 mass% or less of a total content of saturated fatty acids having 16 and 18 carbon atoms in constituent fatty acids of the diacylglycerols.

Methods and systems useful for foodborne pathogen detection

Ladisch, *et al.*, Purdue Research Foundation, US9651551, May 16, 2017

Described are methods and systems useful in the processing of food samples to detect pathogenic cells in the samples. Embodiments include homogenizing a food sample, digesting solids of the homogenized food sample, and removing lipids from the homogenized food sample. Cells in the sample can then be concentrated using hollow fiber membrane filtration. Regeneration cycles can enable multiple reuses of the hollow fiber membrane filter. Systems and processes herein can be automated, under the control of a computer.

Lecithin or lecithin preparation having resistance to heat discoloration and a method for producing the same

Fujimoto, *et al.*, Tsuji Oil Mills Co., Ltd., US9650398, May 16, 2017

To provide a lecithin or lecithin preparation of which resistance to heat discoloration is achieved without significant change of the phospholipid composition of the lecithin nor of the oligosaccharide content; and a method for producing the same. A lecithin or lecithin preparation obtained by bringing a lecithin into contact with an adsorbent and removing the adsorbent, the lecithin or leci-

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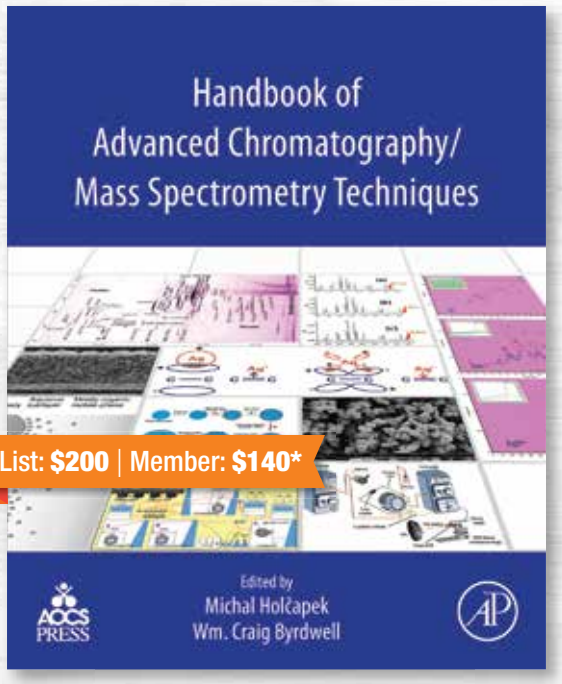

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thin preparation having resistance to heat discoloration and having an oligosaccharide content being 50% by mass or more of the content before the contact with the adsorbent.

Compositions for external application, containing adenosylcobalamin for improvement of skin diseases

Shin, *et al*., Korea Research Institute of Chemical Technology, Hanall Biopharma Co., Ltd., US9655916, May 23, 2017

The present invention relates to a composition for external application for improving a skin disease (e.g., psoriasis). The composition contains adenosylcobalamin (coenzyme B12), optionally in admixture with other cobalamins. The composition can be present in the form of liposomal preparations, which are made of a phospholipid and cholesterol.

Colorant neutralizer

MacDonald, *et al*., Kimberly-Clark Worldwide, Inc., US9657257, May 23, 2017

A composition for a medium that can discharges organic unsaturated colorant molecules that may stain is described. The composition can quickly and effectively neutralize a discoloration that results from, in particular, blood or blood-based, ink, or grease stains. The composition can remove the stain within, typically about 20–30 minutes, and can achieve color contrast of a Delta E value of about 15–20 or greater. The composition can be adapted for different uses and embodied in various cleaning, stain-fighting, cosmetic, personal hygiene, or medical products.

Process for production of low-saturate oils

Dayton, Bunge Global Innovation LLC, US9657319, May 23, 2017,

Provided here is an enzymatic process for production of low-saturate oil, in one embodiment, low-palmitic oils from triacylglycerol sources. The enzymes used in the processes herein are saturase enzymes, including palmitase enzymes. The oils produced by the processes herein are used in food products.

Personal care composition comprising a pre-emulsified formulation

Carter, *et al*., The Procter & Gamble Company, US9655821, May 23, 2017

The present invention is directed to a personal care composition comprising a pre-emulsified emulsion comprising from about 0.25% to about 80% of one or more materials selected from the group comprising metathesized unsaturated polyol esters, sucrose polyesters, fatty esters with a molecular weight greater than or equal to 1,500 and mixtures thereof or, by weight of said hair care composition; wherein an emulsifier is selected from the group consisting of anionic, non-ionic, cationic, amphoteric and mixtures thereof wherein the average particle size of the pre-emulsified emulsion is from about 20 nm to 20 μ from about 5% to about 50% of one or more anionic surfactants, by weight of said hair care composition; at least about 20% of an aqueous carrier, by weight of said hair care composition wherein the composition is stable with respect to one of the following measures selected from emulsion particle size, viscosity, or visual phase separation and mixtures thereof.

Coating composition for the protection of complex metal structures and components used in submerged environments

Fink, *et al*., Oxifree Global Ltd., US9657180, May 23, 2017

A coating composition for application to a subsea component or structure has cellulose acetate an amount of approximately 47% by weight of the total composition, diisooctyl phthalate in an amount of approximately 17% by weight of the total composition, a fatty acid ester in an amount of approximately 23% by weight of the total composition, a vegetable oil in an amount of approximately 8% by weight of the total composition, a stabilizer and a silica amorphous in which the stabilizer and the silica amorphous are in amount of approximately 5% by weight of the total composition. The stabilizer can be either titanium dioxide or aluminum dioxide. The vegetable oil is canola oil.

Process for preparing an oleogel

Ergun, *et al*., Dow Global Technologies LLC, US9655376, May 23, 2017

A continuous process for preparing an oleogel from ethylcellulose and an oily feed material, wherein the process comprises: (a) feeding ethylcellulose to the feed zone of an extruder, the extruder having a plurality of oil feed ports along its length; (b) feeding at least one oily feed material into at least one of the oil feed ports; (c) mixing the oily feed material with the ethylcellulose to form a substantially homogeneous mixture; (d) cooling the mixture to form an oleogel.

Process for producing epichlorohydrin

Krafft, *et al*., Solvay, US9663427, May 30, 2017

Process for producing epichlorohydrin comprising subjecting to a dehydrochlorination operation, dichloropropanol produced from glycerol comprising aldehydes.

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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Tocopherols, tocomonoenols, and tocotrienols in oils of Costa Rican palm fruits: a comparison between six varieties and chemical versus mechanical extraction

Irías-Mata, A., et al., *J. Agric. Food Chem. 65*: 7476–7482, 2017, http://dx.doi.org/ 10.1021/acs.jafc.7b02230.

Palm oil is one of the richest sources of tocotrienols and may contain other non-tocopherol vitamin E congeners. The vitamin E profiles of fully ripened fruit mesocarp of three *Elaeis guineensis*, two *Elaeis oleifera* and one hybrid O × G palm fruit genotypes from Costa Rica were analyzed by high-performance liquid chromatography with fluorescence detection and gas chromatography–mass spectrometry after mechanical extraction by a screw press and chemical extraction with hexane. γ-Tocotrienol, α-tocotrienol, and α-tocopherol were the most abundant tocochromanols, while other tocopherols (β-tocopherol, γ-tocopherol, and δ-tocopherol) and α-tocomonoenol were detected at minor concentrations. Significant differences in vitamin E profiles between genotypes were observed, and the variety *E. oleifera* Quepos (CB9204) had by far the highest content of total tocotrienols (890 μg/g of oil) and total vitamin E (892 μg/g of oil). Chemical extraction with hexane afforded up to 2.5-fold higher vitamin E yields than screw press extraction. α-Tocomonoenol co-eluted with γ-tocopherol in reversed-phase high-performance liquid chromatography analyses and is a possible source of error in the quantification of γ-tocopherol in foods.

Sensitive and selective quantification of free and total malondialdehyde in plasma using UHPLC-HRMS[S]

Mendonça R., *et al., J. Lipid Res.58*: 1924–1931, 2017, http://dx.doi.org/10.1194/jlr.D076661.

Quantification of malondialdehyde (MDA) as a marker of lipid peroxidation is relevant for many research fields. We describe a new sensitive and selective method to measure free and total plasmatic MDA using derivatization with 2,4-dinitrophenylhydrazine (DNPH) and ultra-HPLC-high-resolution MS. Free and total MDA were extracted from minute sample amounts (10 μl) using acidic precipitation and alkaline hydrolysis followed by acidic precipitation, respectively. Derivatization was completed within 10 min at room temperature, and the excess DNPH discarded by liquid-liquid extraction. Quantification was achieved by internal standardization using dideuterated MDA as internal standard. The method's lowest limit of quantification was 100 nM, and linearity spanned greater than three orders of magnitude. Intra- and inter-day precisions for total MDA were 2.9% and 3.0%, respectively, and those for free MDA were 12.8% and 24.9%, respectively. Accuracy was 101% and 107% at low and high concentrations, respectively. In human plasma, free MDA levels were 120 nM (SD 36.26) and total MDA levels were 6.7 μM (SD 0.46). In addition, we show the applicability of this method to measure MDA plasma levels from a variety of animal species, making it invaluable to scientists in various fields.

Food and fuel from Canadian oilseed grains: Biorefinery production may optimize both resources

Shim,Y.Y., *Eur. J. Lipid Sci. Technol. 119*: 16003589, 2017, http://dx.doi.org/10.1002/ejlt.201600358.

Food and fuel markets are seen as competing for common land and biomass resources. However, in a well-designed biorefinery, the production of food and fuel might be synergistic. Canadian oilseed crops could be processed in Canada to increase opportunities for rural development and improved environmental stewardship. Biorefinery processing of grain crops will yield fractions with little or no utility as food. The objective of this study was to simultaneously optimize the yield of high quality food, animal feed, and energy co-products. Oilseed crops grown in western Canada are typically processed into two fractions: oil and meal. The quality of oilseed meal, as a nutritional ingredient, is greatly affected by extraction processes. It is proposed that processes are developed to separate anti-nutrients and compounds that have nutritional value to achieve a maximum yield of total nutrients. Organic materials that have little nutritional value might then be processed for utilization as biomass for energy or chemicals. We have devised processes for fractionation of various Cruciferous crops that simultaneously produce food, feed, industrial chemicals, and raw materials for energy production. In this report, we describe the performance of several crops that potentially produce high quality protein for food as well as oil, carbohydrate, and glucosinolates that could be used for industrial purposes.

Phytosterols on growth performance, antioxidant enzymes, and intestinal morphology in weaned piglets

Hu, Q., *et al., J. Sci. Food Agric. 97*: 4629–4634, 2017, http://dx.doi.org/10.1002/jsfa.8333.

Plant extracts have been used widely to improve growth, lower cholesterol, and exert antioxidative defense and antimicrobial activities in animal production. The present study aimed to investigate the effects of dietary phytosterols (PS) on growth performance, antioxidant enzymes, and intestinal morphology in weaned piglets. A total of 120 crossbred piglets, weighing 9.58 ± 0.26 kg,

were randomly allocated to three treatments: control, PS (0.2 g kg^{-1}), and polymyxin E (0.04 g kg^{-1}, antibiotic control). Compared to the control, PS or polymyxin E supplementation decreased diarrhea rate, serum cholesterol, and malondialdehyde (MDA) of the piglets ($P < 0.05$). Liver MDA was significantly decreased in PS-fed piglets compared to the control ($P < 0.05$), although there was no difference between the control and polymyxin E-fed piglets. PS increased the villous height/crypt depth ratio of the duodenum and jejunum compared to the control ($P < 0.05$). Polymyxin E supplementation in piglets did not alter the villous height/crypt depth ratio but raised the villous height and crypt depth of the duodenum compared to the control ($P < 0.05$). The results of the present study indicated that PS could decrease diarrhea rate, lower serum cholesterol, reduce lipid peroxidation and ameliorate intestinal morphology in weaned piglets. In addition, PS exerted better amelioration on intestinal morphology than polymyxin E in piglets.

Lipidomics insights in health and nutritional intervention studies

Ibáñez, *et al.*, *J. Agric. Food Chem* 65: 7827–7842, 2017, http://dx.doi.org/10.1021/acs.jafc.7b02643.

Lipids are among the major components of food and constitute the principal structural biomolecules of human body together with proteins and carbohydrates. Lipidomics encompasses the investigation of the lipidome, defined as the entire spectrum of lipids in a biological system at a given time. Among metabolomics technologies, lipidomics has evolved due to the relevance of lipids in nutrition and their well-recognized roles in health. Mass spectrometry advances have greatly facilitated lipidomics, but owing to the complexity and diversity of the lipids, lipidome purification and analysis are still challenging. This review focuses on lipidomics strategies, applications, and achievements of studies related to nutrition and health research.

Changes in virgin olive oil volatiles caused by *in vitro* digestion

Quintero-Flórez, A., *et al.*, *J. Agric. Food Chem.* 65: 7900–7907, 2017, http://dx.doi.org/10.1021/acs.jafc.7b01965.

Volatile compounds are responsible for some sensory characteristics of virgin olive oil (VOO); however, they have not been studied from a nutritional point view. In this work, the effect of the simulated digestion on VOO volatile compounds responsible for green flavor was studied, analyzing their changes through the three steps of an in vitro digestion model (mouth, stomach, and small intestine). Index of recovery and bioaccessibility were determined for the main volatiles of "Picual" VOO. At end of the duodenal step, higher recoveries of ethanol, pent-1-en-3-ol, β-ocimene, and nonanal were observed. From the 10 volatile compounds analyzed, only six compounds were bioaccessible. The compounds with the highest bioaccessibility were pent-1-en-3-ol, nonanal, β-ocimene, and ethanol. The results showed for the first time the recovery and bioaccessibility of several volatile compounds present in VOO.

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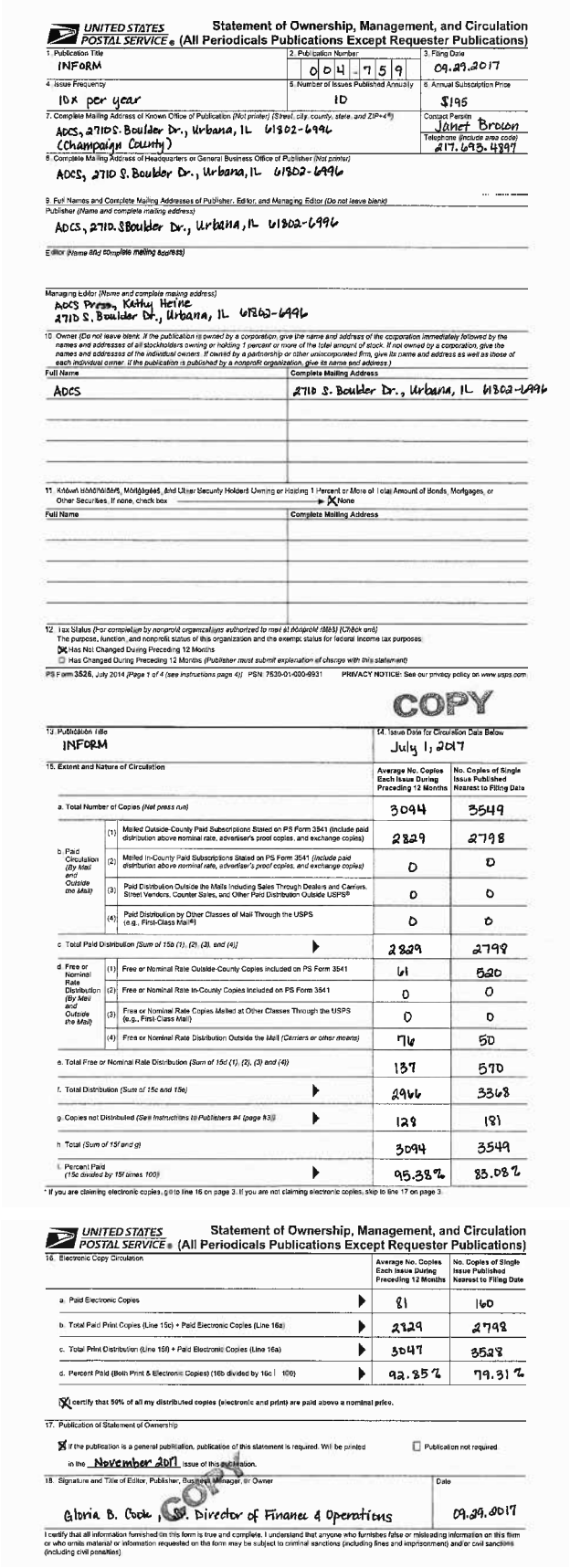

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Concentrations, stability, and isolation of the furan fatty acid 9-(3-methyl-5-pentylfuran-2-yl)-nonanoic acid from disposable latex gloves

Müller, M., *et al.*, *J. Agric. Food Chem.* 65: 7919–7925, 2017, http://dx.doi.org/10.1021/acs.jafc.7b02444.

Because of their antioxidant properties, furan fatty acids (furan-FAs) are valuable minor compounds with a widespread occurrence in all living matter. Unfortunately, pure standards are not readily available, because they usually contribute only 1% to the lipid fraction. A known exception of this is the milky fluid of *Hevea brasiliensis*, commonly known as latex, in which the furan-FA 9-(3-methyl-5-pentylfuran-2-yl)-nonanoic acid (9M5) contributes about 90% to the triacylglycerides. In this study, we investigated the content of 9M5 in 30 different disposable latex gloves, which ranged from 0.7 to 8.2 mg/g of glove. The light degradability of 9M5 in latex gloves was investigated, and different amounts of 9M5 in disposable latex gloves were attributed to varying exposure time to light. Additionally, over 100 mg of the methyl or ethyl ester of 9M5 (purity of >98%) could be extracted from disposable latex gloves, employing cold extraction and silver ion chromatography. With this method, standards for the quantitation of furan-FAs are obtained easily and rapidly in all laboratories.

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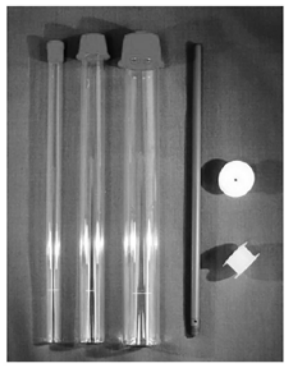

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Lipid accumulation mechanisms in auto- and heterotrophic microalgae

Chen, H.-H. and J.-G. Jiang, *J. Agric. Food Chem.* 65: 8099–8110, http://dx.doi.org/10.1021/acs.jafc.7b03495.

Microalgae lipids have attracted great attention in the world as a result of their potential use for biodiesel productions. Microalgae are cultivated in photoautotrophic conditions in most cases, but several species are able to grow under heterotrophic conditions, in which microalgae are cultivated in the dark where the cell growth and reproduction are supported by organic carbons. This perspective is covering the related studies concerning the difference between hetero- and autotrophic cultivation of microalgae. The auto- and heterotrophic central carbon metabolic pathways in microalgae are described, and the catalyzing reactions of several key metabolic enzymes and their corresponding changes in the protein level are summarized. Under adverse environmental conditions, such as nutrient deprivation, microalgae have the ability to highly store energy by forming triacylglycerol (TAG), the reason for which is analyzed. In addition, the biosynthesis of fatty acids and TAGs and their difference between auto- and heterotrophic conditions are compared at the molecular level. The positive regulatory enzymes, such as glucose transporter protein, fructose-1,6-bisphosphate aldolase, and glycerol-3-phosphate dehydrogenase, and the negative regulation enzymes, such as triose phosphate isomerase, played a crucial role in the lipid accumulation auto- and heterotrophic conditions.

Obesity-associated gene TMEM18 has a role in the central control of appetite and body weight regulation

Larder, R., *et al.*, *Proc. National Acad. Sci. 114*: 9421–9426, http://dx.doi.org/10.1073/pnas.1707310114.

The growing size and sophistication of genome-wide association studies have led to the identification of variants which are clearly and reliably associated with obesity. A strong association between increased BMI and a region of human chromosome 2, near to the gene *TMEM18*, has been repeatedly demonstrated in children and adults. The function of TMEM18 in the control of appetitive behavior and body composition has been poorly characterized. In murine models, we show germline loss results in weight gain while adult onset hypothalamic overexpression results in weight loss, supporting the hypothesis that TMEM18 acting within the central nervous system can affect energy balance. We also report a structure and putative molecular function of TMEM18, challenging the current published model.

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Industrial Applications

Biodiesel production from *Neochloris oleoabundans* by supercritical technology

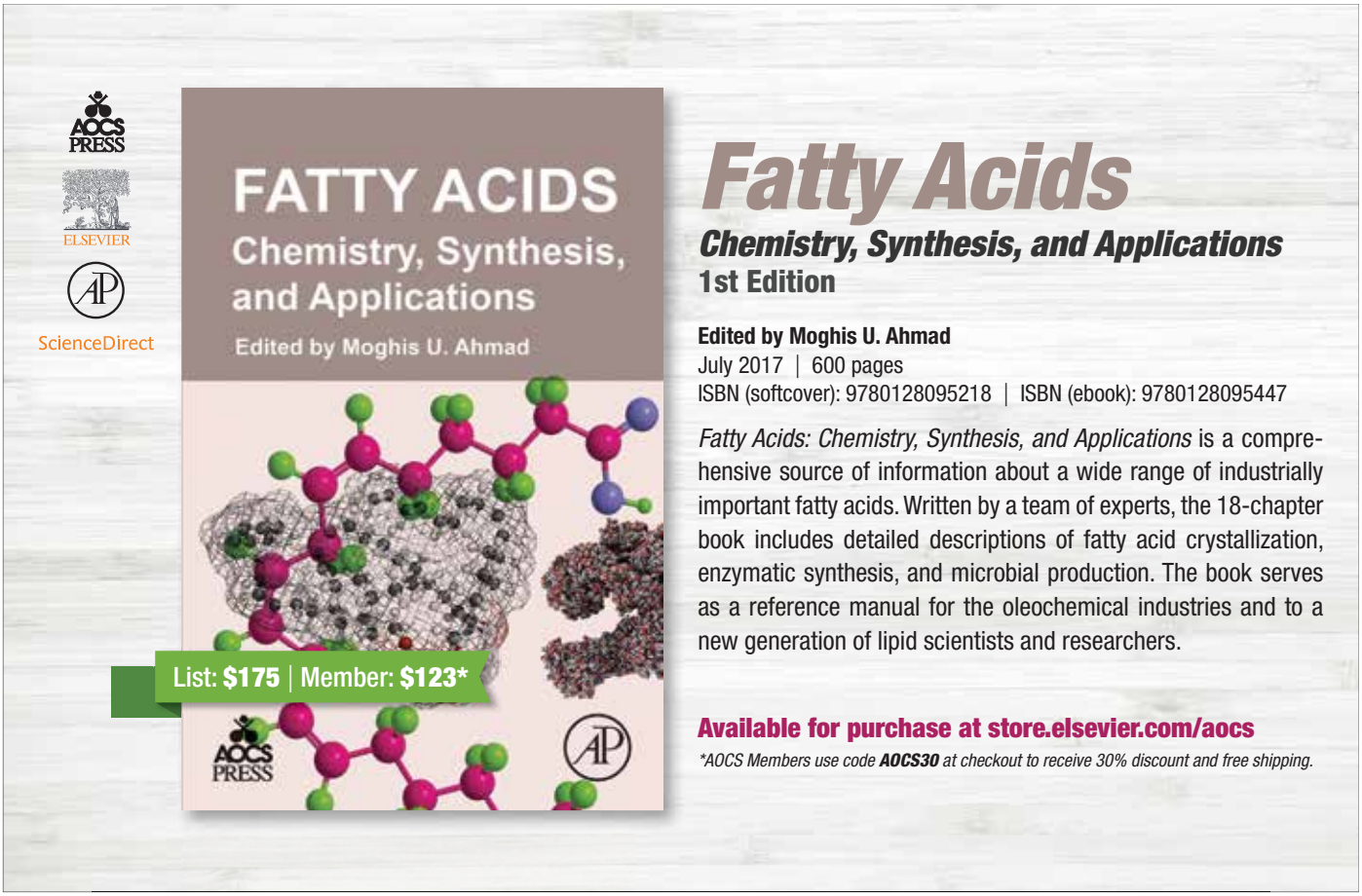
Hegel, P., *et al*, *Chem. Eng. Process.: Process Intensification*, online, September 2017, https://doi.org/10.1016/j.cep.2017.08.018.

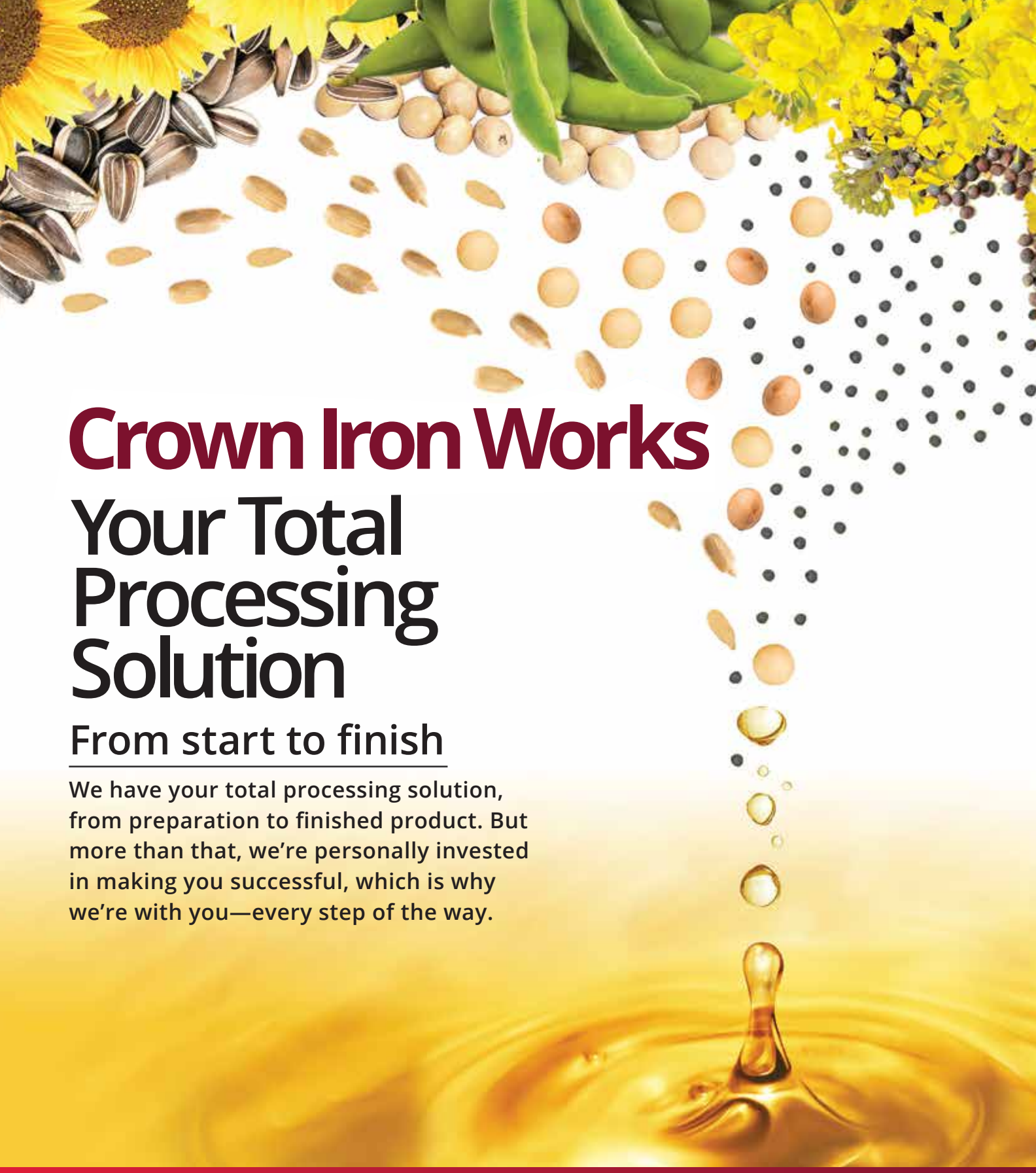
Oleaginous microalgae have been proposed as a sustainable alternative biomass to produce biodiesel in lieu of conventional vegetable oils derived from oilseed crops. Particularly, recent studies pointed out the potential of *N. oleoabundans,* cultured in seawater or in anaerobically digested dairy manure, to produce triglycerides with high content of monounsaturated fatty acids. The supercritical technology has been recognized as a green sustainable alternative to transform biomass into valuable products. Thus, the aim of the present work was to study the direct supercritical alcohol processing of partially dried *N. oleoabundans* biomass and subsequent reaction products fractionation by supercritical CO_2 or liquid n-hexane. A direct alcoholysis of microalgae biomass was carried out at different temperatures (250°C and 280°C) and increasing reaction times to evaluate the fatty acid ester production. Bio-oils from microalgae with up to 35 wt.% fatty acid esters were obtained by twofold extraction with n-hexane. Conversely, supercritical CO_2 fractionation produced upgraded bio-oils with up to 68 wt.% of fatty acid esters content.

Effect of *Crambe abyssinica* oil degumming in phosphorus concentration of refined oil and derived biodiesel

Costa, E., *et al*., *Renew. Energy*, online September 2017, https://doi.org/10.1016/j.renene.2017.08.089.

In the present study, the effect of different degumming processes on the phosphorus content of *Crambe abyssinica* oil and resultant biodiesel was evaluated. The non-edible oil was submitted to water degumming and chemical degumming with different concentrations of phosphoric acid and varying the acid to oil volume percentages. Phosphorus content of the products was measured by UV spectroscopy after sample calcination, according to NP 1994:2000. Biodiesel was produced by transesterification using a 6:1 methanol to oil molar ratio and 1 wt% sodium hydroxide as catalyst at 65 °C, during 1 h. The biodiesel produced directly from the crude oil presented high phosphorus concentration (>20 ppm); consequently, a degumming process was required to fulfil the quality standard (<4 ppm according to EN 14214). Water degumming was not effective, leading to biodiesel with a phosphorus concentration of 12.2 ppm. Among the acid degumming processes evaluated and taking into account technical and operational variables, the best established conditions, which allowed the fulfilment of the quality standard regarding phosphorus concentration, was considered to be 25 wt% acid concentration and 0.80 vol% of acid to oil.





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