Advanced crop quality
Lecture- 9

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Lipids

What are the main functions of lipids in plants?

Lipids are found in every part in plants, and have vital role in biology either from plant or animal origin.

They perform many important functions, including :

- ✓ Storing metabolic energy, (e.g., triacylglycerols in seeds)
- ✓ Protecting plants against dehydration and pathogens
- ✓ Carrying electrons.
- ✓ Absorbing light.
- ✓ Lipids also contribute to the formation of membranes.
- ✓ They can act as important signaling molecules and hormones.

to regulate cell metabolism.

What is the source of the formation of fatty acids and glycerol in plants?

- The scientist Wadly (1944) explained that the sugars resulting from the photosynthesis process are transformed into sugars then the formation of starch, and through the process of decomposition and oxidation of monosaccharides, glycerol is produced, while in the case of reduction and condensation of monosaccharides, fatty acids are formed.

$Co_2 + H_2O$ → سكر احادي → سكر ثنائي → نشا

reduction and condensation

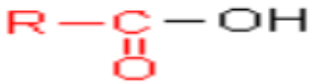
decomposition and oxidation •

fatty acids •

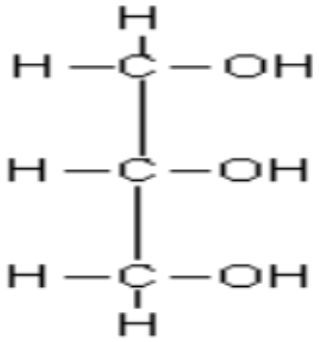
glycerol •

Structures of Fats and Oils

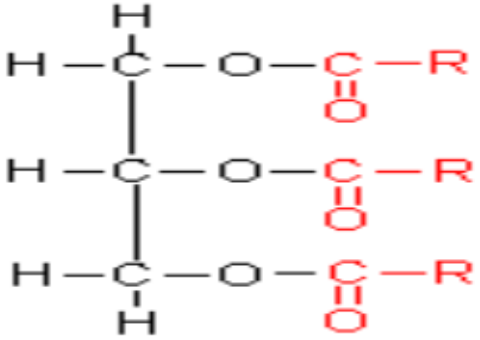
Fats and oils, whether of vegetable or animal origin, are a group of organic materials called triglycerides (or triacylcylgerols) because they are esters composed of three fatty acid units joined to glycerol, a trihydroxy alcohol.



Fatty acid



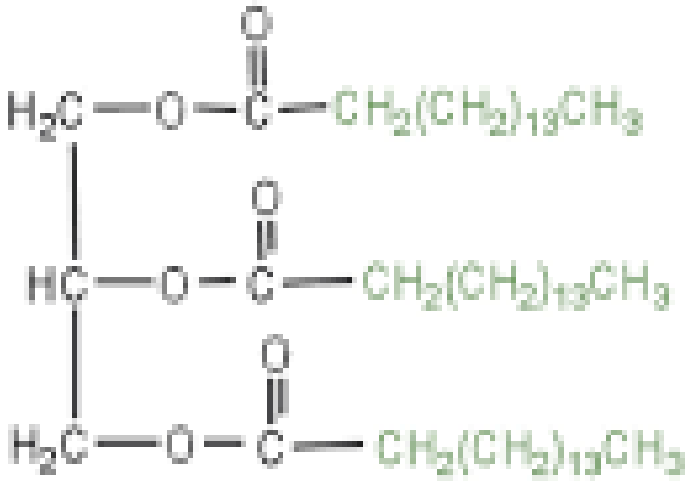
Glycerol



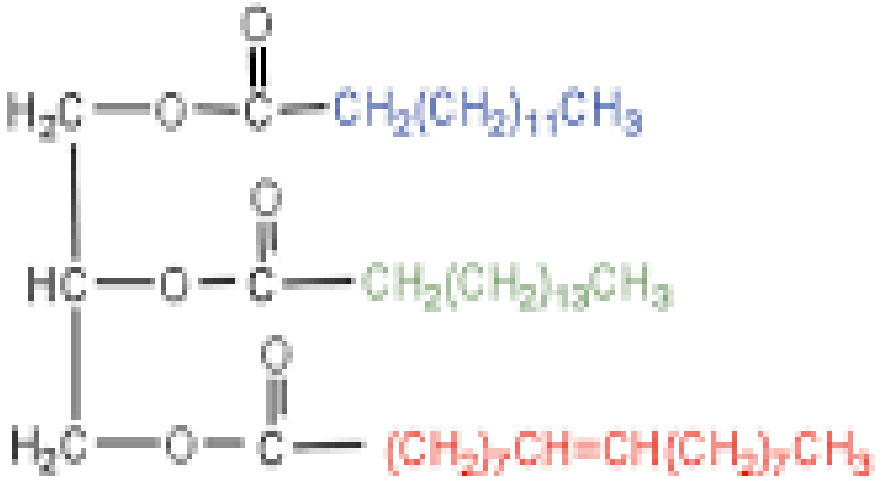
Triacylglycerol

Simple &Mixed Triglyceride

- If fats and oils contains the same fatty acid, the resulting ester is called a simple triglyceride. Although simple triglycerides have been synthesized in the laboratory, they rarely occur in nature.
- A typical triglyceride obtained from naturally occurring fats and oils contains two or three different fatty acid components and is thus termed a mixed triglyceride.



Tristearin
a simple triglyceride



a mixed triglyceride

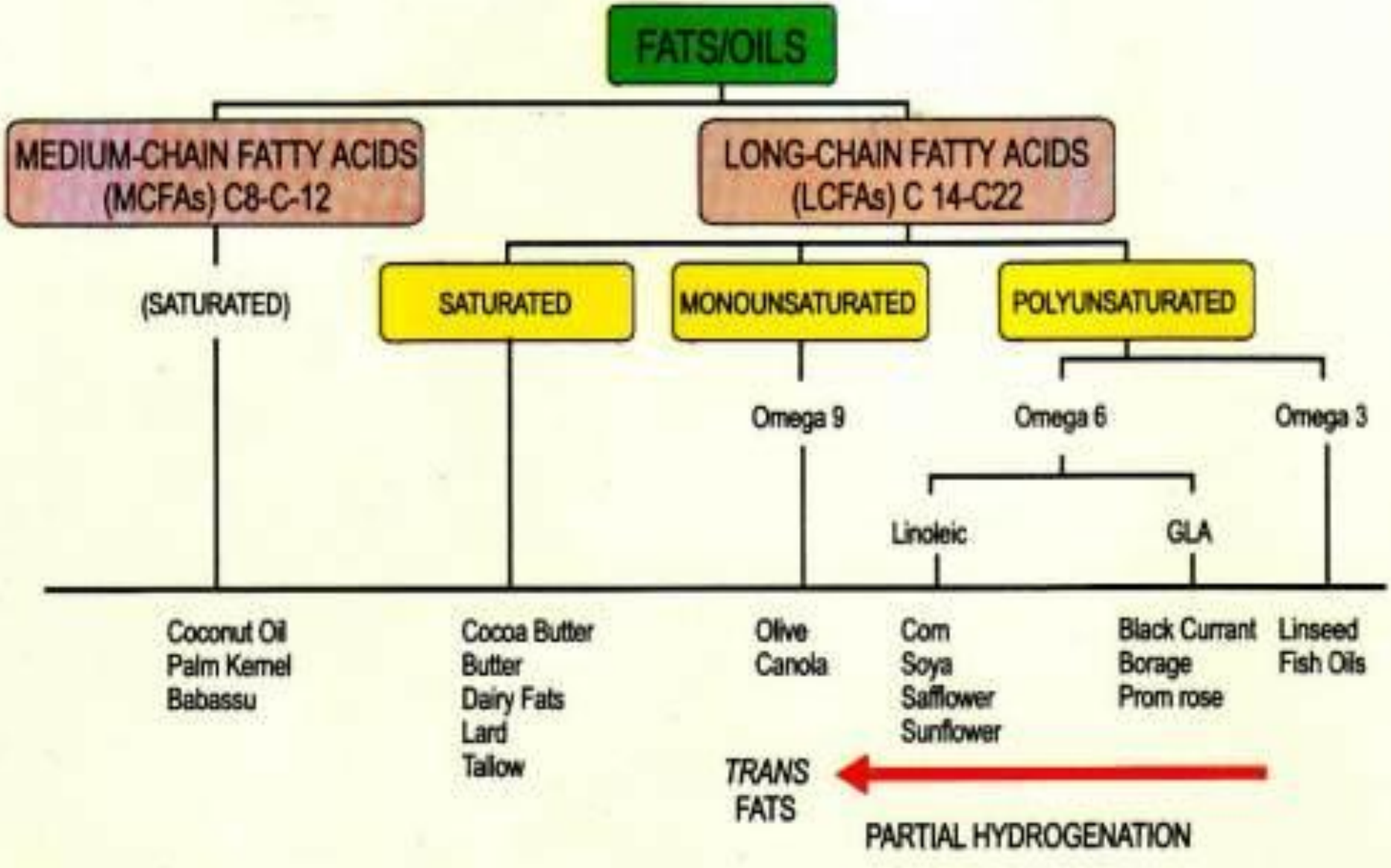
Oils quality

- The quality of the oils comes from the quality of the fatty acid which is included in its composition.
- The oil contains an energy that is estimated at twice the energy of carbohydrates.
- Therefore, the presence of oil in the seeds is energy for the growth of seedlings because they are considered a food store, even if they are in small quantities.
- In most of the plant parts, we notice when the oils are accompanied by the disappearance of sugars.
- There is a consumption of carbohydrates, as is what happens in sunflower seeds and flax
- Fats do not dissolve in water, as they cannot be transferred from one cell to another or from one tissue to another.
- The word oil or fat is two explanations for the physical state of the ester.
- If it is liquid at normal temperatures, the name is oil, and if it is solid, then it is called fat. This depends on the relationship to the carbon chain of the fatty acid.

Types of fatty acids

Type of Fatty Acid	Double Bonds	Diagram
Saturated	None	
Monounsaturated	One	
Polyunsaturated	Multiple (>1)	

CLASSES OF FATS & OILS

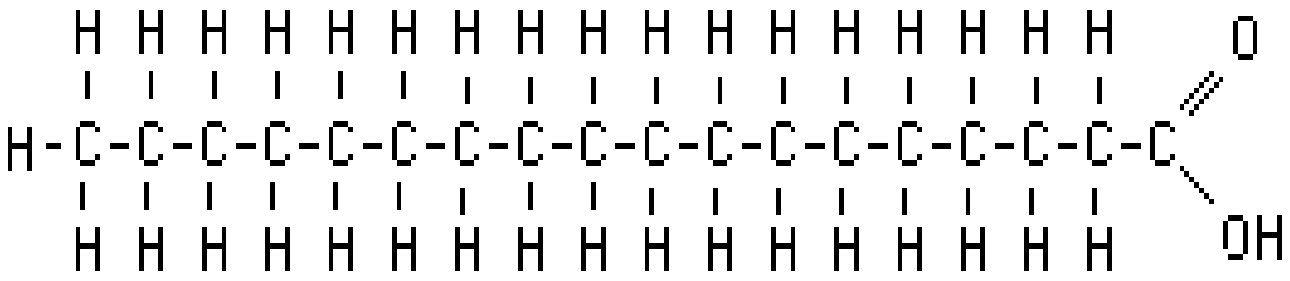


Classification of Fatty Acids

One system of fatty acid classification is based on the number of double bonds.

- **1-saturated fatty acids:** 0 double bonds

Acids with a long continuous unbranched hydrocarbon chain containing single bonds between carbon atoms and the most common containing 16 carbon atoms is **palmitic acid** or containing 18 carbon atoms such as stearic acid.

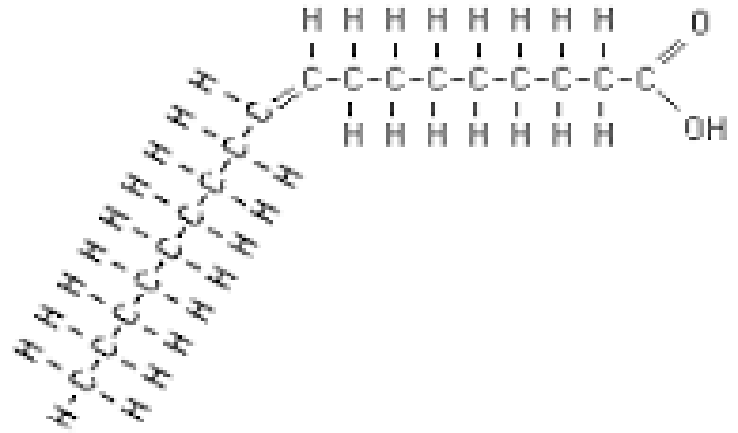


Stearic acid, a saturated fatty acid

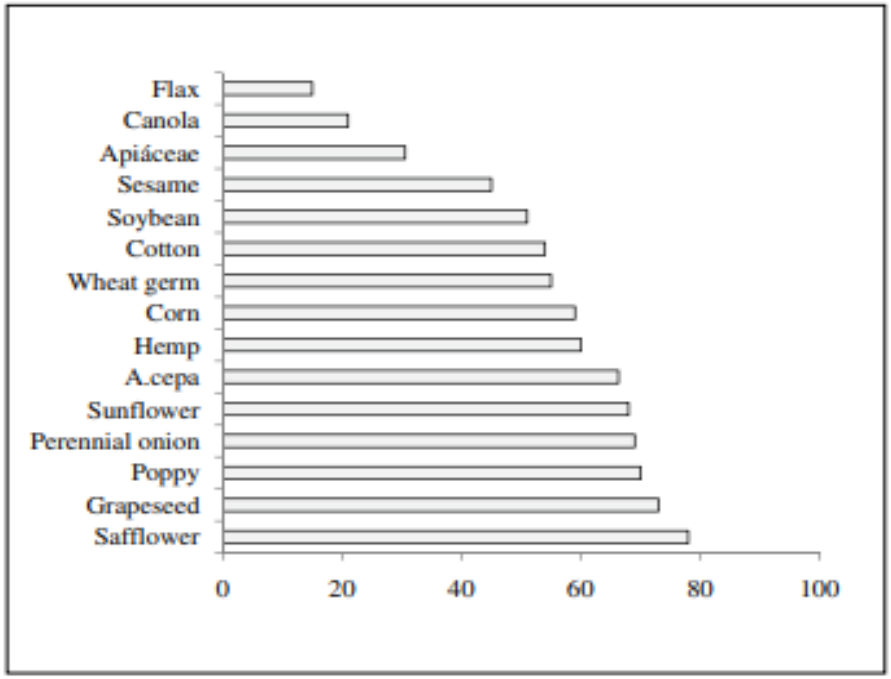
2-Unsaturated fatty acids

❖1 double bond: monounsaturated fatty acids

saturated Oleic acid is a typical monounsaturated fatty acid.



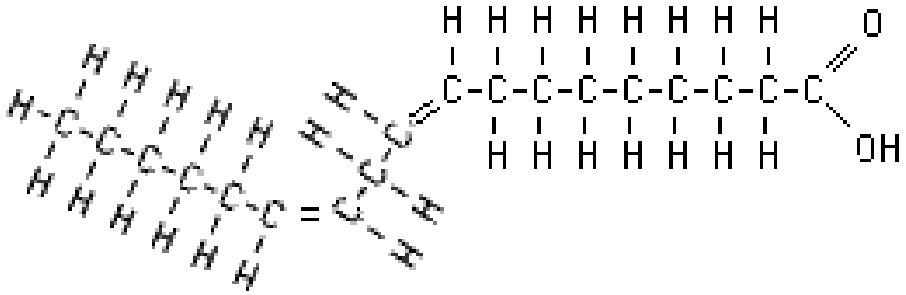
Oleic acid, a monounsaturated fatty acid. Note that the double bond is *cis*; this is the common natural configuration.



Content (%) of oleic acid in several natural oils.

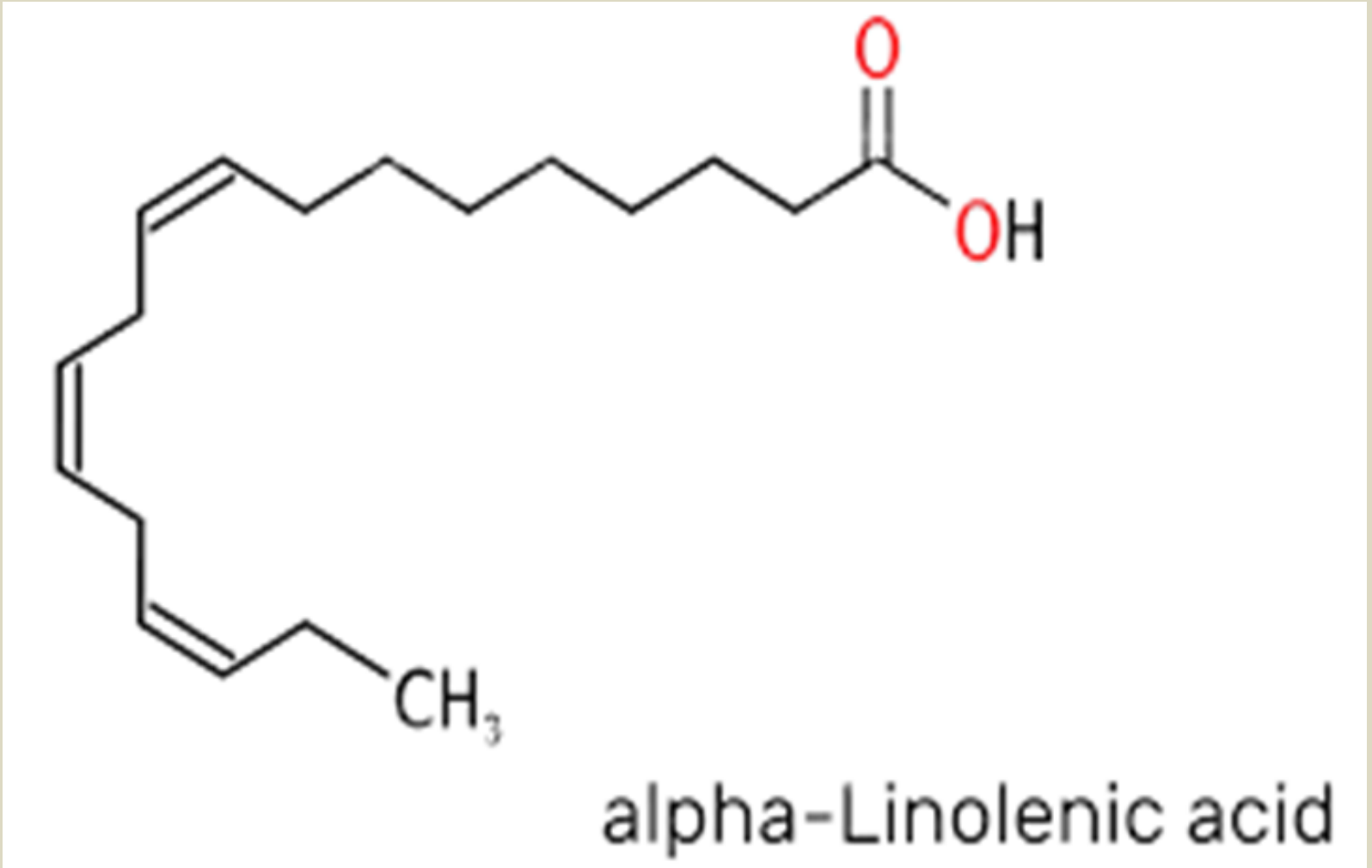
2 double bonds: polyunsaturated fatty acids

-Linoleic acid is a typical polyunsaturated fatty acid.

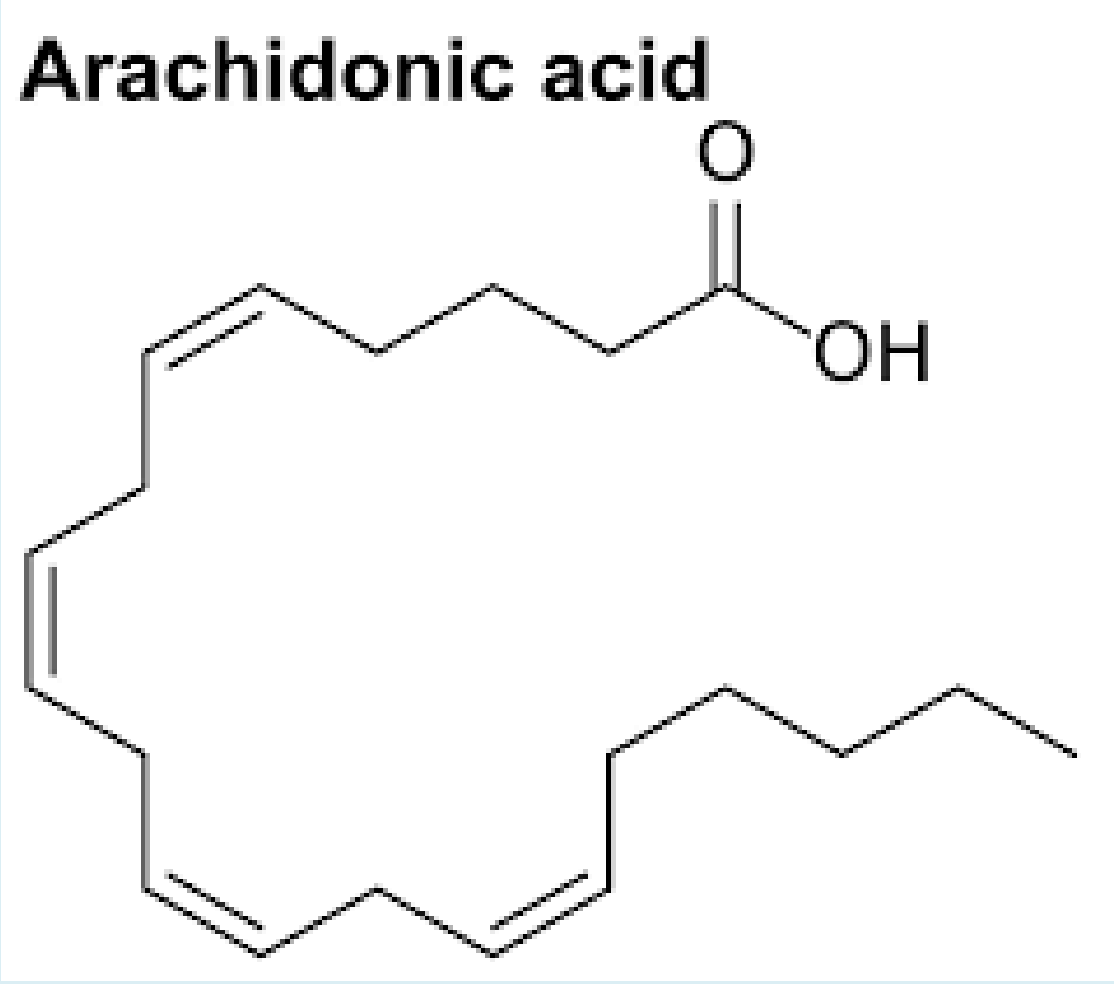


Linoleic acid, a polyunsaturated fatty acid.
Both double bonds are *cis*.

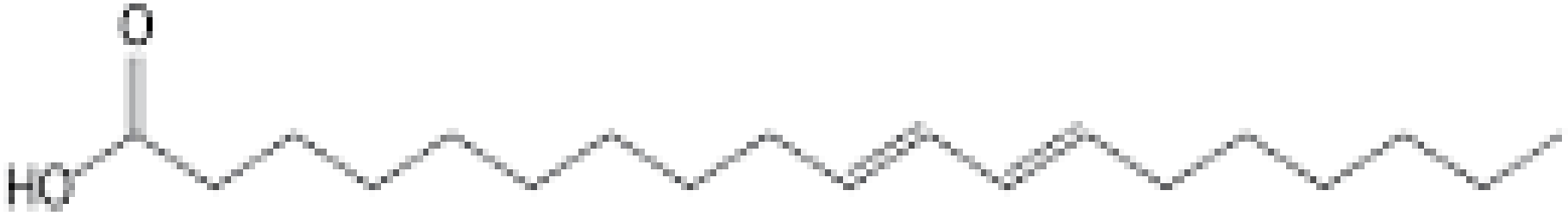
- 3-double bonds -Linolenic acid



- 4- double bonds, such as Arachidonic acid

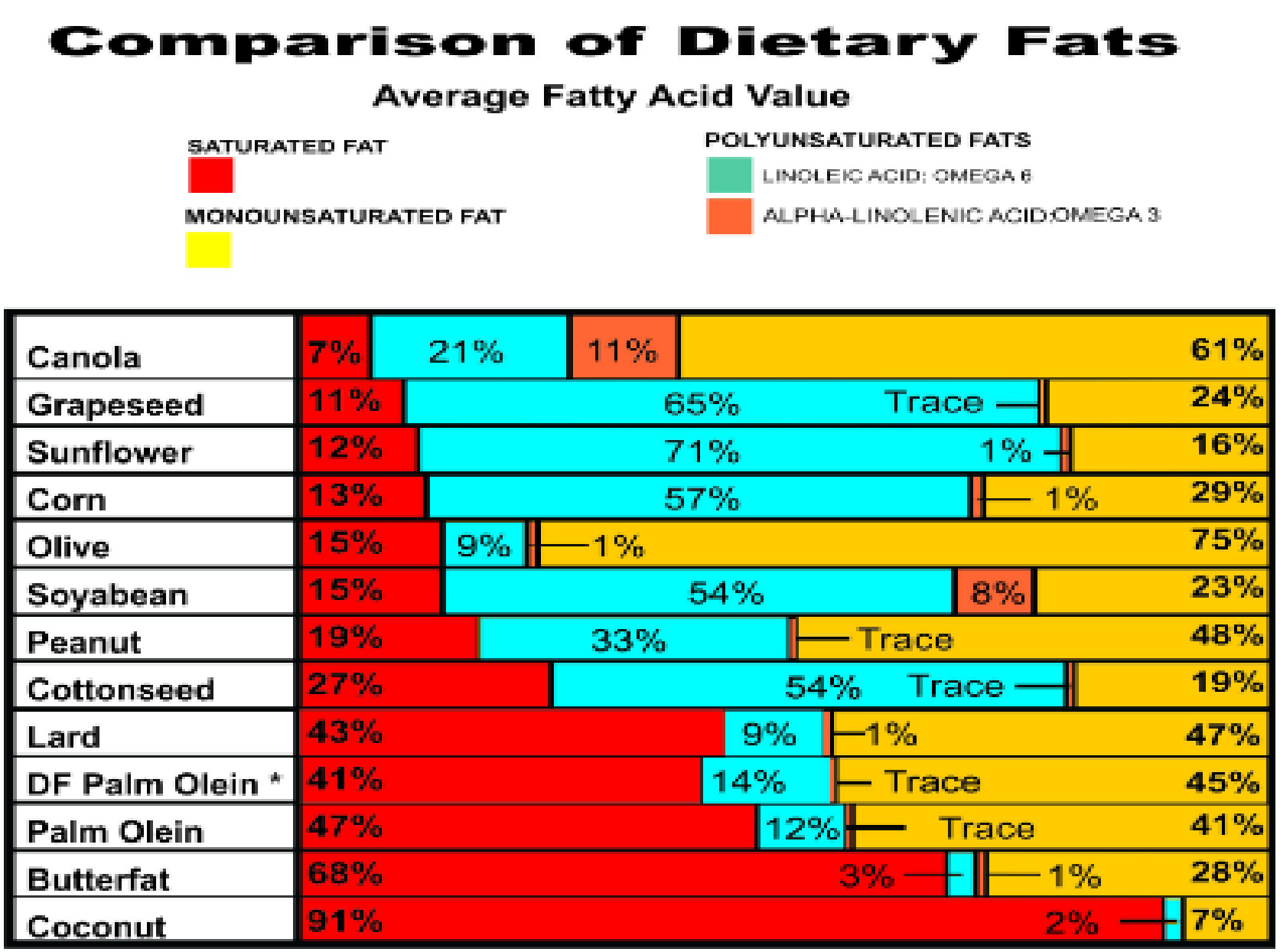


Oleic acid



Linoleic acid

Linolenic acid



*Double Fractionated

Fig. Comparison of Average Fatty Acid Values of Dietary Fats

Bases for testing fats and oils

1-Color tone:

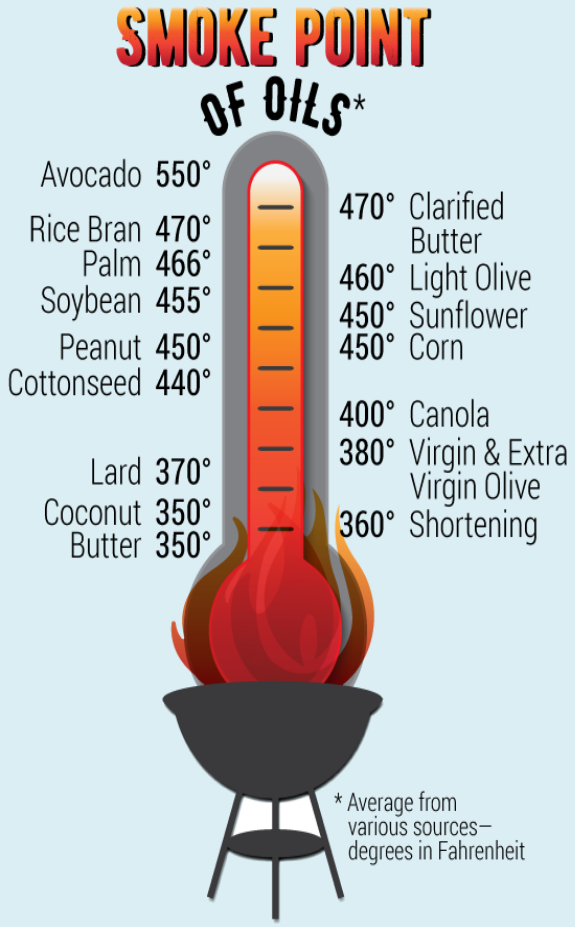
This is done by more than one method, such as the Lovibond method, which is done by comparing the standard color or by the spectrophotometer method, which is based on the absorption of light in a specific wavelength (520-550 nanometers) and it is calculated by equations.

2-Smoke point: It is the temperature at which it begins to give off moke, due to the thermal decomposition of the oil into glycerol and free fatty acids.

- Temperatures above the smoke point of an oil are undesirable, as the acrolein starts to be produced, and the oil goes rancid.

-**Several factors determine the smoke point of an oil. Saturated fatty acids provide stability and are more resistant to high heat, while polyunsaturated fats are more sensitive to both light and heat**.

-This means that excessive heat can cause production of heat free radicals and harm the body if consumed.



3-Melting point

The fat differs in this characteristic depending on the length of the chain (stearic acid) and the number of unsaturated bonds.

Oils have lower melting points than fats(WHY?)

Oil	Melting Temperature (°C) (deg F)
Butter	32 - 35
Castor Oil	-18
Cocoa butter	34
Coconut Oil	25
Cotton Seed Oil	-1
Lard	41
Linseed Oil	-24
Margarine	34 - 43
Mutton Tallow	42
Olive Oil	-6
Palm Kernel Oil	24
Palm Oil	35
Peanut Oil	3
Rapeseed Oil	-10
Sunflower Oil	-17
Soybean Oil	-16
Tung Oil	-2.5

4-Titre Point

It is the highest temperature at which the molten fat begins to freeze at Cool it gradually. It is used to determine the purity of fatty acids.

It is known that the higher the freezing point of fat, the more:

1- The hardness of the fat increased.

2- The percentage of saturated acids increased and the percentage of unsaturated acids decreased.

5-Saponification Value:

The number of mg of potassium hydroxide required to neutralize the fatty acids resulting from the complete hydrolysis of 1g of the sample.

Knowing the saponification number, we can conclude the following:

1- The amount of alkali needed to saponify the fatty substance.

2- The amount of soap produced.

3- The amount of glycerin in the fatty substance.

4- The average molecular weight of the fatty substance and then the average length of the fatty carbon chain of the mixture of fatty acids that make up the fatty substance.

6-The iodine value:

Is the mass of iodine in grams that is consumed by 100 grams of oil or fat.

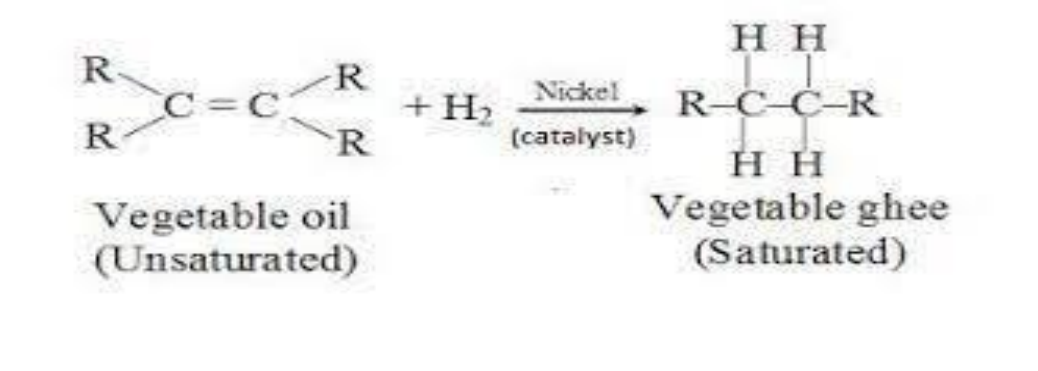
- Iodine numbers are often used to determine the amount of unsaturation in fats, oils and waxes.
- Usually, iodine combines with fatty acids that have double bonds, which gives an idea of the unsaturation of the fatty acids in its composition.
- When the value of the iodine number decreases, this indicates the saturation of the fatty acids that make up the fatty substance.

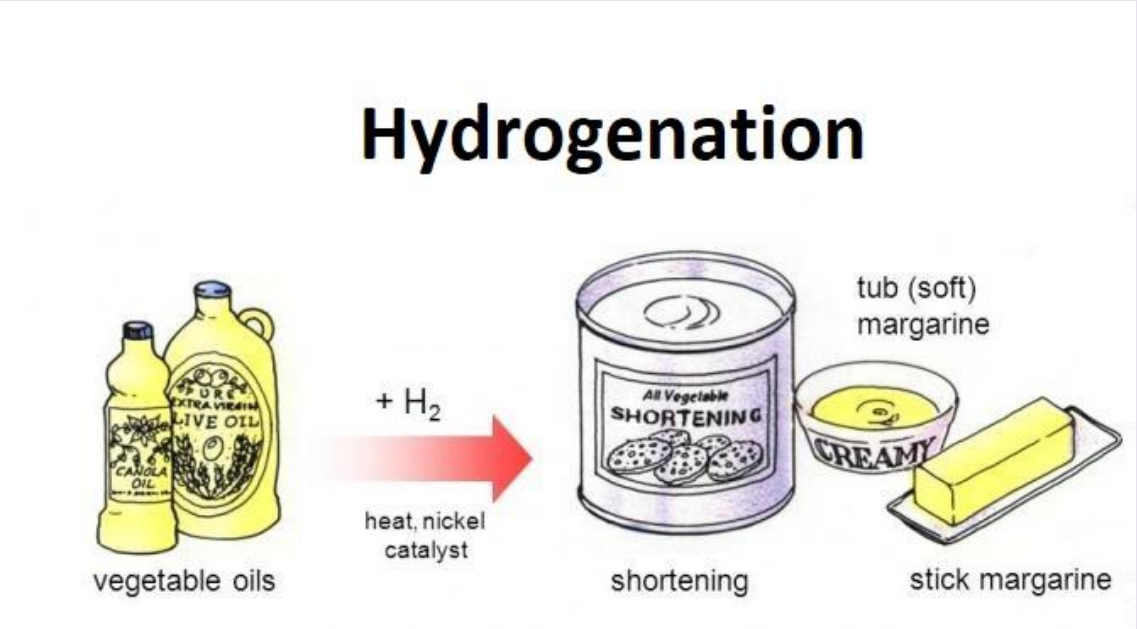
- **Saturated fatty acids have all the carbon atoms saturated, so this type of fatty acid cannot react with iodine.**
- **As for unsaturated fatty acids, they interact with iodine, where the double bonds are saturated with iodine. At first, we notice that the color of iodine disappears, and the color remains constant when all double bonds are saturated.**
- **Therefore, the iodine number of unsaturated fatty acids is higher than the iodine number of saturated fatty acids.**
- **Dryable oils are considered the highest value oils in terms of their iodine number, and the iodine number of oils is always higher than the iodine number of solid fats. It is also used to detect adulteration in olive oil.**

Oil	Iodine Value
Coconut oil	7.5-10.5
Olive oil	79-90
Palm oil	4-22
Sunflower oil	125-140
Ghee	26-38
Groundnut oil	84-100
Mustard oil	98-110
Sesame oil	103-116

Hydrogenation:

Is a process where manufacturers add hydrogen to a liquid fat, such as vegetable oil, to turn it into a solid fat at room temperature.





7-Acidity Number:

It is the number of milligrams of potassium hydroxide (KOH) needed to neutralize the free fatty acids present in 1 gram of fat or oil.

Oils and Fats	Acid value mg KOH/1 g oil	References
Refined sunflower	0.2–0.5	[12,13]
Crude *Jatropha curcas*	15.6–43	[8,14]
Refined Safflower	0.35	[15]
Crude palm	6.9–50.8	[16,17]
Cottonseed	0.6–2.87	[18,19]
Corn	0.1–5.72	[20.21]
Coconut	1.99–12.8	[22,23]
Soybean	0.1–0.2	[24,25]
Animal fats	4.9–13.5	[26]
Canola	0.6–0.8	[27,28]
Waste cooking	0.67–3.64	[29]

Rancidity of oils &fats

Rancidity is the process through which oils and fats become partially or completely oxidized after exposure to moisture, air, or even light. Foods can go rancid long before they become old.

- Fats or oils that have changed their chemical and physical properties.
- change and smell due to decomposition or oxidation, using different compounds.
- changing the taste of food and preventing it from vitamin A, carotene and vitamin E.
- affecting in reaching the state of rancidity, copper salts, iron salts, moisture and heat.
- Vegetable oils and fats are less rancid than animal oils may rancid when they are in their seeds in storage


Thank you
for Listening!