Fats and oils
Where's the fat?
Fat
Fats and oils outline

- Structure
  - Components
  - Physical properties
    - Unsaturation and chain length
- Function in foods
- Market forms
- Deep fat frying
- Emulsions
  - Definitions, types, and emulsifiers
Fats and oils outline

• Fat spoilage
  – Odor absorption
  – Oxidative rancidity
  – Hydrolytic rancidity
The difference between fats and oils

• Fats are solid at room temperature

• Oils are liquid at room temperature
Fat and oil components

Glycerol

3 fatty acids
Triglycerides
Fatty acid chain length

Butyric acid, 4 carbon atoms

Stearic acid, 18 carbon atoms
Fatty acid saturation

Oleic acid, 18:1

Linoleic, 18:2
Fatty acid saturation

• Fatty acids may have
  – no double bonds - saturated
  – one double bond - monounsaturated
  – many double bonds - polyunsaturated
Effect of structure on physical properties

• Generally, as chains become longer and/or more saturated, the triglyceride is more likely to be a fat (solid at RT)

• As chains become shorter and/or more unsaturated, the triglyceride is more likely to be an oil (liquid at RT)
Functions/uses of fats

- **Tenderizer**
  - Baked goods, “shortening power”
- **Leavening**
  - Need a plastic fat like Crisco for this
- **Emulsion ingredient**
  - Salad dressings
- **Heat transfer**
  - Frying, deep fat frying

Plastic fat + sugar + beating → Incorporate air
Market forms of fats

- **Butter**
  - 80% milkfat, 20% water

- **Margarine**
  - oleo, a butter substitute
    - 80% fat, 20% water
    - Fat may be animal, vegetable, or a combination

- **Lard**
  - 100% fat, pork
  - Pork carcass fat is rendered to produce lard
Lard molecules are very alike and have very similar properties.
Market forms of fats

• **Suet**
  – 100% fat, from beef

• **Vegetable oils**
  – 100% fat from the seeds of peanut, corn, cottonseed, safflower, sunflower, soybean, canola (Canadian oil, low acid) and olive

• **Hydrogenated fats**
  – 100% fat obtained by chemical reaction of hydrogen with vegetable oils
Hydrogenation of fats

• Unsaturated fats are not as stable as saturated fats and are susceptible to oxidation (rancidity)

• Also, it may be desirable to convert the liquid vegetable oils into solid form for the production of hydrogenated shortenings and vegetable margarines

• To do this, the unsaturated fats are hydrogenated
Hydrogenation

Unsaturated
Liquid, Corn oil

Saturated
Solid, Crisco
Types of hydrogenated fats

• With emulsifiers
  – Makes it possible to keep water and fat together during mixing a food such as a cake, cookies, or other bakery product
  – Emulsifiers may be mono- or diglycerides or lecithin
  – Example = Crisco
Types of hydrogenated fats

• Without emulsifiers
  - Used for deep fat frying
  - In this application we don’t want emulsifiers as they lower the smoke point and are degraded to acrolein

\[
\text{Emulsifier} \xrightarrow{\text{heat}} \text{Acrolein}
\]
Types of hydrogenated fats

• Without emulsifiers
  – Sometimes antifoaming agents (silicones) are added to these fats to control the water released during deep frying

• Lightning Quiz
Emulsions

- A dispersion of two unlike, insoluble liquids
- Types
  - Temporary
    - Vinegar and oil
  - Permanent
    - Mayonnaise
      - Vinegar, oil, egg yolks (lecithin), mustard
      - Lecithin is the emulsifier
Emulsions (Oil in water, O/W)

Oil droplets want to coalesce--reduces surface tension
Emulsions (Oil in water, O/W)
Emulsions (Oil in water, O/W)

Separates and floats to top because oil is less dense than water
Emulsifiers

- In order to prevent this separation we need an emulsifier
- Emulsifiers are molecules that have an end that likes water and an end that likes oil (a molecule with a split personality)
Emulsifiers

- Emulsifiers have the following general molecular features

  - Polar head, likes water
  - Non-polar tail, likes oil
Emulsions (Oil in water, O/W)

To prevent phase separation we need an emulsifier.
Emulsions (Oil in water, O/W)

What happens to this picture when we add emulsifiers?
Emulsions (Oil in water, O/W)

This system is stabilized due to a lowering of surface tension by the emulsifier.
Emulsifier analogy

Problem here? Yes!

Problem here? No.
Emulsifier analogy

Boiler
Up!!

Nuts!!

Mr. Emulsifier
O/W vs. W/O emulsions

- Emulsions can be oil-in water (o/w) or water-in-oil (w/o)

- Examples
  - o/w - mayonnaise
  - w/o - butter
Mayonnaise preparation

- Egg yolks
- Vinegar
- Oil (1 T at a time)

Beat continuously

Emulsion

Emulsions
Mayonnaise - Standards of Identity

• At least 65% oil

• Egg yolk containing ingredient

• Acid
  – Vinegar, lemon juice
Broken emulsions

- If a mayonnaise emulsion should break as a result of freezing or long storage, it is possible to re-form it by adding the broken emulsion gradually (1 T at a time) to an egg yolk with vigorous beating after each addition.
Salad dressing

• A mayonnaise substitute
• It is cheaper than real mayonnaise
  – Why?
    • Must contain 30% oil (less than mayo, and oil is an expensive ingredient)
    • Remaining thickening is provided by a modified food starch
Deep fat frying

• Requirements
  – Flavorless fat
  – High smoke point
    • Fats last longer
    • Prevents excessive fat absorption
## Smoke points

<table>
<thead>
<tr>
<th>Oil/fat</th>
<th>Smoke point, F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn oil</td>
<td>450</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>450</td>
</tr>
<tr>
<td>Peanut</td>
<td>450</td>
</tr>
<tr>
<td>Lard</td>
<td>360-400</td>
</tr>
<tr>
<td>Shortening</td>
<td>450</td>
</tr>
<tr>
<td>Shortening + emulsifiers</td>
<td>319-376</td>
</tr>
</tbody>
</table>
Maintaining smoke points

- To keep smoke point high
  - Keep fat clean - strain after each use
  - Use correct fryer configuration to minimize exposed surface area
Smoke point and flash point

- **Smoke point**
- **Flash point**

**Typical operating range**

**Temperature increasing**
Degradation of smoke point

- Smoke point
- Flash point
- Frying temp.
- Smoke point

Use time

Temperature

 lots of smoke in your kitchen

lots of firemen in your kitchen
Prevention of excessive fat absorption

• Choose correct type of fat
  – This means one with a high smoke point

• Fry at the correct temperature
  – This means the highest practical temperature to assure complete cooking without excessive surface browning. Usually this is just a little below the smoke point
Prevention of excessive fat absorption

• Minimize exposure time of food to the fat
  – Pay attention!

• Understand that certain ingredients will cause extra fat absorption
  – These are the so-called “rich” ingredients
  – Fat, sugar, liquid (especially dairy), egg
Fat spoilage

- Odor absorption
  - Keep covered
- Oxidative rancidity
- Hydrolytic rancidity
Trilinolein

A polyunsaturated fat/oil as might be found in vegetable oils
It is subject to oxidative rancidity

But where does the oxidation take place?
Oxidative rancidity

A peroxy radical
Oxidative rancidity

A hydroperoxide

More unsaturated fat

Degradation to form smelly compounds
<table>
<thead>
<tr>
<th>Promoter</th>
<th>To prevent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat</td>
<td>Keep cool</td>
</tr>
<tr>
<td>Light</td>
<td>Keep covered</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Keep covered</td>
</tr>
<tr>
<td>Metal ions</td>
<td>Strain after use</td>
</tr>
<tr>
<td>Already rancid fats</td>
<td>Don’t combine new and old fats</td>
</tr>
<tr>
<td>Unsaturated fats</td>
<td>---</td>
</tr>
</tbody>
</table>
Hydrolytic rancidity

This type of rancidity is mainly a problem in dairy products.

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