Major components: (2) ***Fats and Oils***

2. Fats and Oils…

- Produce 9 Cal/g
- Should contribute NO more than **30%** of our caloric intake
- Dietary fats/oils, essential fatty acids
  - needed by the body to maintain proper health & functioning

2. Fats and Oils

Chemical composition

- ***What are fats?***
- Chemically known as *triacylglycerols* or *triglycerides*
  - Triglycerides (TG): Triesters of glycerol & fatty acids

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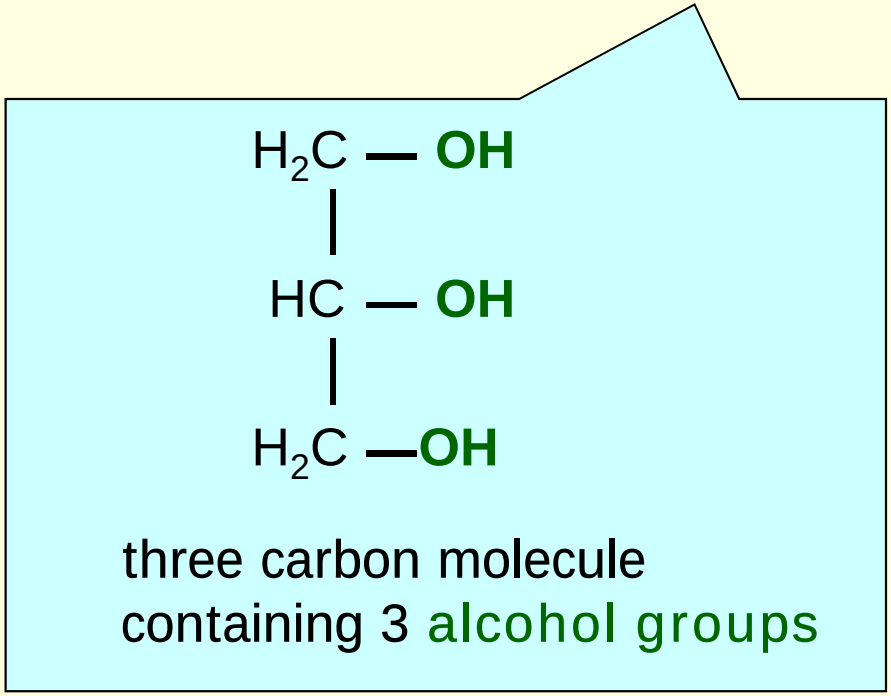


What are fats?

- Chemically known as *triacylglycerols* or *triglycerides*
  - Triglycerides (TG): Triesters of glycerol & fatty acids

Fatty acids: R1, R2, R3

hydrocarbon chains, with *carboxylic acid* (COOH) at one end and a *methyl* group (CH3) at the other end

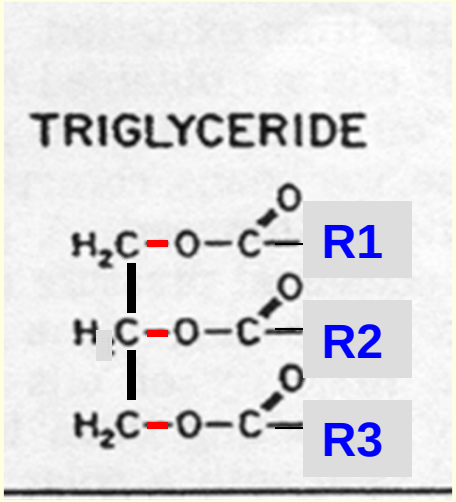
2. Fats and Oils

Chemical composition…

- ***What are fats?***
- Chemically known as *triacylglycerols* or *triglycerides*
  - Triglycerides (TG): Triesters of glycerol & fatty acids

Ester bonds hold fatty acids (R1,R2, R3) to glycerol

Joining the OH groups of glycerol to COOH groups of fatty acids



2. Fats and Oils

Chemical composition…

- most common fatty acids in food TG: C-16, C-18
- some foods have shorter chain fatty acids (eg. coconut oil: C12)
- others also contain longer chain fatty acids (eg. fish: C20 and C22)

2. Fats and Oils

Saturated and Unsaturated

- What are **saturated** and **unsaturated** fats?
  - saturated & unsaturated fatty acid constituents

2. Fats and Oils

Saturated and Unsaturated

- What are **saturated** and **unsaturated** fats?
  - saturated & unsaturated fatty acid constituents

no double bonds

C-C

- What are **saturated** and **unsaturated** fats?
  - saturated & unsaturated fatty acid constituents

With double bonds
C=C (MUFA, PUFA)

COMMON FORMULA OF F. A.

Y: X (n- Z)

- Y: Number of carbon
- X: Number of double bonds
- n: Numbering of double bonds from methyl (CH3) end
- Z: Number of first double bonds

Example:18 carbon fatty acids

$CH_3(CH_2)_{16}COOH$	Saturated **(Stearic)**
$CH_3(CH_2)_7CH=CH(CH_2)_7COOH$	Monounsaturated **(Oleic)**
$CH_3(CH_2)_4CH=CH\text{-}CH_2\text{-}CH=CH(CH_2)_7COOH$	Polyunsaturatred **(Linoleic)**

Linoleic acid is an omega 6 fatty acid since its first double bound from the methyl end starts on Carbon number 6

Practice writing the formula in Y:X(n-z) format
Stearic 18:0
Oleic 18:1(n-9)
Linoleic 18:2(n-6)

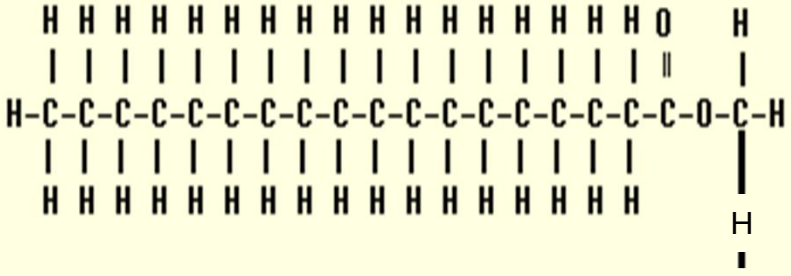
2. Fats and Oils

Properties…

Animal fats

- usually **solid** at room temp;
- saturated fatty acids

"linear" chains – pack together more tightly- higher MP



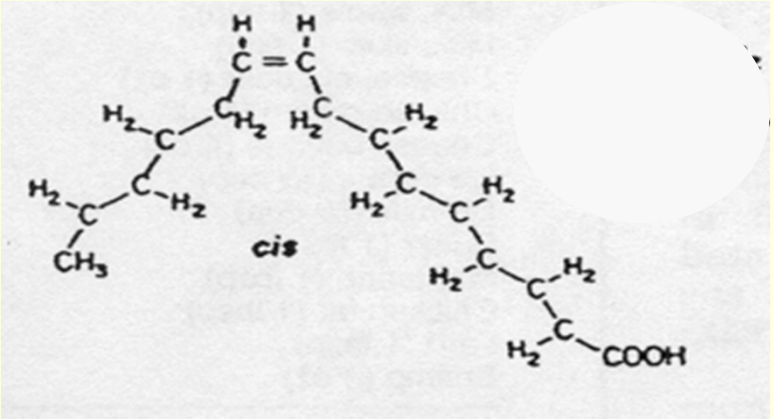
2. Fats and Oils

Properties of Saturated, Unsaturated

Vegetable oils

- usually **liquid** at room temp;
- Unsaturated fatty acids: MUFA, PUFA
  - *cis* configuration: carbon chain segments on same side of the double bond
  - bend toward each other ..."kink" in chains...

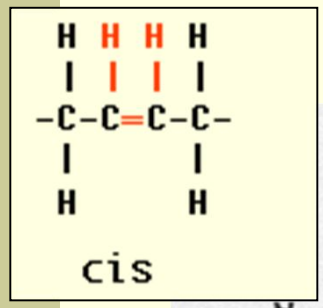
pack together less tightly – lower melting point

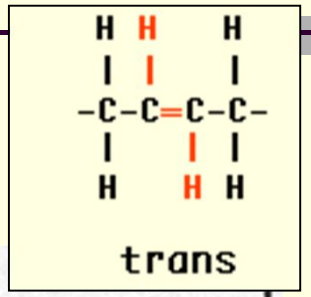


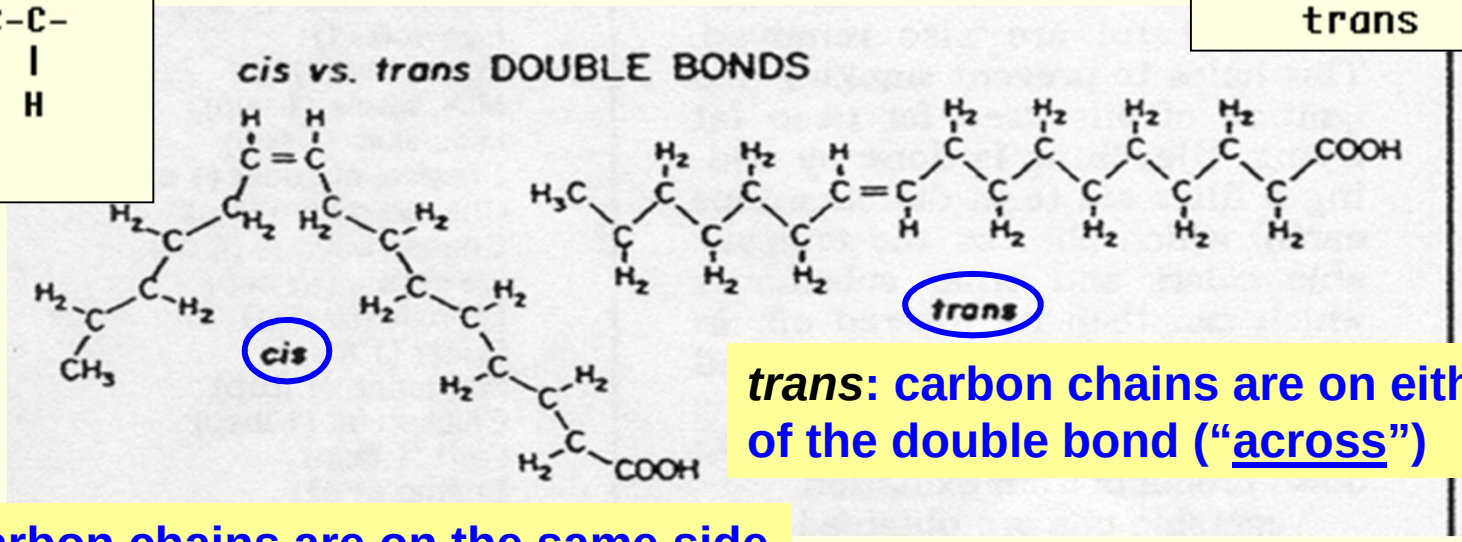
2. Fats and Oils

Unsaturated…configuration

- UFA *Cis* configuration- naturally occurring







***trans*: carbon chains are on either side of the double bond ("<u>across</u>")**

***Cis*: carbon chains are on the <u>same</u> side of the double bond**

2. Fats and Oils

Properties of Saturated, Unsaturated

Vegetable oils…

Also less stable!

double bonds – easily oxidized (oxidative rancidity)

- PUFA more reactive than MUFA

2. Fats and Oils

Rancidity

improper storage, repeated exposure to high temp.

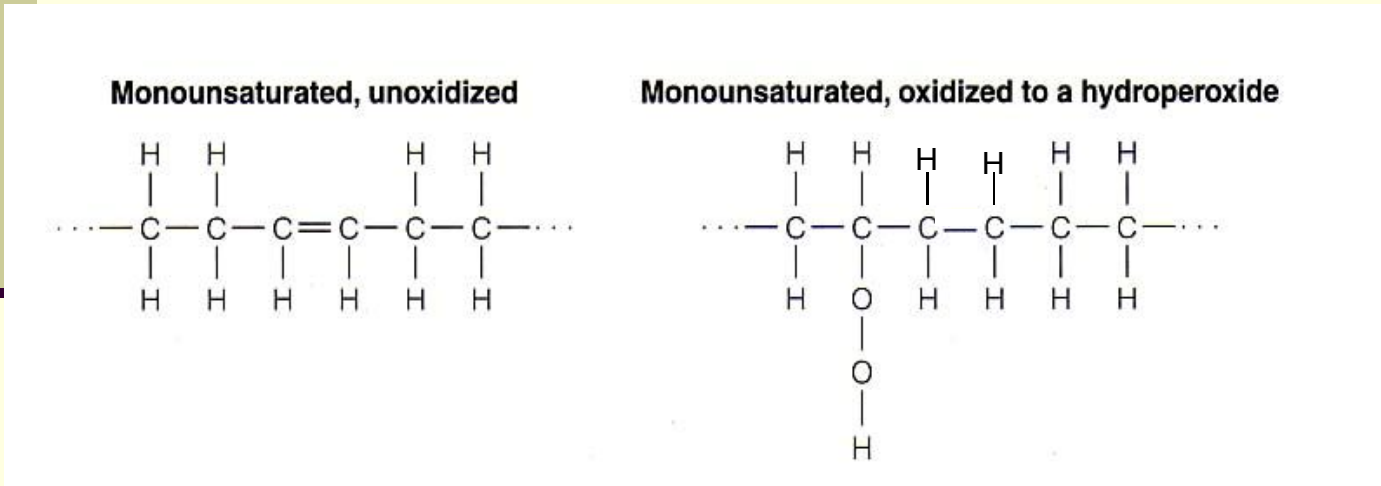
2 types:

1. OXIDATIVE
2. HYDROLYTIC or LIPOLYTIC

2. Fats and Oils
Properties

1. Oxidative rancidity (double bonds + oxygen → products ... off-flavours, carcinogenic compounds ...)

UFA or PUFAs + heat, light, Oxygen → hydroperoxides → OHs, ketones aldehydes,



2. Fats and Oils

Properties

2. Hydrolytic or lipolytic rancidity (cleavage of bond linking FA to glycerol → releasing free FAs)

- **lipase enzymes**

Triglyceride + lipase → short-chain (free) FAs + glycerol

(odorous)

- **Reduce <u>rate of oxidative rancidity</u>**:
  - proper storage & packaging (away from light, oxygen, warm temp)
  - limiting repeated exposure to high temp
  - addition of antioxidants (natural and synthetic)
  - hydrogenation

2. Fats and Oils

Hydrogenation (partial):

- Also used by the food industry to "harden" liquid oils into semi-solid fats (e.g. margarine)

Trans FA can be generated!

P. Hydrogenation of UFAs = *Trans*-fats

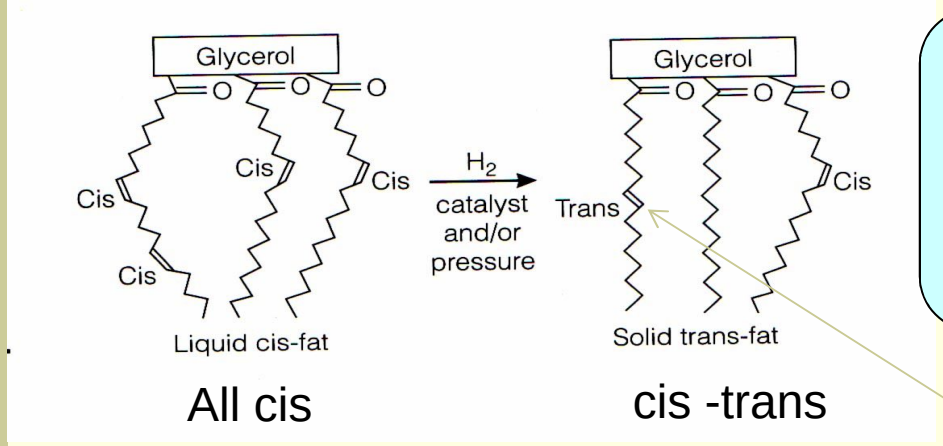
- hydrogen atoms are forced into the unsaturated double bonds of the UFA

- Raises the fat melting point (MP)
  - less prone to oxidize

Critical thinking question

- What will affect the melting point of fats/oils?

P. Hydrogenation of UFAs ⇒ *trans* FA



Newer margarines use blending to achieve the desired solid-liquid ratio and melting properties.

trans configuration

- Trans fatty acids : lose "*kink*" originally present in the *cis* form
  - "pack closer together" = the texture more semi-solid.

BUT… healthy?

Trans-fats...

- Behave like saturated fat
- Raise LDL cholesterol $\Rightarrow$ Coronary Heart Disease (CHD)!
- Labelling required: amount of *Trans-fat*

(2) Fats
Functional properties

- Mouthfeel- lubricant in food
- Carrier of aroma & flavour
- Shortening/Tenderizing power
- high-temperature medium (deep fat frying)
- Emulsifiers

Review: Table in Lesson 2

2. Fats and Oils

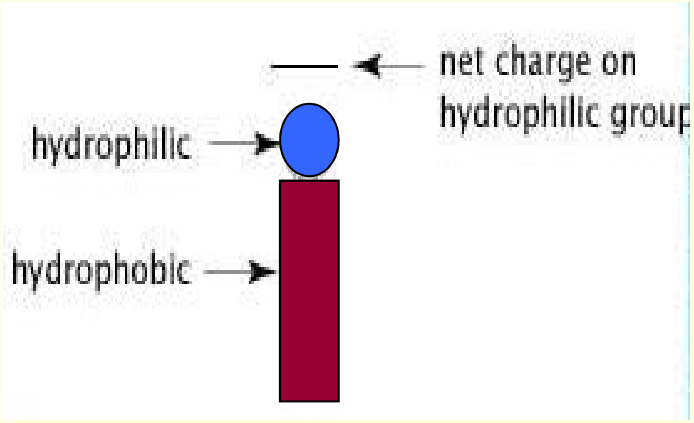
Emulsions & Emulsifiers

- O/W or W/O Emulsions
- ***Emulsifiers***
  - lecithin (phospholipid) from *egg yolk*, *soybean oil*
    - 2 FAs + phosphoric acid linked to glycerol
- help reduce interfacial tension → form an emulsion

2. Fats and Oils

Emulsifiers…

- amphiphilic /amphipathic molecules:
  - Hydrophilic: water-loving (i.e. glycerol linked to an organic acid)
  - Hydrophobic/lipophilic: water-hating or lipid-loving groups; (i.e. fatty acid)



NOTE:

stabilizers (not the same as emulsifiers)

- Increase viscosity of the continuous phase
  - keep the droplets suspended or dispersed
  - E.g. Polysaccharides

Thinking Lab:

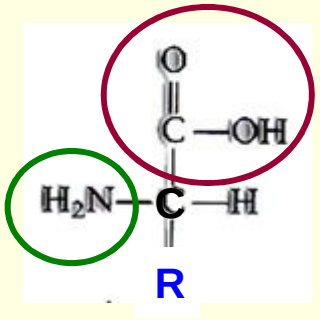
- Can you imagine what a piece of pie would look and taste like without the presence of fat in the crust? What functional properties of fat are involved in the pie crust formation?

- Some people use oil in their pie crust recipe, and some use lard. Which contains more saturated fat?

Major components: (3) ***Proteins***

3. Proteins…

- Contribute to 4 Cal/g
  - Require 0.8 g protein per kg body wt (adults)
  - Excess → converted to energy (4 Cal/g) or stored as fat.
- Polymers or long chains of amino acids linked by peptide bonds



amino group (**NH2**) and acidic (carboxylic **COOH**) group on the same carbon atom

R= side chain (hydrophobic, charged, polar, aromatic)

3. Proteins – Amino acids…

- 20 different amino acids naturally occurring in the human body and in foods
- 9 are essential (cannot be synthesized by humans). Must be obtained from FOOD

E.g. Leucine, Phenylalanine (used in aspartame...), Tryptophan...

3. Proteins-

- Amino acid sequence and 3-D structure of protein determines the Functional Properties in food as well as Nutritive value of the proteins

3. Proteins- **Protein quality**

- Protein quality of animal proteins is usually higher than plant proteins

  - **Plant** proteins
    - less digestible than animal proteins
    - have a less favorable ratio & quantity of one or more essential amino acids

3. Proteins- **Protein quality**

- Protein quality of foods can be improved by

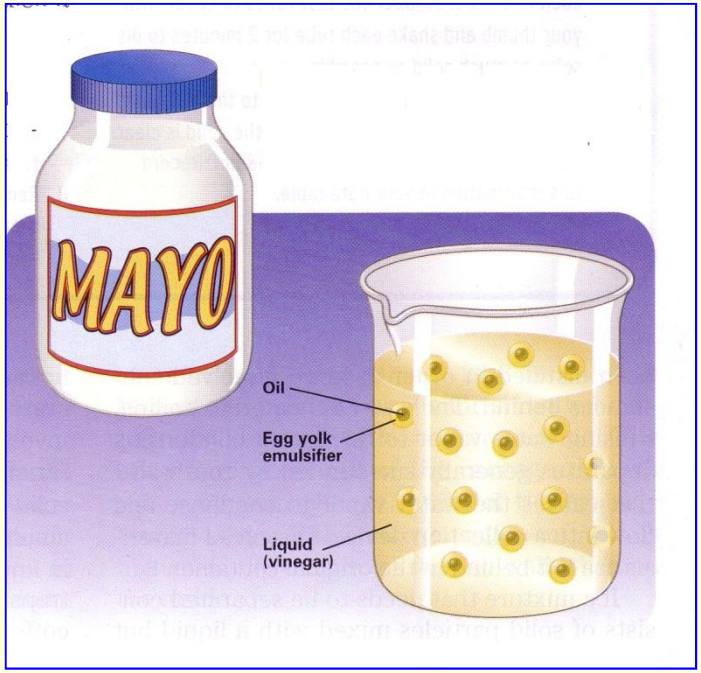
  …*mixing* = "**complementation**"

  "30 g of breakfast cereal **when consumed** with 125 ml of milk represents a good source of protein"

  …*mixing* = "**supplementation"**

3. Proteins- Functional properties

- **Emulsifiers**
  - **amphiphilic** molecules,
    - reduce interfacial tension;
    - eg., *egg yolk <u>proteins</u> in mayonnaise*



3. Proteins- Functional properties

- Foams
  - Trap air bubbles & form rigid 3-D structure when heated or cooled → solid foams
    - eg. meringues, bread, ice cream
- Gels
  - form 3-D structure that can trap water
    - eg. gelatin gels; yogurt; cheese; frankfurters

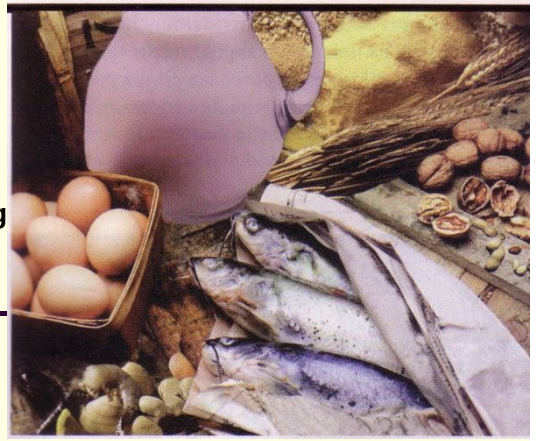
3. Proteins- Functional properties

- Enzymes: Proteins that function as biological catalysts
  - Promote a chemical reaction that will not occur spontaneously
  - Inherent in the foods or added in processing
  - desirable or undesirable reactions in foods

What are some examples of enzymes?
some we have already discussed in this course…

3. Proteins- Allergies

http://www.inspection.gc.ca/food/consumer-centre/food-safety-tips/labelling-food-packag storage/allergen/eng/1332442914456/1332442980290



- unable to digest certain proteins → exhibit symptoms of allergic reactions
- The 10 most common **food allergens/sensitivity promoters**:
  - milk, eggs, fish and crustaceans (shrimp, crabs), wheat, tree nuts, peanuts, soybeans, Sesame Seeds , Mustard, Sulphites
  - Peanut and tree-nuts most common

Cheese Making Procedure

Cheese Making Procedure

Major components: (4) ***Water***

4. Water

- Plays a key role in the quality of foods
- Free versus bound water
  - free water
    - properties typical of water
    - Found in *tissue* food systems & *dispersions*
    - Available for all chemical, enzymatic reactions & for microbial growth

4. Water

- bound water
  - adsorbed on macromolecules
    - E.g. proteins or polysaccharides,
  - bound to smaller molecules
    - sugars & salt
  - not readily available for chemical, enzymatic or microbial activity

4. Water- water activity

water activity (a_w)

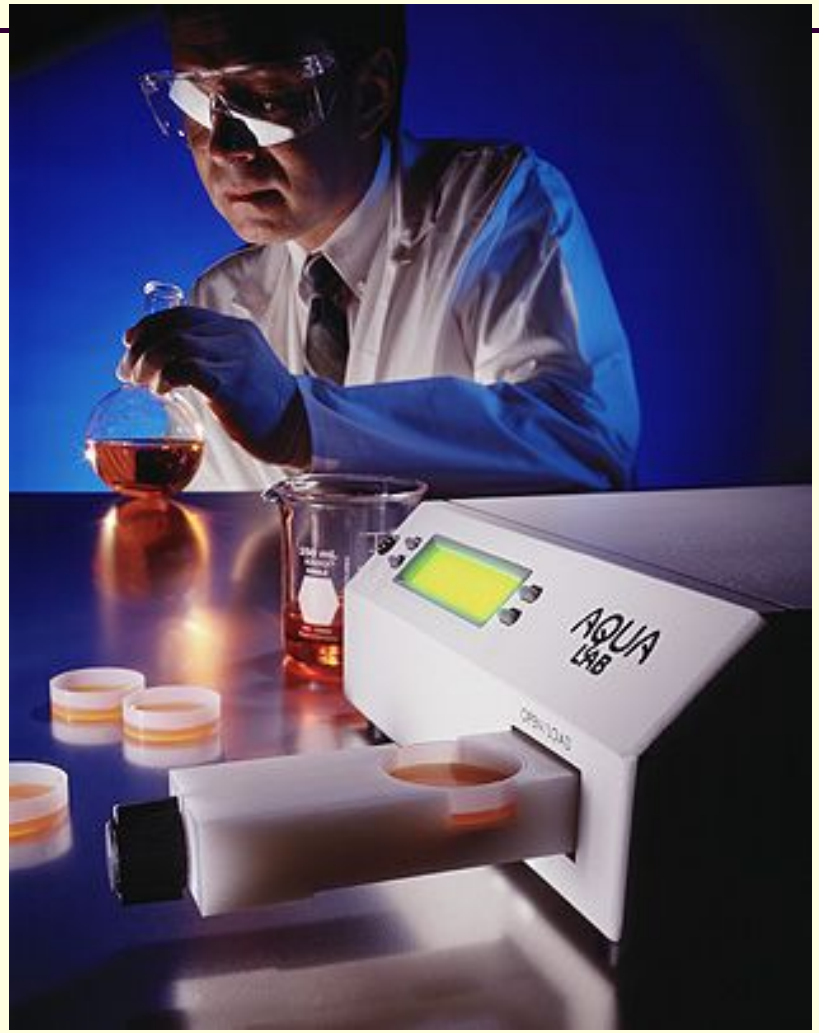
$$\frac{\text{vapour pressure of water in food at X}^{o}\text{C}}{\text{vapour pressure of pure water at X}^{o}\text{C}}$$

a_w can range from 0 to 1.0

4. Water- water activity

How is Aw determined in foods?

See animated figure in Lesson 2



4. Water- water activity

- Water content – total (measured)
- Water activity – primarily free

  "...indicator of the water available for chemical reactions, microorganisms..."

  - Table in L. 2
    - a_w and water content of various foods
    - the 2 values are not always related:

      salami a_w = 0.90, 61% water content

      bread a_w = 0.96, 35% water content

4. Water- water activity

- **Aw** in foods can be controlled (adjusted) by:
  - Addition of solutes (sugars, salts) - **bind** free water
  - Physically removing free water from foods
    - Processing: **freezing** (lesson 7),
    - **Concentration** or **dehydration** (lesson 8)