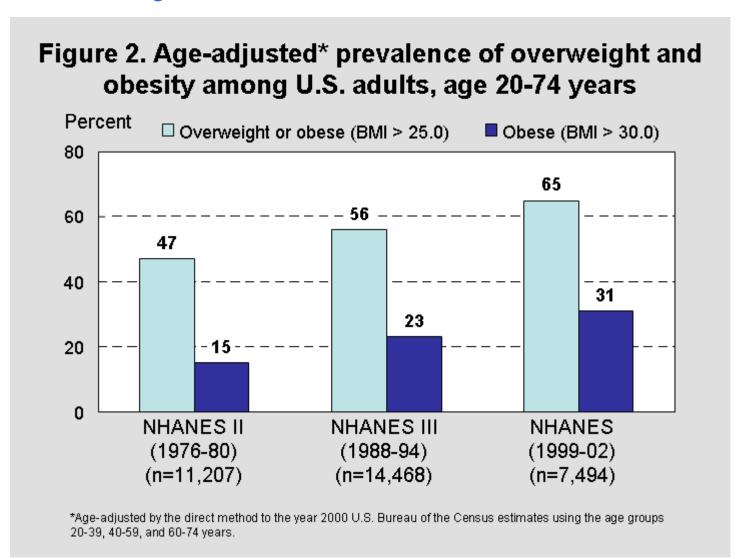
Structuring liquid oils using non-conventional strategies: organogels, crystal hydrates and polymers

Alejandro G. Marangoni University of Guelph

The problem, The Opportunity

- Our sedentary lifestyle and poor eating habits have lead to a dramatic increase in the proportion of overweight and obese people in both affluent and not-so-affluent societies
- This will lead to an increase in the incidence of cardiovascular disease and type II diabetes
- Society will be burdened with the astronomical costs of caring for an unhealthy population
- This will be very, very expensive!

Obesity in adults – a disaster



http://www.cdc.gov/nchs Center for disease prevention and control National Center for Health Statistics

Present

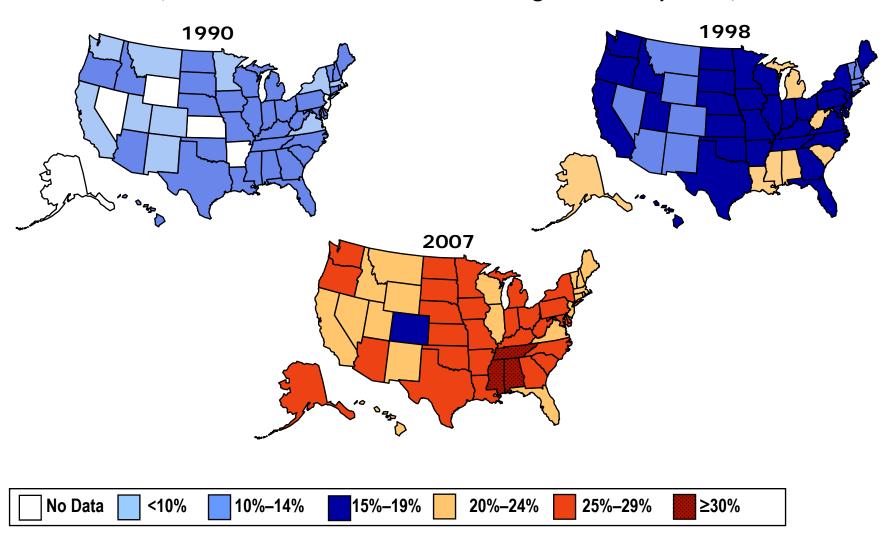
 2005-2006.....35.3% of adults clinically obese (BMI>30)

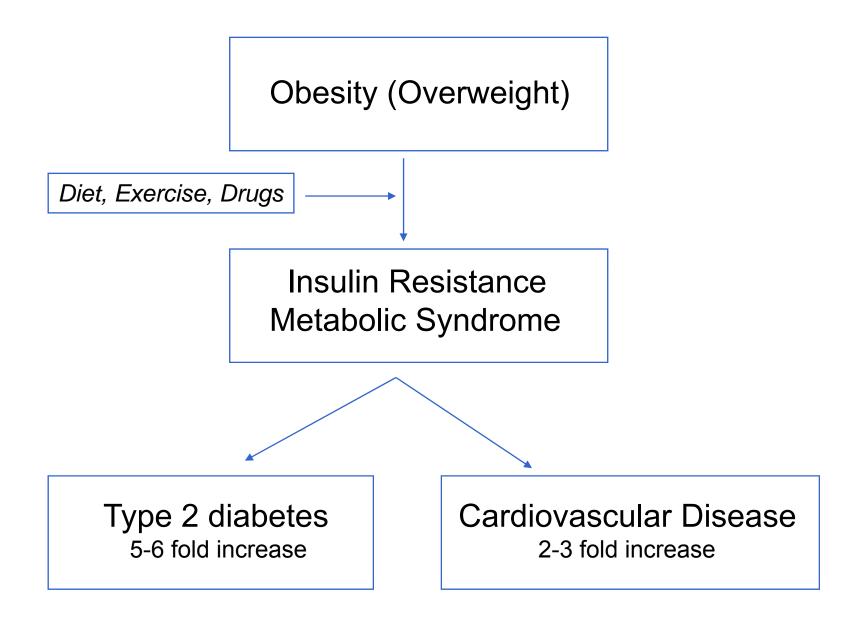
 2003-2006......16.3% of children 2-17 are clinically obese (BMI>30)

Obesity Trends* Among U.S. Adults

BRFSS, 1990, 1998, 2007

(*BMI ≥30, or about 30 lbs. overweight for 5′4″ person)





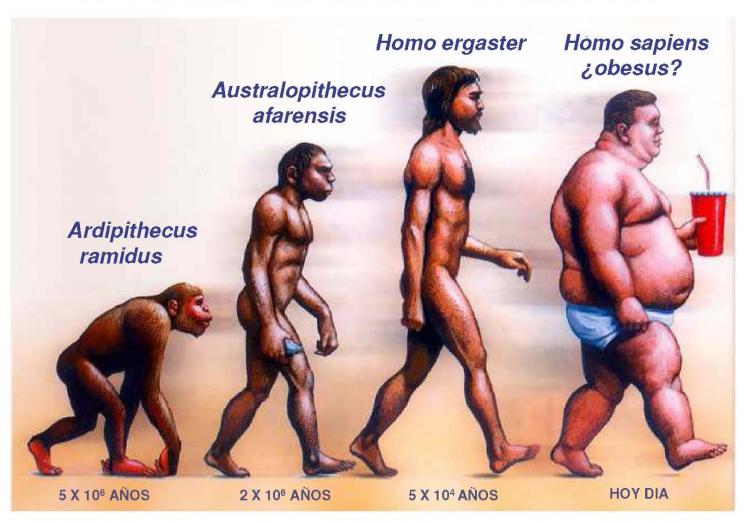
Recommendation?

 Reduce the total amount of fat, sugar, sodium and calories we consume

Improve on the nutritional quality of food

Exercise more

EVOLUCION NUTRICIONAL DEL HOMBRE



VEGETARIANO (EXCEPCIONALMENTE CARNIVORO) **OMNIVORO**

GOLOSO

(CARNIVORO MAL ADAPTADO)

(CARNIVORO MUY MAL ADAPTADO)

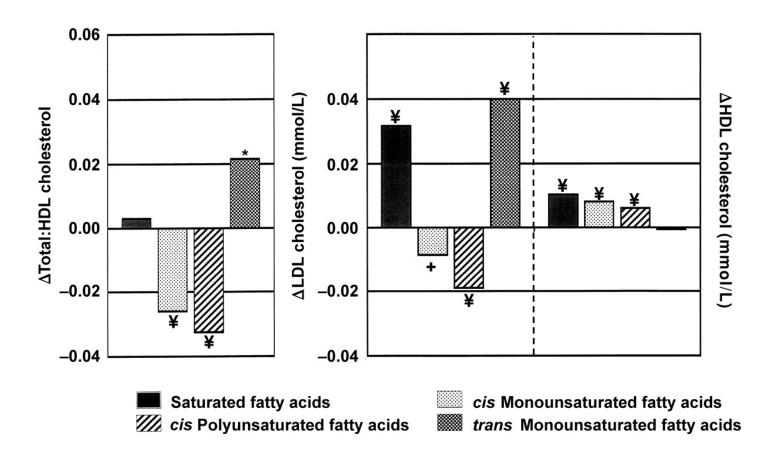
Implementation?

 Food manufacturers must produce more healthful food products with very similar eating qualities as the "not-so-healthy" version

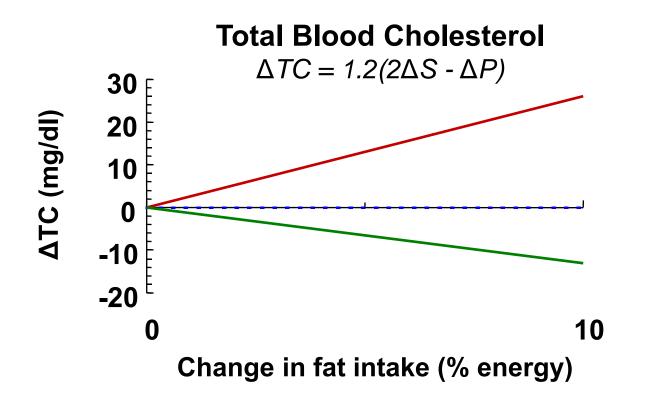
The price cannot increase by much or at all.

Fat Issues.....

The 'evil' trans and saturated fatty acids...



Saturated fatty acids elevate serum triglyceride levels



SAFA

saturated fatty acids

MUFA

mono-unsaturated fatty acids

PUFA

poly-unsaturated fatty acids

Recommendations for the level of saturated fat intake

WHO

The Expert Report's specific recommendations on diet include limiting fat to between 15 and 30 percent of total daily energy intake and saturated fats to less than 10 percent of this total.....~20g/day

American Heart Association

Limit total fat intake to less than 25–35 percent of your total calories each day; Limit saturated fat intake to less than 7 percent of total daily calories.....~14g/day

The illegal food of the 21st century?



Warning: Eating a couple of these muffins a day will make you obese and probably give you a heart attack and you may develop diabetes along the way. Keep out of reach of children.

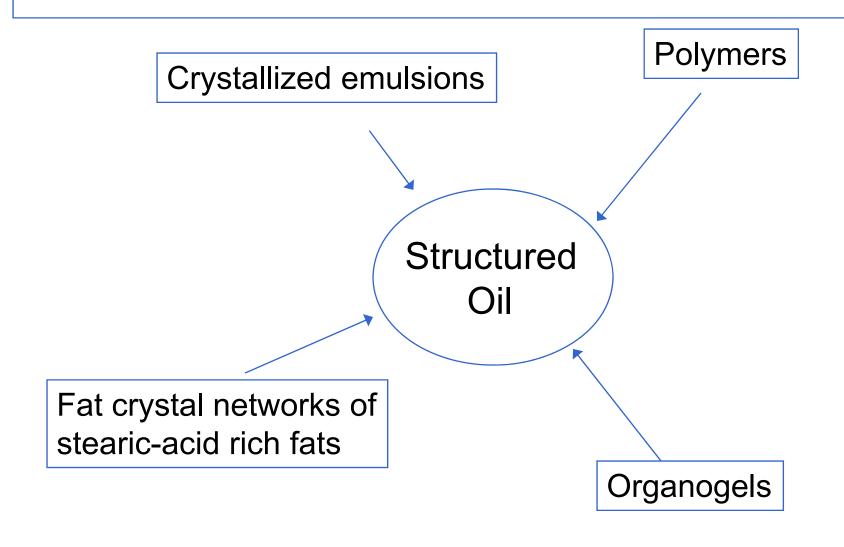
Nutritional Label for this 134g muffin

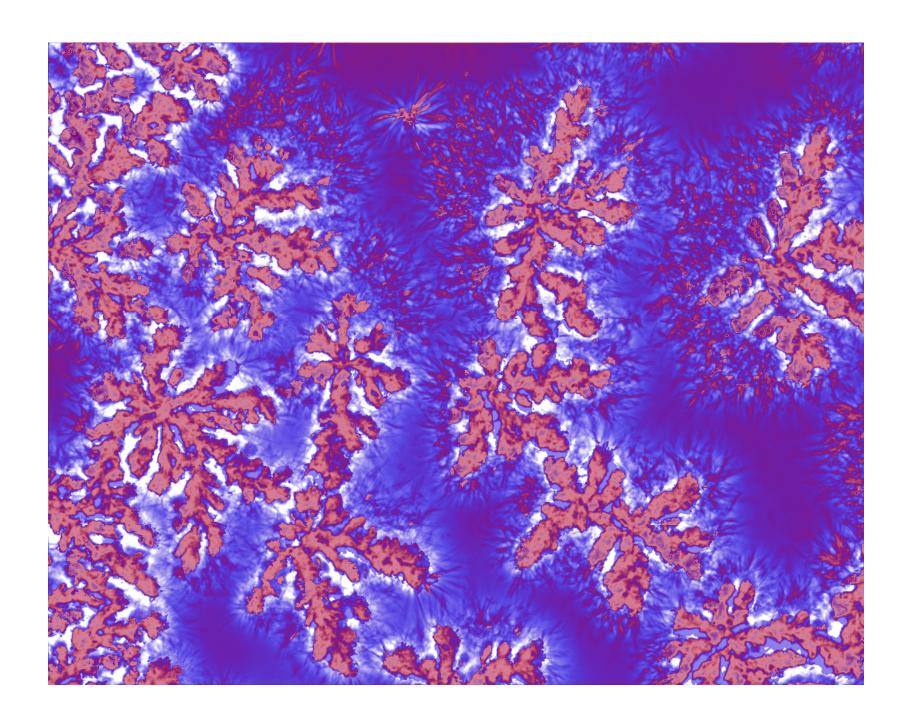
- Calories 560
- Fat Calories 240
- Total Fat 27g
- Sugars 42g

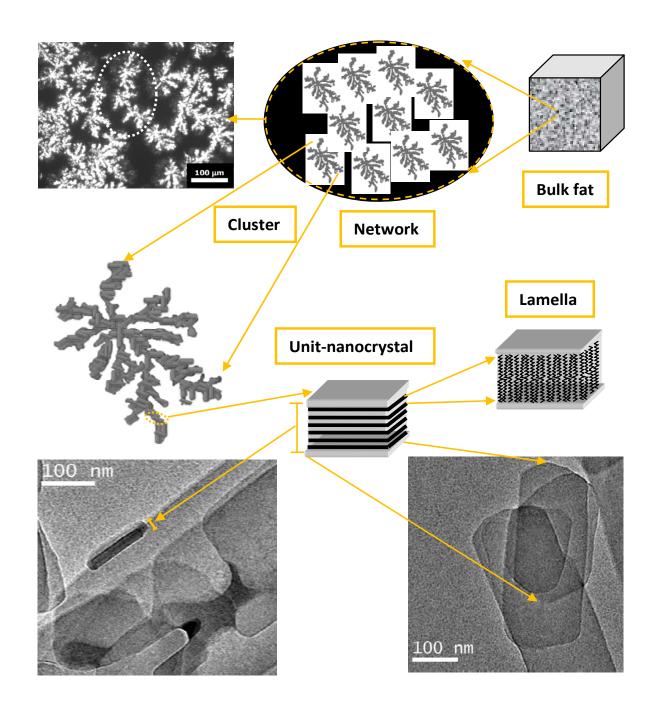
Target for "Fats" of the Future....

- Decreased lipid content (30-50% water)
- No trans fatty acids
- Minimum amounts of saturated fatty acids for functionality
- Forget fat-free...fats and oils taste good

Novel Strategies for Structuring Liquid Oils







Organogels

Definition of a gel

A substance is a gel if it has a continuous structure with macroscopic dimensions that is permanent on the time scale of an analytical experiment and is solid-like in its rheological properties.

A gel is an organogel if

The immobilized solvent phase is an organic liquid (vs. hydrogel)

Proposed SAFIN Organogel Definition

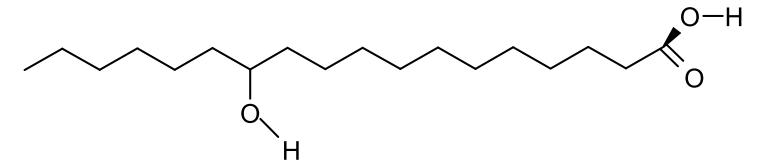
Self-standing, thermoreversible, anhydrous, viscoelastic materials structured by a three-dimensional supramolecular network of self-assembled small molecules in an organic liquid at concentrations no greater than their percolation threshold, usually ≤2% (w/w).



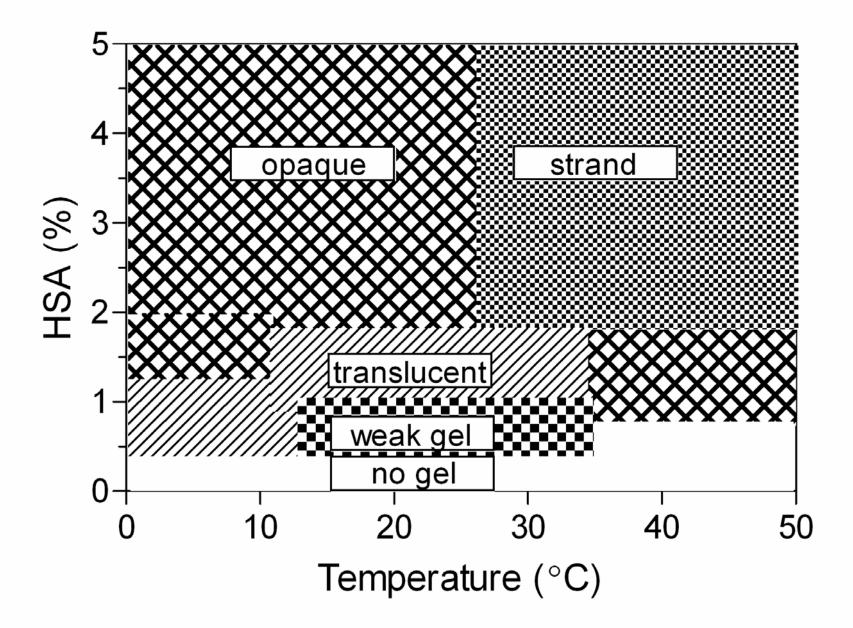
Organogelators relevant to food applications

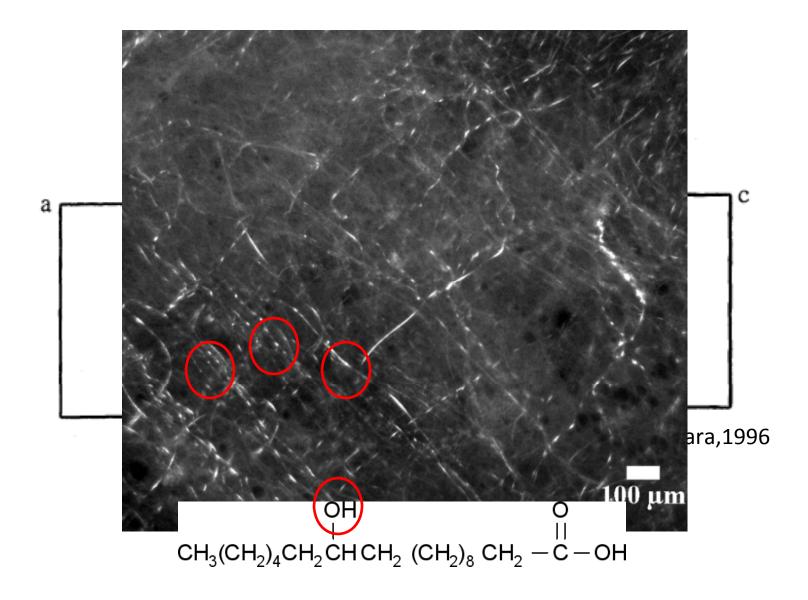
- Lecithin + Sorbitan Tristearate
- Sorbitan monostearate
- Long-chain alcohols + fatty acids (18 carbon long optimal)
- Glycerol Monostearate
- Phytosterols + Oryzanol
- Long chain, hydroxy fatty acids (12hydroxystearic acid or ricinelaidic acid)
- Waxes
- Ceramides

12-hydroxystearic acid (HSA)

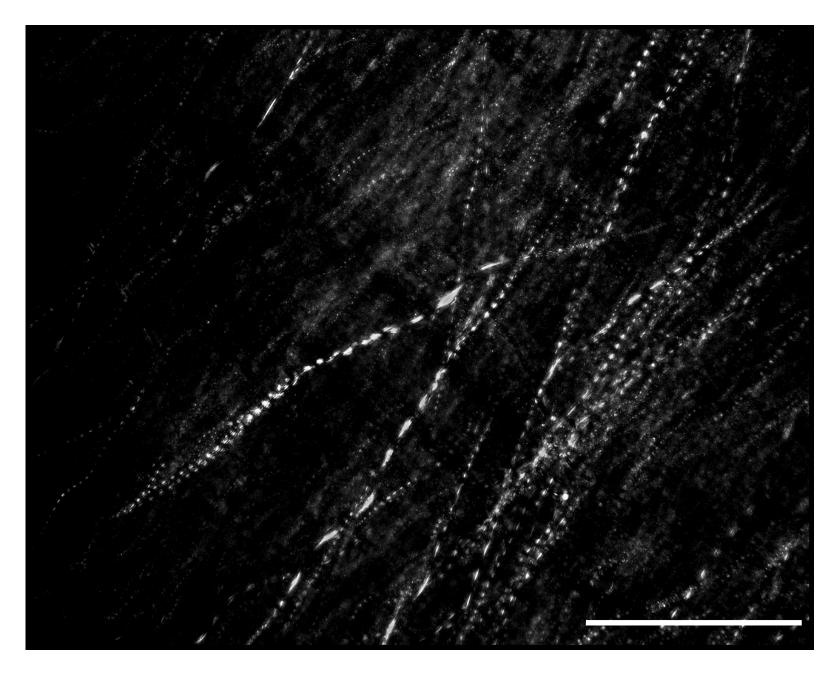


Ricinelaidic Acid

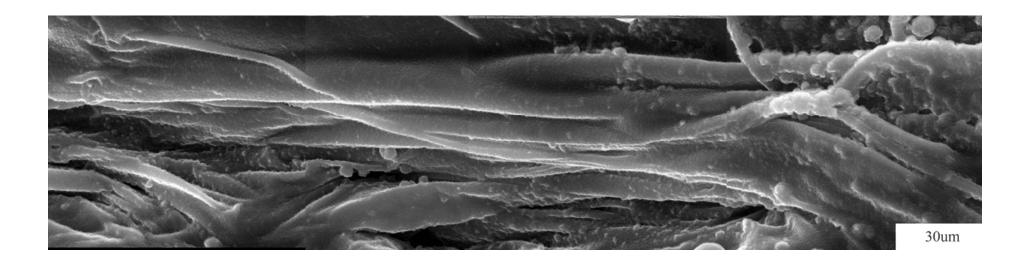




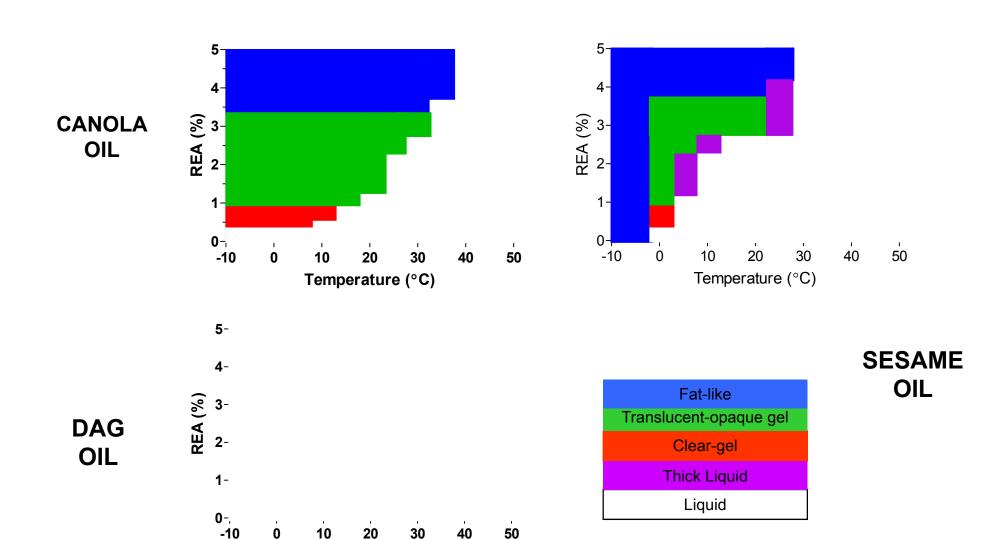
Fiber structure Fiber axis (1.a) n.(c.sinß) Terech and Weiss, 1994



30μm thick sample of 2.5%HSA stored at 30°C for 24 hours, with slices taken every 3μm and stacked using a maximum pixel intensity procedure. 100μm magnification bar.



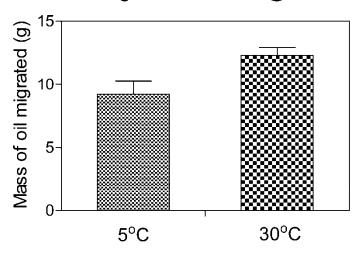
Solvent effects

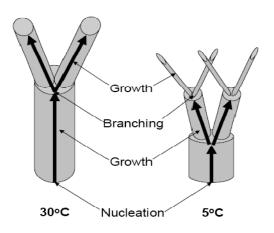


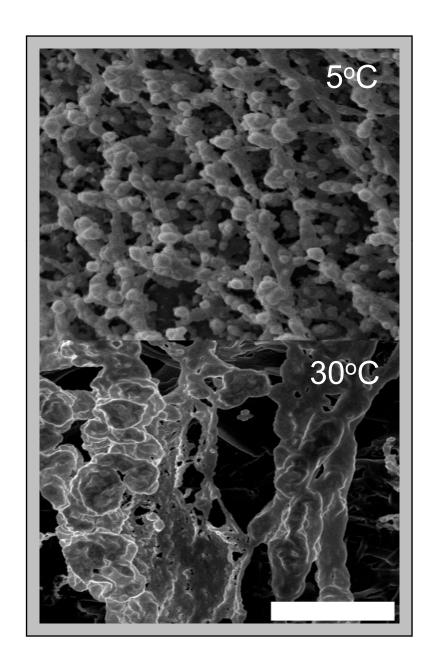
Temperature (°C)

Temperature Effects on HSA SAFIN structure

Oil migration after 1 hr@ RT

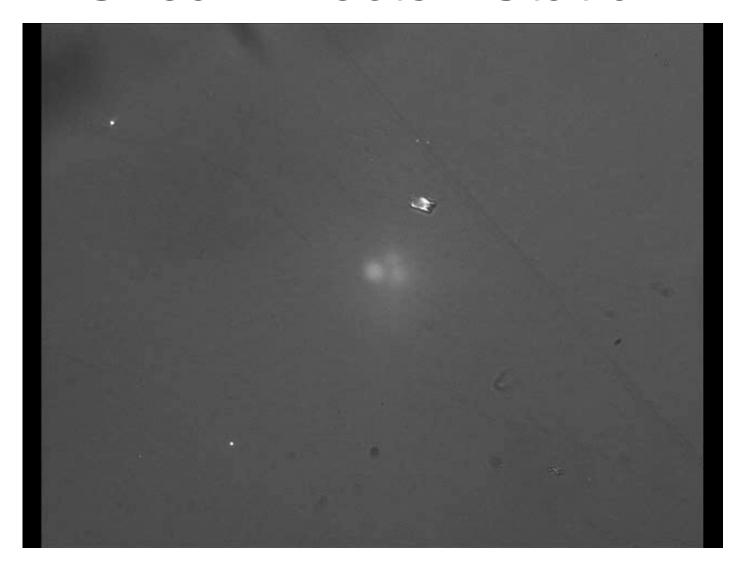






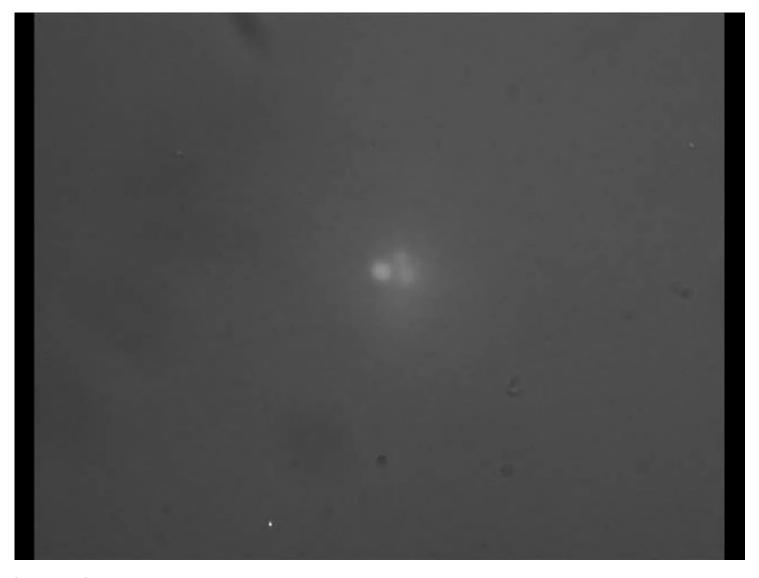
Prof. Michael Rogers

Shear Effects - Static



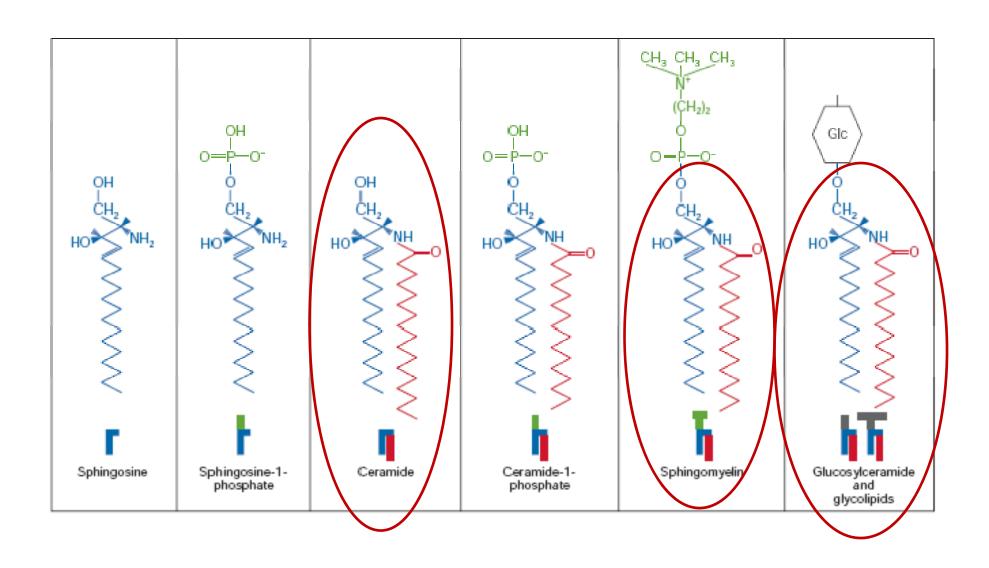
Edmund Co, M.Sc.

Shear Effects - 400 s⁻¹

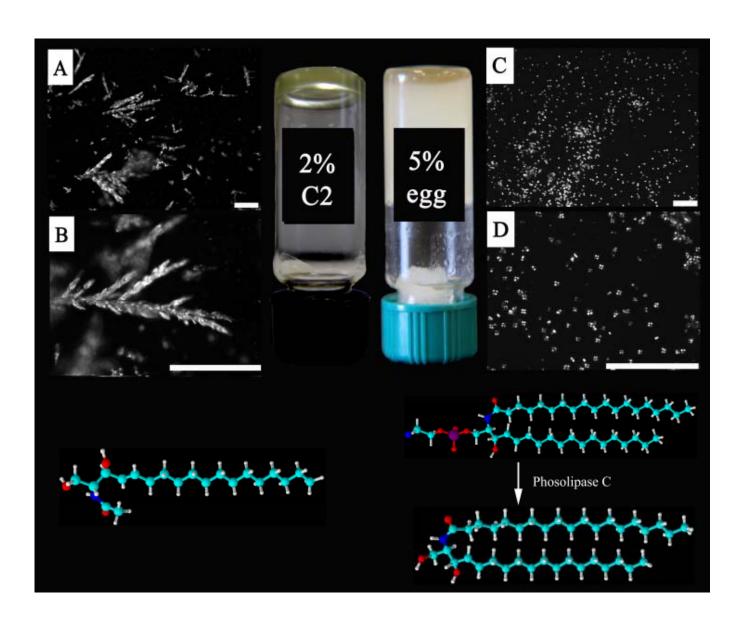


Edmund Co, M.Sc.

Sphingolipids, ceramides, glycolipids



Ceramide Organogelator



β -sitosterol + γ -oryzanol Bot and Agterof (2006)

R=H campestryl ferulate R=CH3 sitosteryl ferulate - double bond = campestanyl, sitostanyl ferulate

Why are organogels exciting?

- Self assembly properties (easy to make, nanoscale structuring)
- Exhibit interesting properties/functionalities
 - Acute temperature/moisture sensitivities
 - Ability to solubilize guest molecules
 - Applications as transdermal delivery vehicles
- Potential to structure oil without saturates/trans

Potential Applications of Edible Oil Organogels

- 1) Inhibition of oil migration
- 2) Controlled release of bio-actives
- 3) Healthy structuring of food lipids
- 4) Stabilization of w/o emulsions



β-Carotene

β-Carotene, a lipophilic phyto-nutrient with antioxidant properties, has been associated with a decreased risk for a number of chronic diseases.

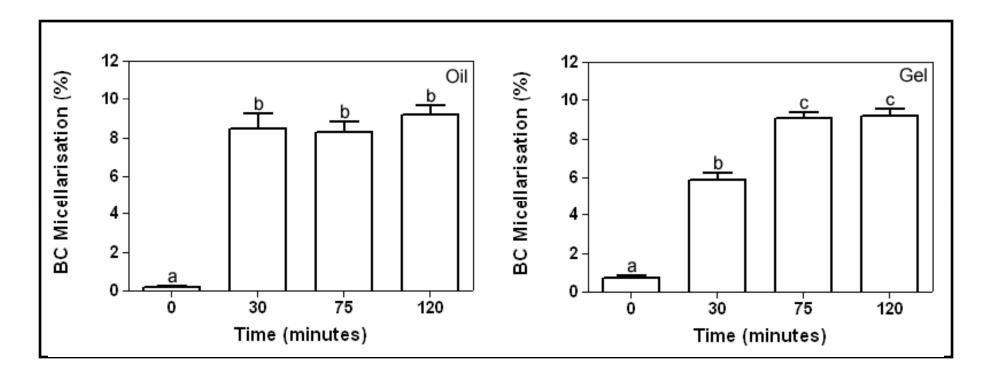


β-Carotene

Bioavailability of β-C: 10-30%

The presence of dietary fats in the digestive tract increases the bioavailability of β-C.

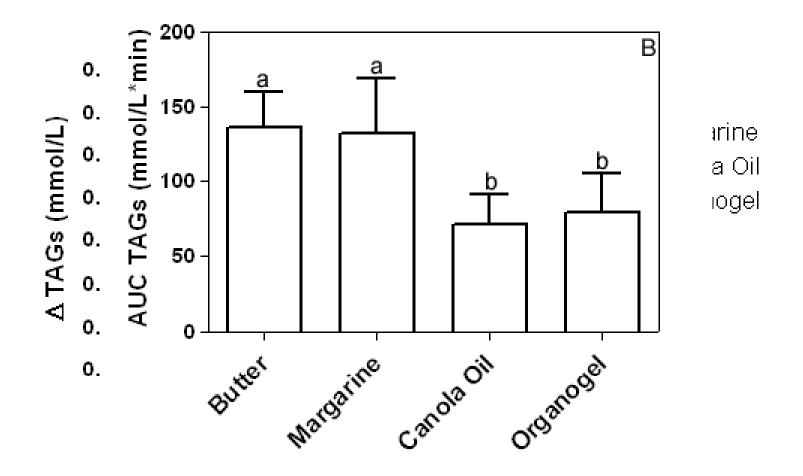




Maximum β-C micellarisation was reached by 30 min for oil; but not until 75 min for gel.

β-Carotene release was significantly delayed by the immobilization of oil within the 12-HSA network.

Healthy Oil Structuring



TAGs: 12-HSA Organogel < Butter and Margarine (p<0.05)

Emulsion Stabilization

The addition of 12-HSA to w/o emulsions significantly increases their stability.

