FE 376

FOOD QUALITY CONTROL

FATS AND OIL

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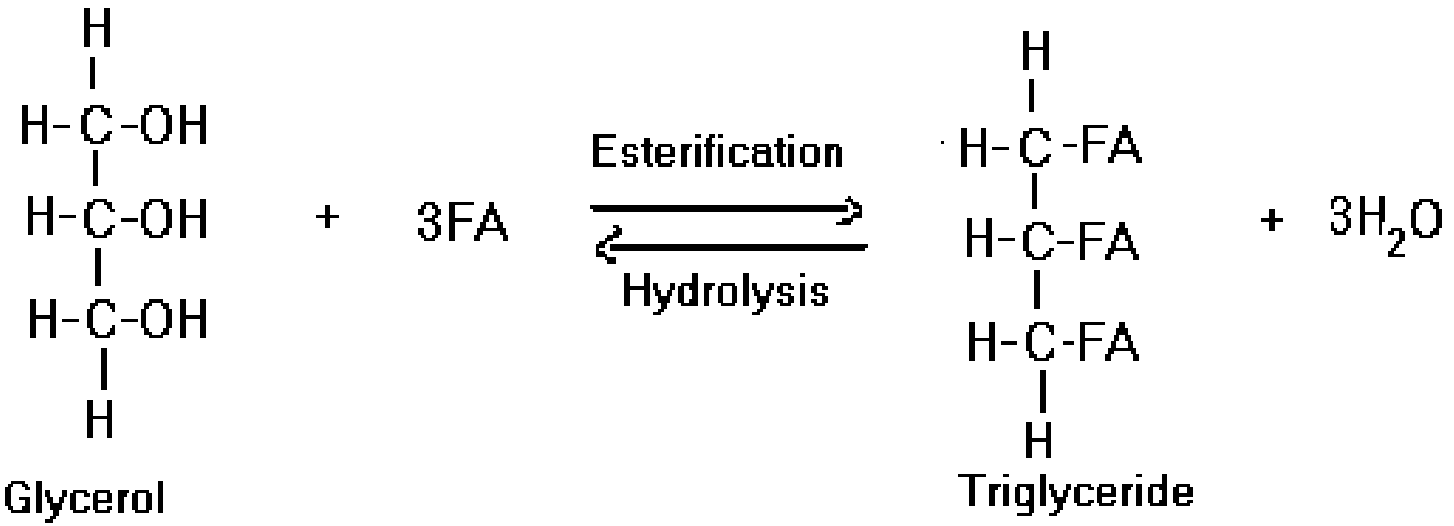
What is fat and oil?

- Fats and oils are esters which result from the reaction of acids and alcohols.When the three –OH groups of a glycerol react with a fatty acid molecule the resulting ester is called as triglyceride.



- Fatty acid can be saturated or unsaturated.
- If fatty acid don't have any double bound→ SATURATED
- If it contains double bonds in structure→UNSATURATED

- All natural fats contains both s.f.a and u.s.f.a ,and the melting points of saturated and unsaturated fatty acid are different from each other, therefore we can not say any melting point for fats we can only mention about melting range.

$\frac{U.S}{S}$ If this ratio increase –>melting point will decrease

If this ratio decrease–>melting point will increase

Hydrolytic rancidity;

- It occurs as a result of hydrolysis of triglyceride molecules to glycerol and free fatty acid.
- It takes place by the presence of moisture in oil. It can be accelerated by the presence of enzymes and microorganisms.
- Result→ unpleasant odour and flavor.

Indicator Free fatty acid

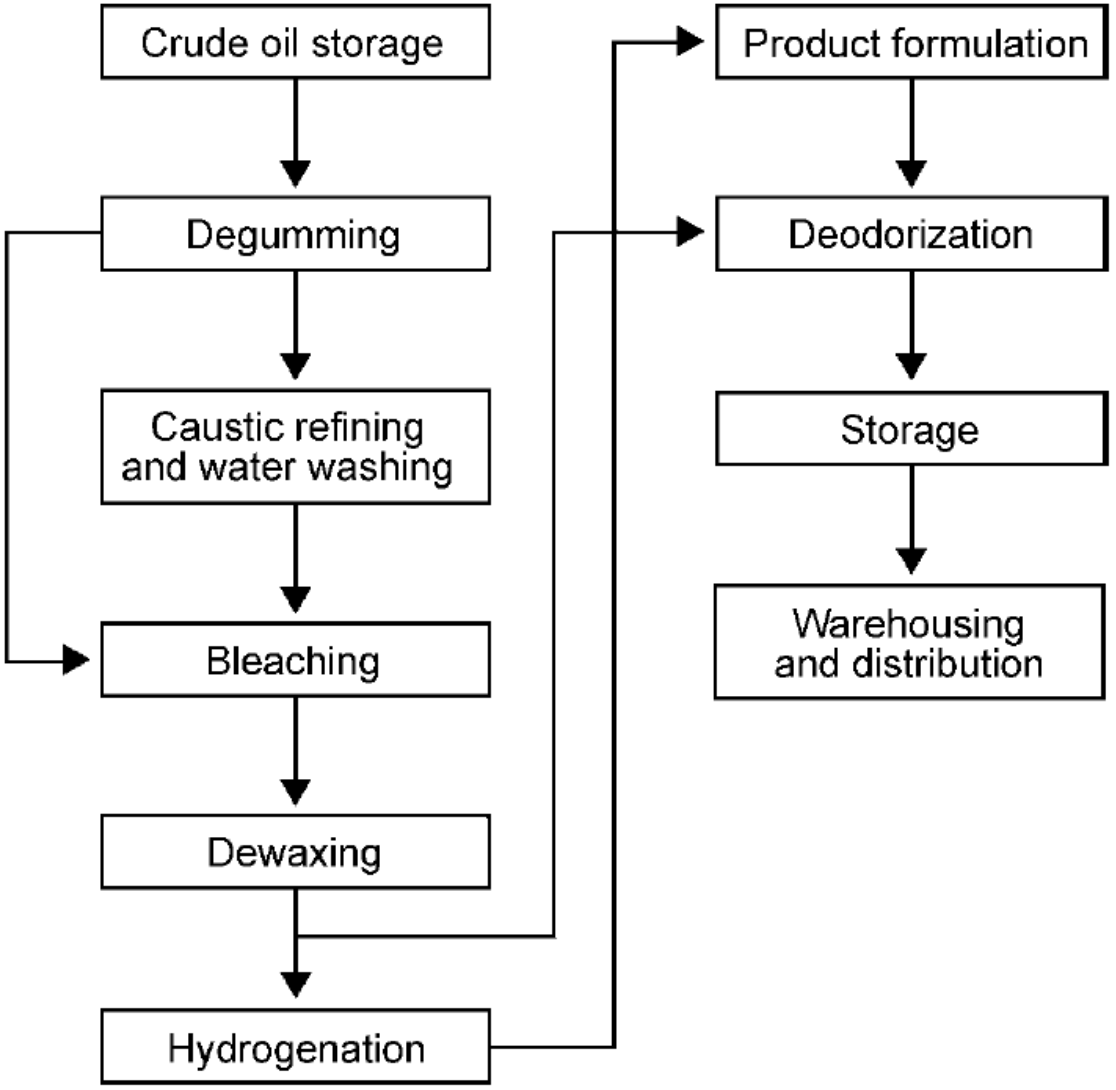
Oxidative rancidity;

- **It** is caused by the reaction of unsaturated oils with oxygen.It completed with 3 stage.
- After each stage different types of substances are produced such as aldehydes ,ketones , lactone ..... and these substances cause undesirable odor and flavor.

Indicator Peroxide value

Aldehydes, ketones, …

Technology



Schematic diagram for sunflower oil refining.

Objectives of Refining

1. Removal of undesired products from crude oils
    - •free fatty acids (FFA)
    - •phospholipids (gums)
    - •oxidised products
    - •metal ions
    - •colour pigments
    - •others

2.Preservation of valuable vitamines.
    (vitamina E ortocopherol–natural anti-oxidants)

3.Minimize oil losses

4.Protection of the oil against degradation

Steps of the chemical refining process

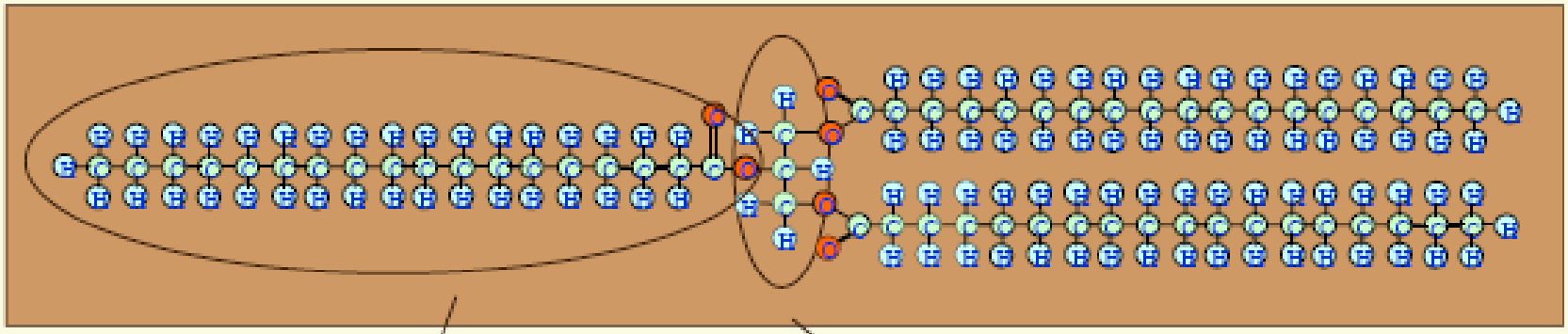
1.Degumming:
Reduction of phospholipid (gum) content

2. Neutralisation:
Removal of free fatty acids and residual gums

3. Bleaching:
Removal of colour pigments and metal ions

4. Deodorization:
Removal of odours

Structure of Triglycerides

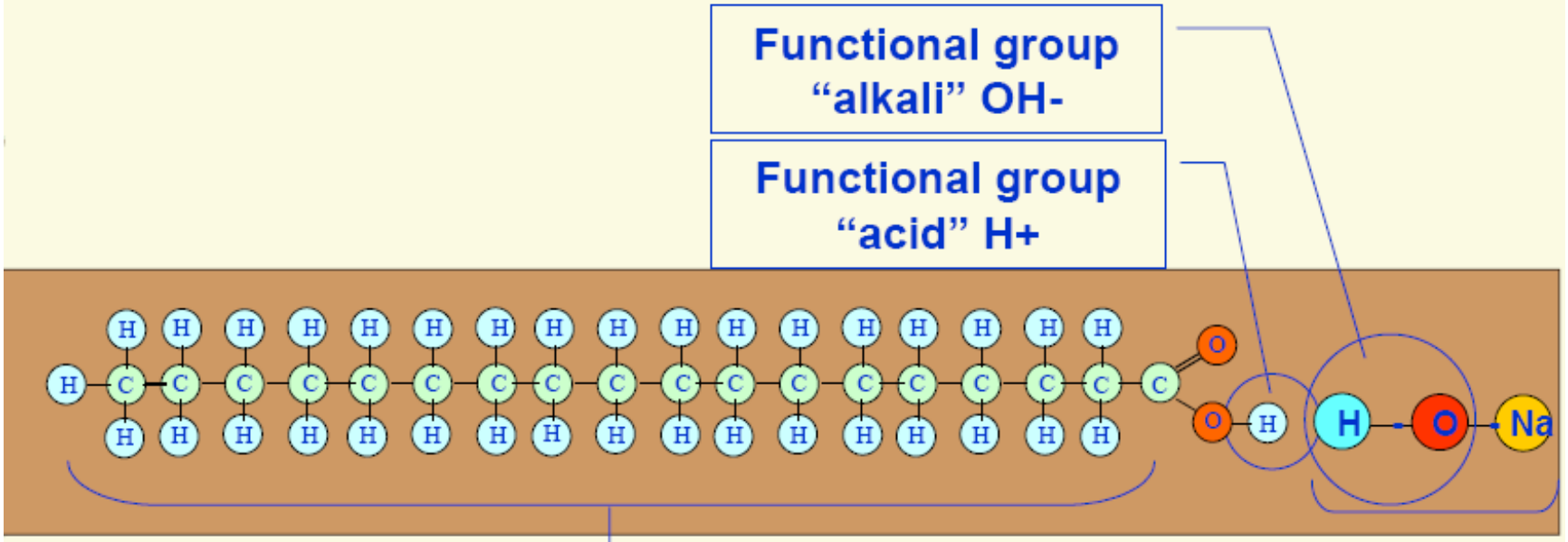


Stearic acid

Glycerol

Chemical Neutralisation

(after the reaction with caustic soda)

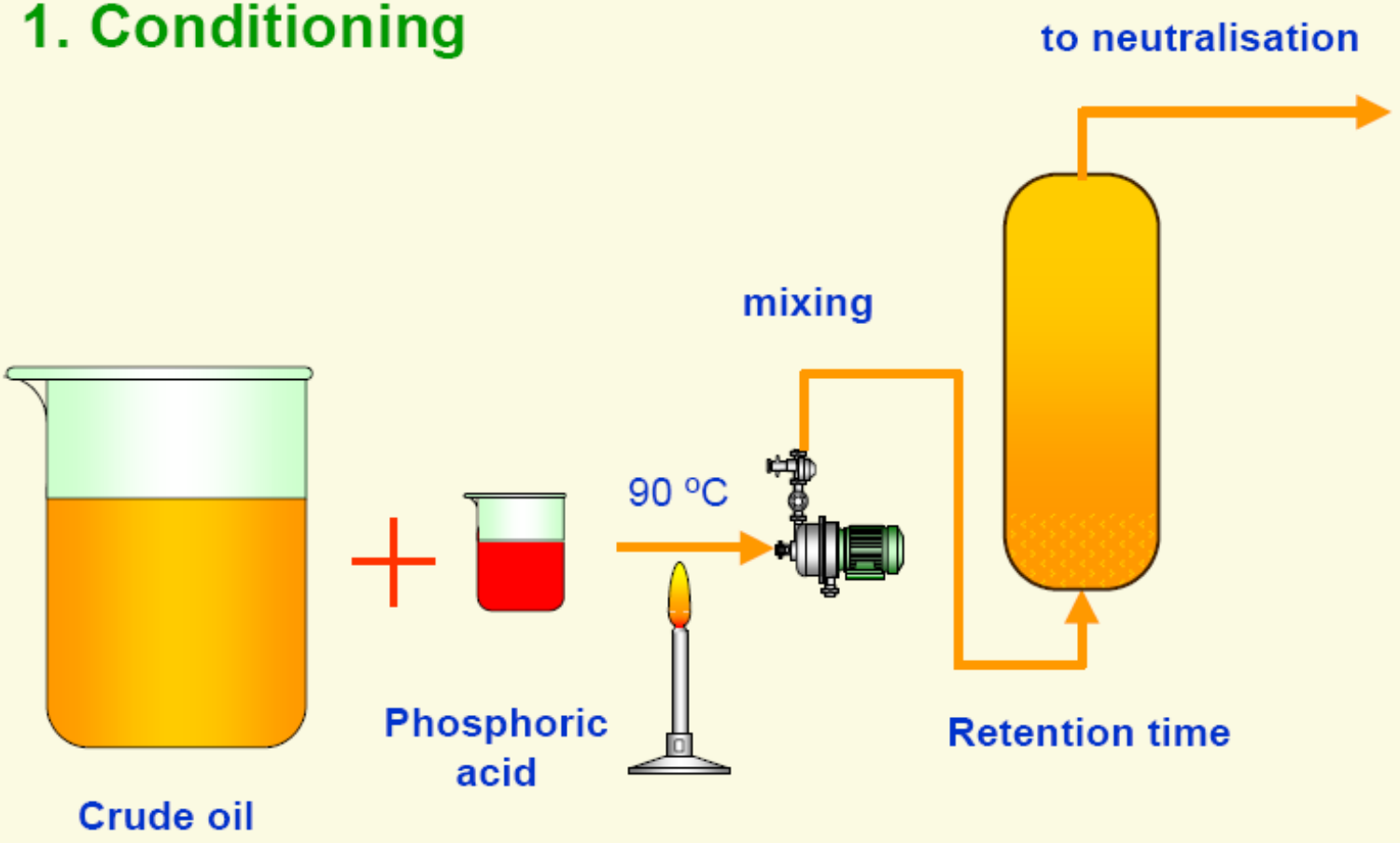


fatty acid + caustic soda

= soap + water

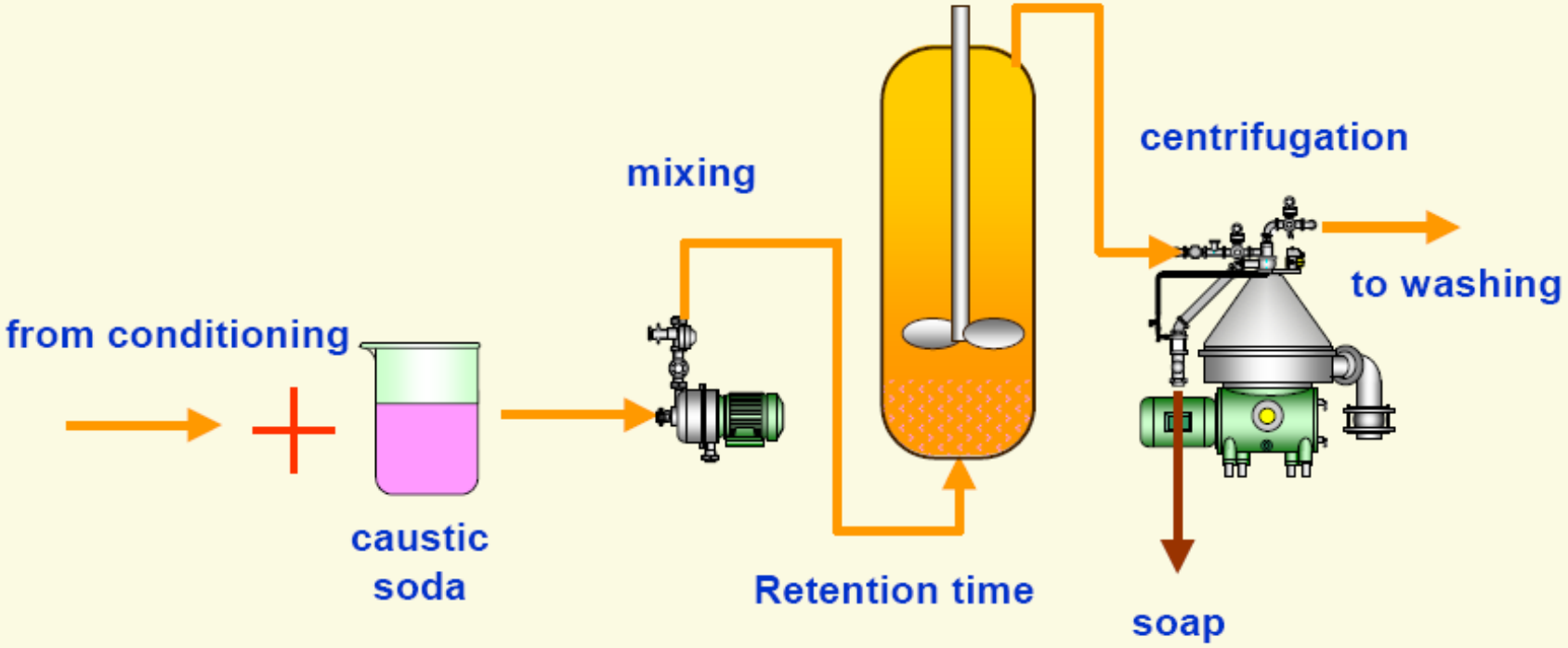
Steps of Alkali Refining

1. Conditioning



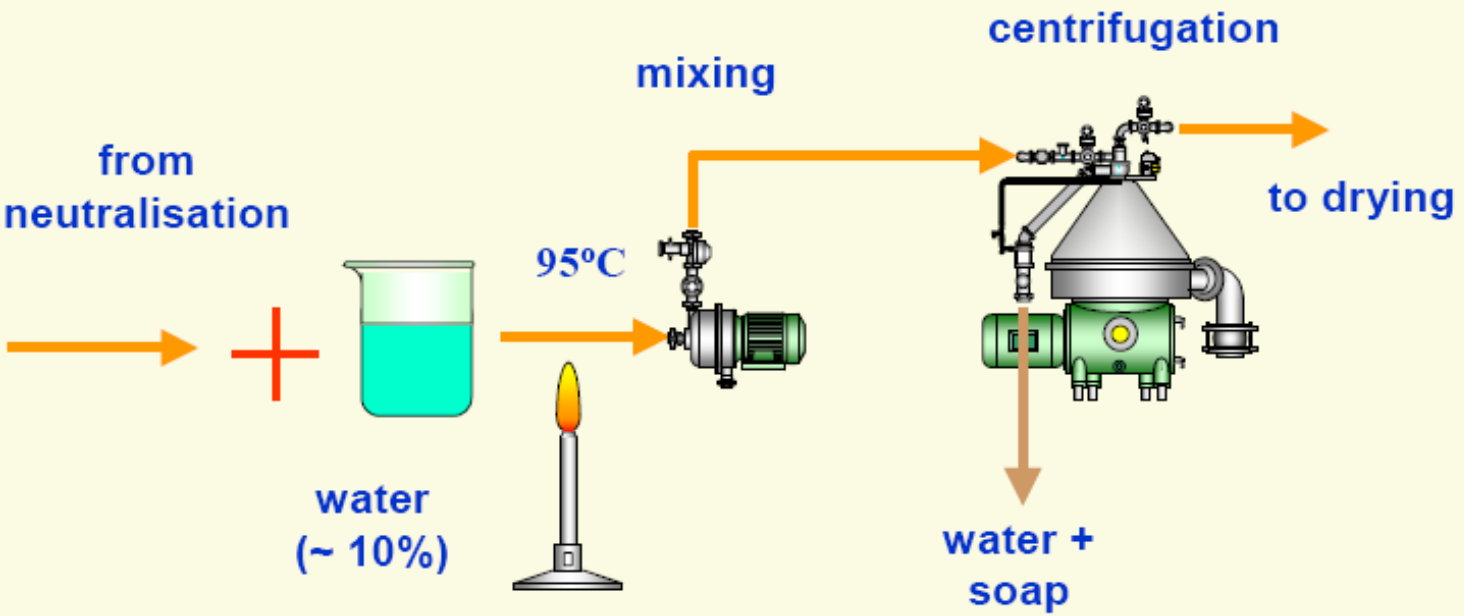
Steps of Alkali Refining

2. Neutralisation



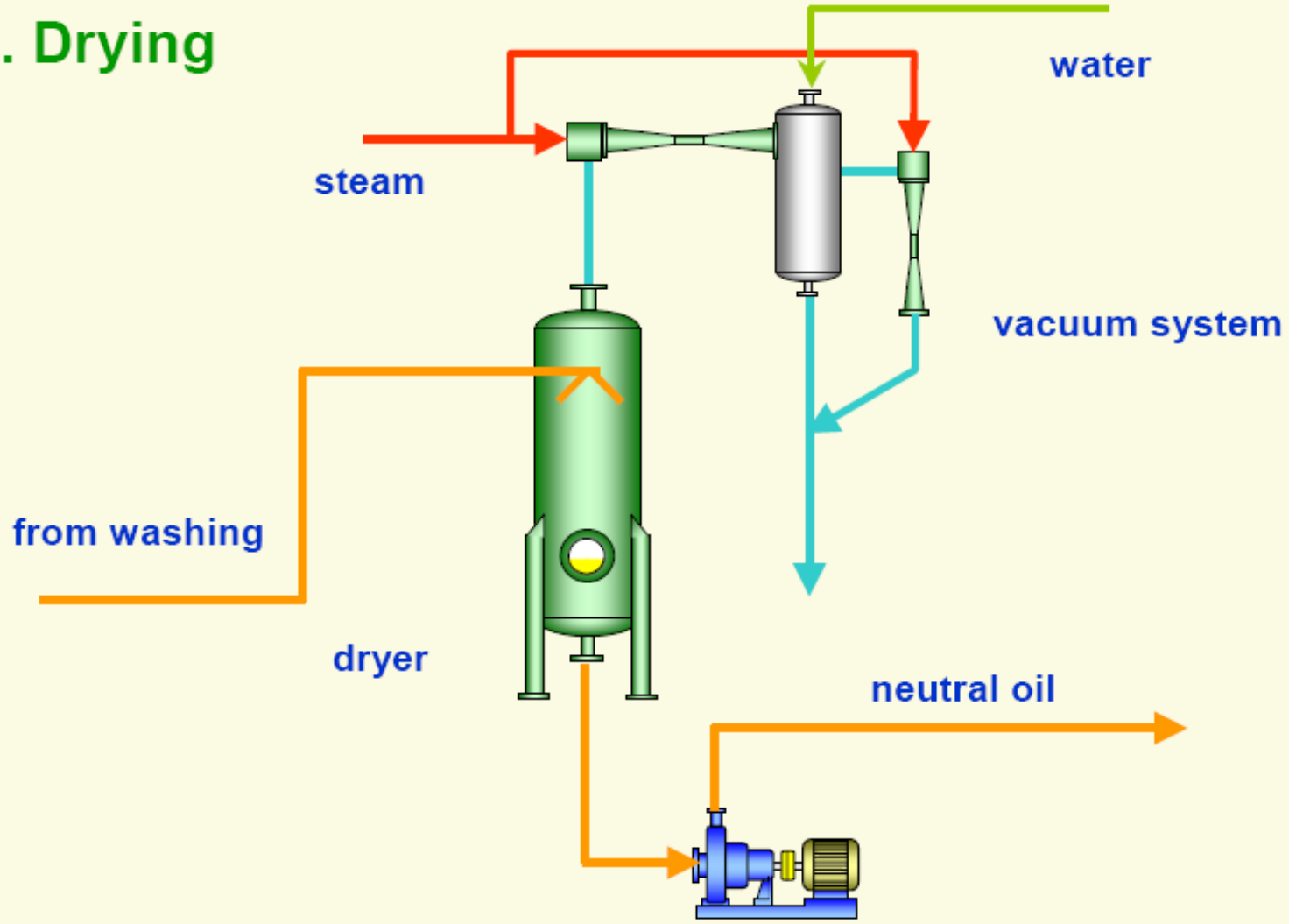
Steps of Alkali Refining

3. Washing



Steps of Alkali Refining

4. Drying



QUALITY EVALUATION:

The physical Quality parameters for plant oils:

- Refractive index
- Specific gravity
- Color
- Melting point

The chemical Quality parameters for plant oil:

- ffa content
- Peroxide value
- Iodine value
- Saponification value.

Refractive index:

- It generally used during the controlling of hydrogenation. After the hydrogenization the refractive index value of a fat reduce and according to this value you can decide about finishing of this process.
- Unsaturated fatty acid shows high refractive index

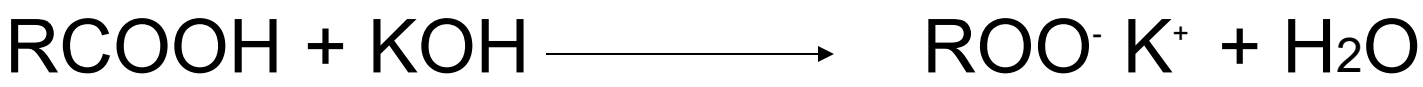
Color:

- It is important to control the natural color which is provided by the pigments in the composition of oil

- Also it is important to control the efficiency of bleaching process

Acid Value

Number of mgs of KOH required to neutralize the Free Fatty Acids in 1 g of fat.



$$AV = \frac{\text{ml of KOH x N x 56}}{\text{Weight of Sample}} = \text{mg of KOH}$$

- The free fatty acid content in a good soybean oil should be less than or equal to 0.05 %. The average molecular weight of free fatty acids of the oil is 280 which is the molecular weight of linoleic aid.
- What is the maximum acid value of the good soybean oil?

- What is the content (%) of free fatty acids of a soybean oil if the acid value is 0.3?
- The average molecular weight of free fatty acids of the oil is 280.

Acid Value

0.05 % in 1gram is 0.5 gram of fatty acid in 1 gram of oil

56 mg of KOH reacts with 280 mg of RCOOH

280 mg of RCOOH / 56 mg of KOH = 5:1

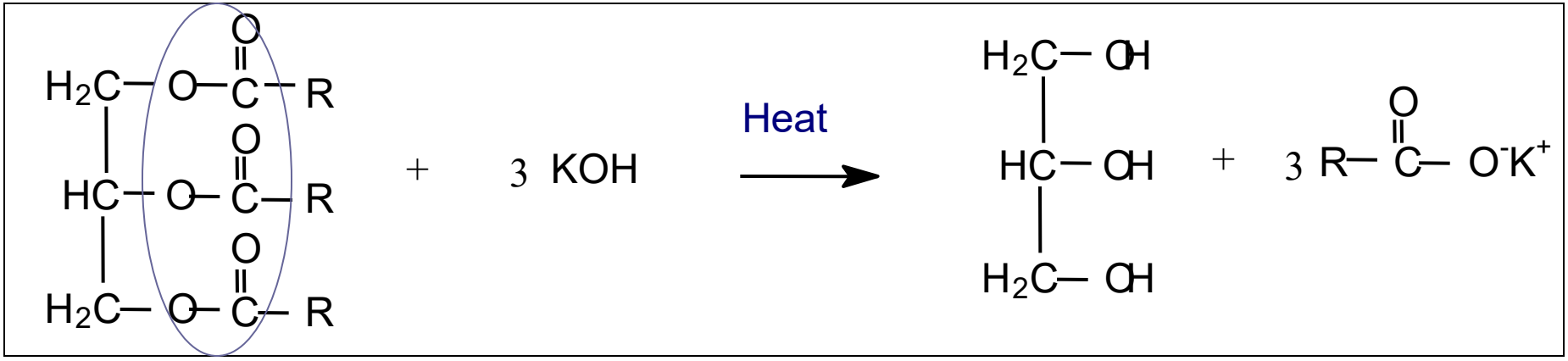
That is, 0.1 mg KOH reacts with 0.5 mg RCOOH

0.3 mg of KOH equals 1.5 mg of RCOOH

1.5 mg of fatty acid in 1 gram of oil is 0.15 %

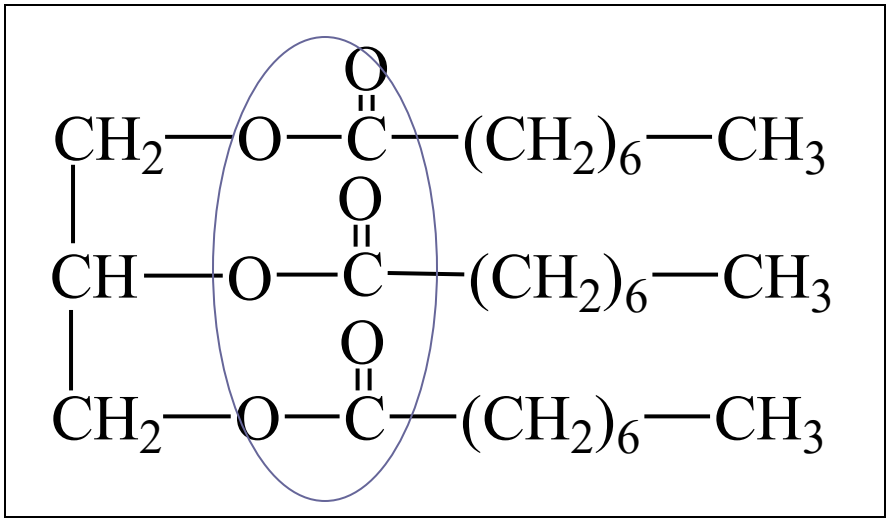
Saponification Value

Saponification - Hydrolysis of ester (triglycerides) under alkaline condition.

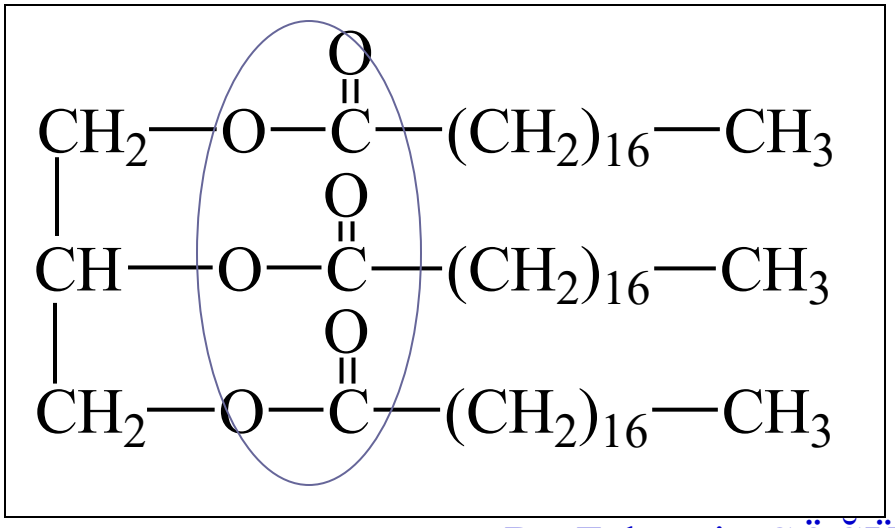


Saponification Value

B Tricaprylin (MW= 450)



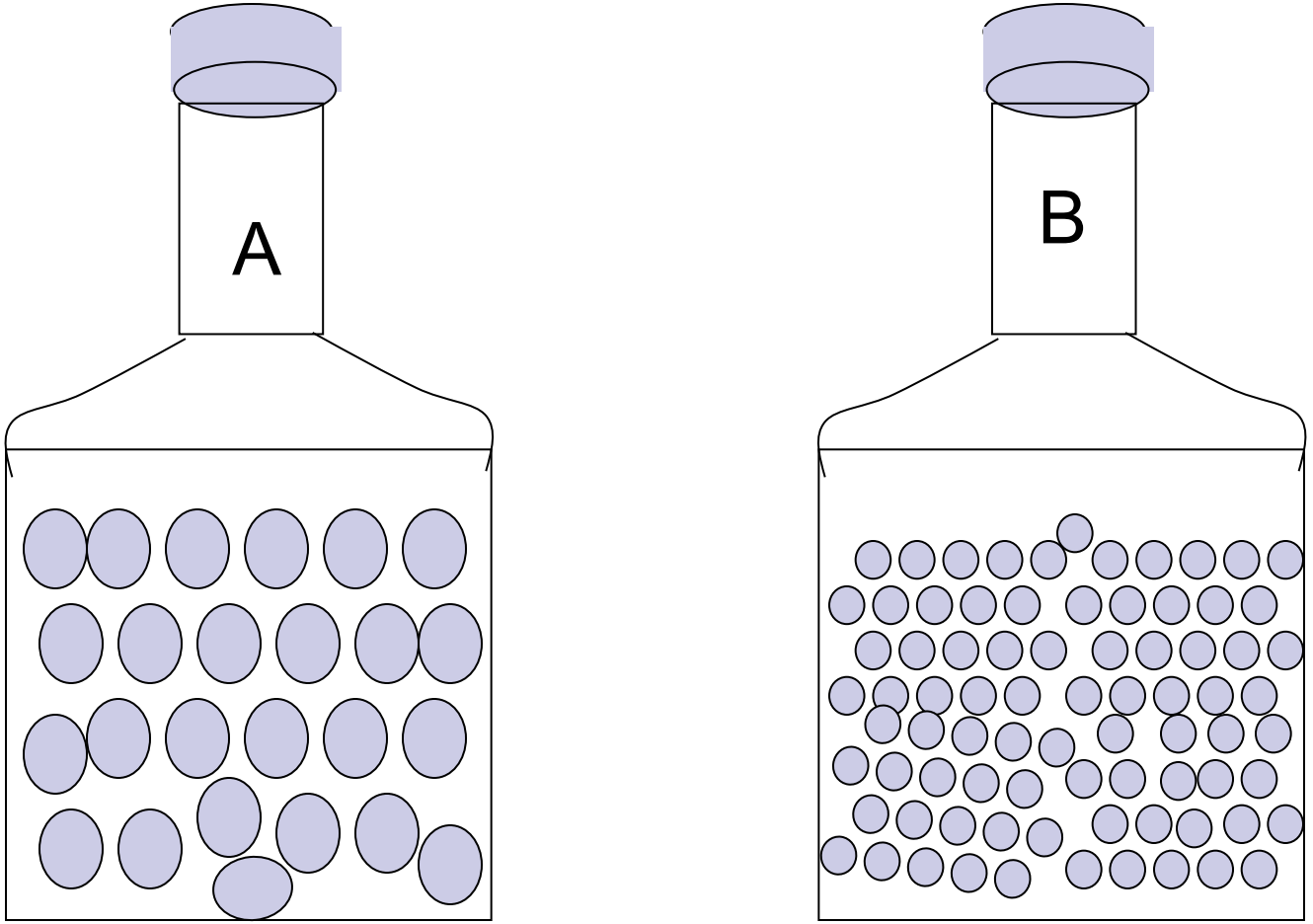
A Tristearin (MW= 890)



1Gram of Oils **A and B**

Saponification Value

Definition : mgs of KOH required to saponify 1 g of fat



; Large molecular triglycerides

; Small molecular triglycerides

Sample A has large molecular weight triglyceride (e.g. MW.890).

Sample B has small molecular weight triglyceride(e.g. MW.450).

In one gram of sample, number of triglyceride in B is about two times more than number of triglyceride in A.

Less mg of KOH is needed to saponify sample A than sample B.

Therefore, saponification value of A is about half of that of sample B

Avogadro's Number (N) = 6.02×10^{23} / mol

Saponification Value Determination

Saponification # --mgs of KOH required to saponify 1 g of fat.

1. 5 g in 250 ml Erlenmeyer.
2. 50 ml KOH in Erlenmeyer.
3. Boil for saponification.
4. Titrate with HCl using phenolphthalein.
5. Conduct blank determination.

$$SP\# = \frac{56.1(B - S) \times N \text{ of HCl}}{\text{Gram of Sample}}$$

B - ml of HCl required by Blank.

S - ml of HCl required by Sample.

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Saponification Values of Fats and Oils

Fat	Saponification #
Milk Fat	210-233
Coconut Oil	250-264
Cotton Seed Oil	189-198
Soybean Oil	189-195
Lard	190-202

Iodine Value

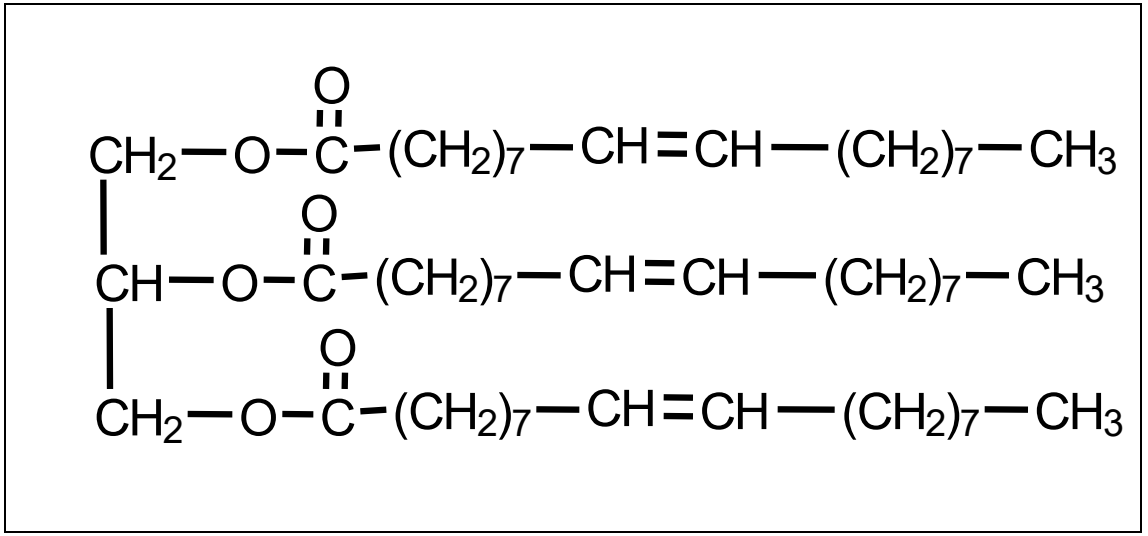
Number of iodine (g) absorbed by 100 g of oil.

Molecular weight and iodine number can calculate the number of double bonds. 1 g of fat adsorbed 1.5 g of iodine value $= 150$.

Iodine Value

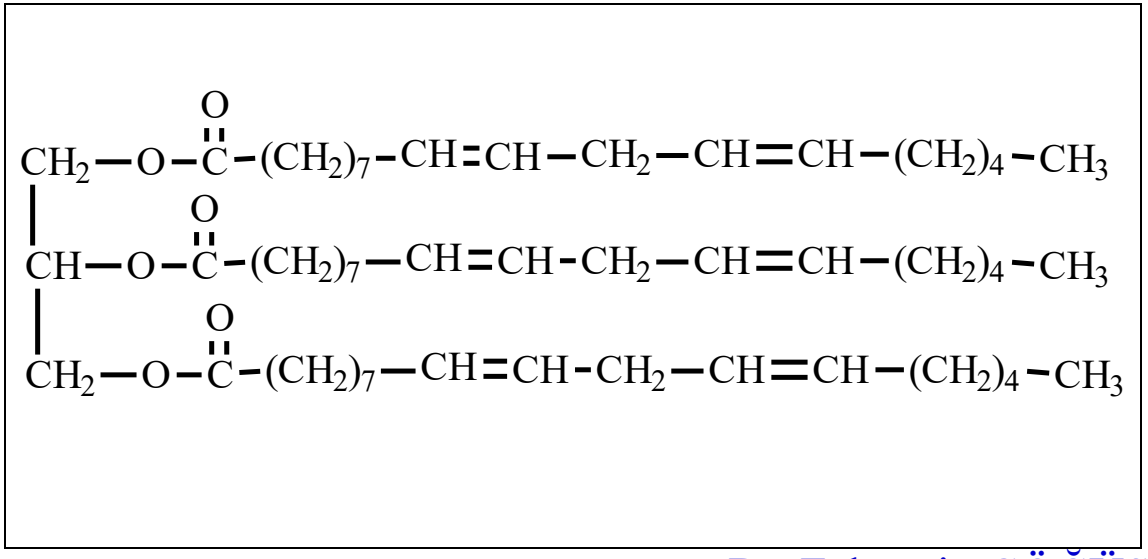
Triolein (MW= 884)

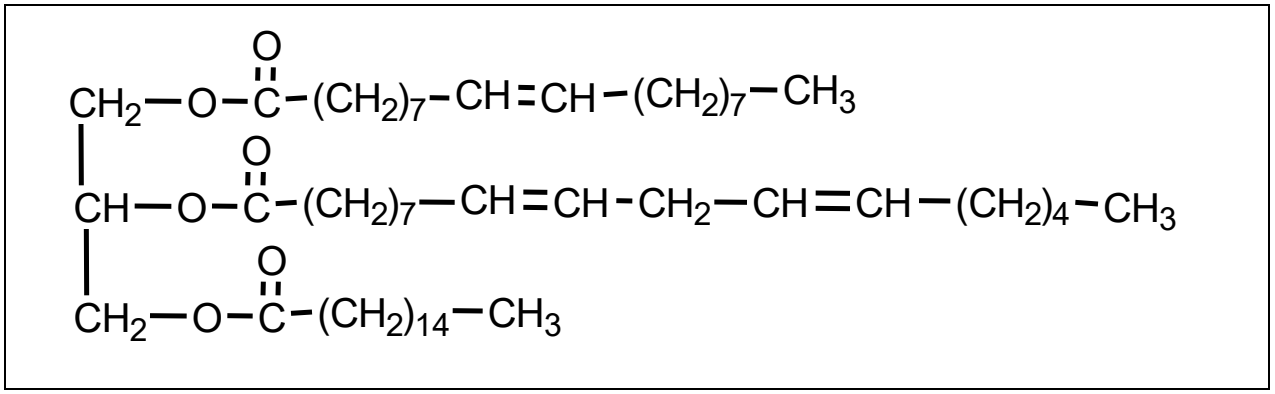
A



Trilinolein (MW= 878)

B

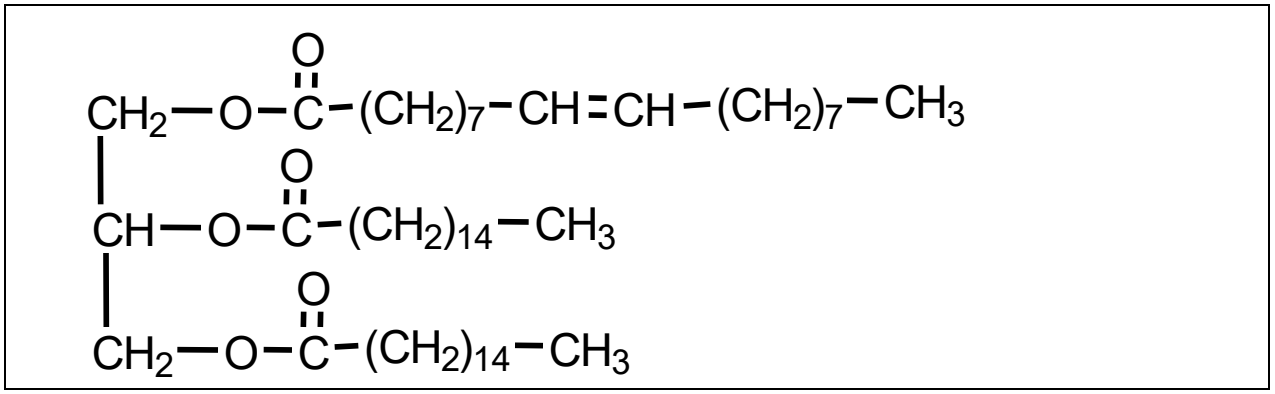




Oleic acid

Linoleic acid

Palmitic acid



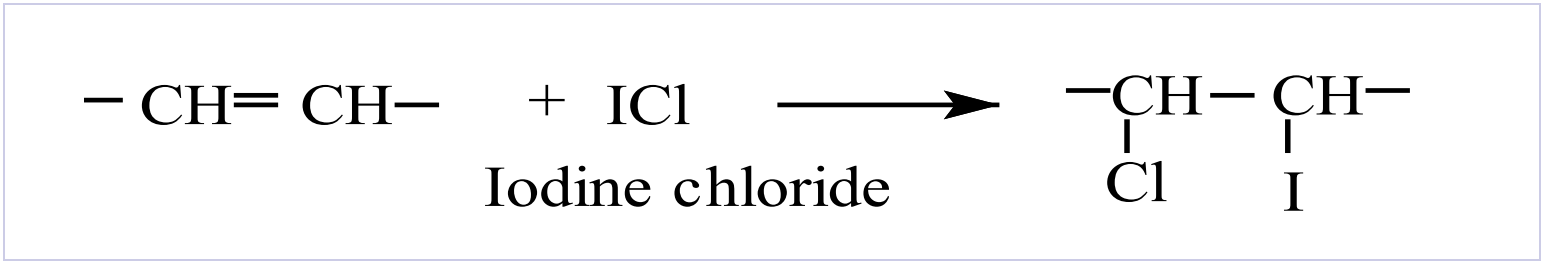
Oleic acid

Palmitic acid

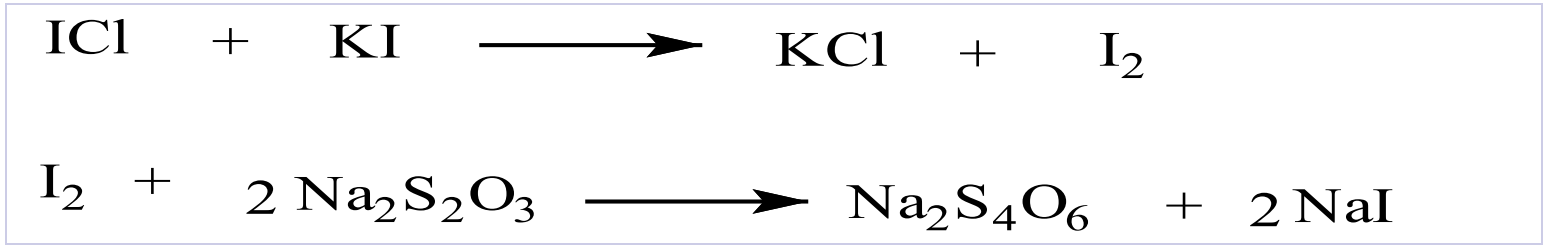
Palmitic acid

Iodine Value Determination

$$\frac{(\text{ml of } Na_2S_2O_3 \text{ volume for blank} - \text{ml of } Na_2S_2O_3 \text{ volume for sample}) \times \text{N of } Na_2S_2O_3 \times 0.127\text{g/meq} \times 100}{\text{Weight of Sample (g)}}$$



Excess unreacted ICl



Iodine Values of Triglycerides

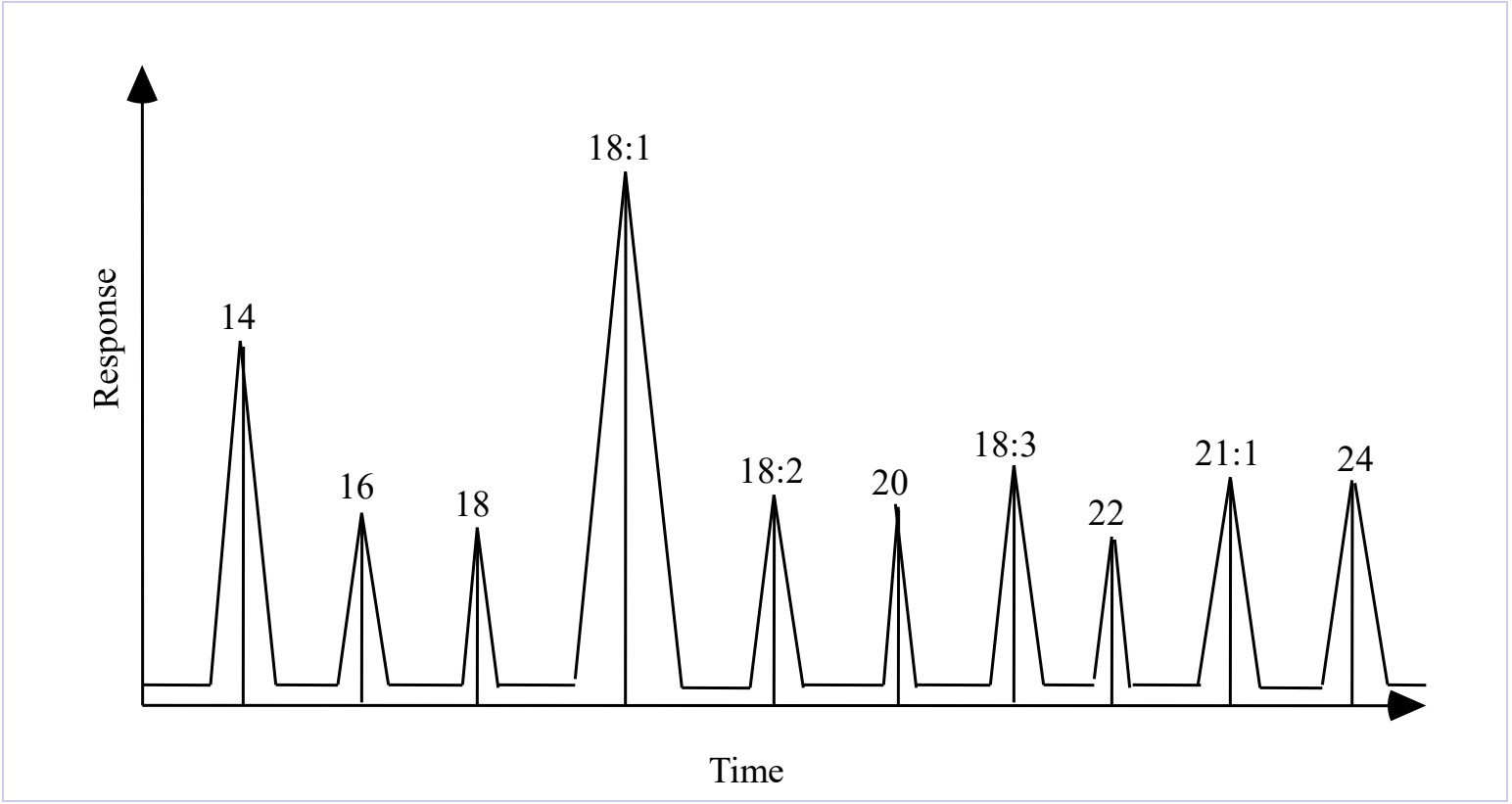
Fatty Acids	# of Double-bonds	Iodine #
Palmitoleic Acid	1	95
Oleic Acid	1	86
Linoleic Acid	2	173
Linolenic Acid	3	261
Arachidonic Acid	4	320

GC Analysis for Fatty Acids

1. Extract fat
2. Saponify (hydrolysis under basic condition)
3. Prepare methyl ester (CH_3ONa)
4. Chromatography methyl ester
5. Determine peak areas of fatty acids

   Fatty acids are identified by retention time
6. Compare with response curve of standard

Fatty Acids Methyl Esters



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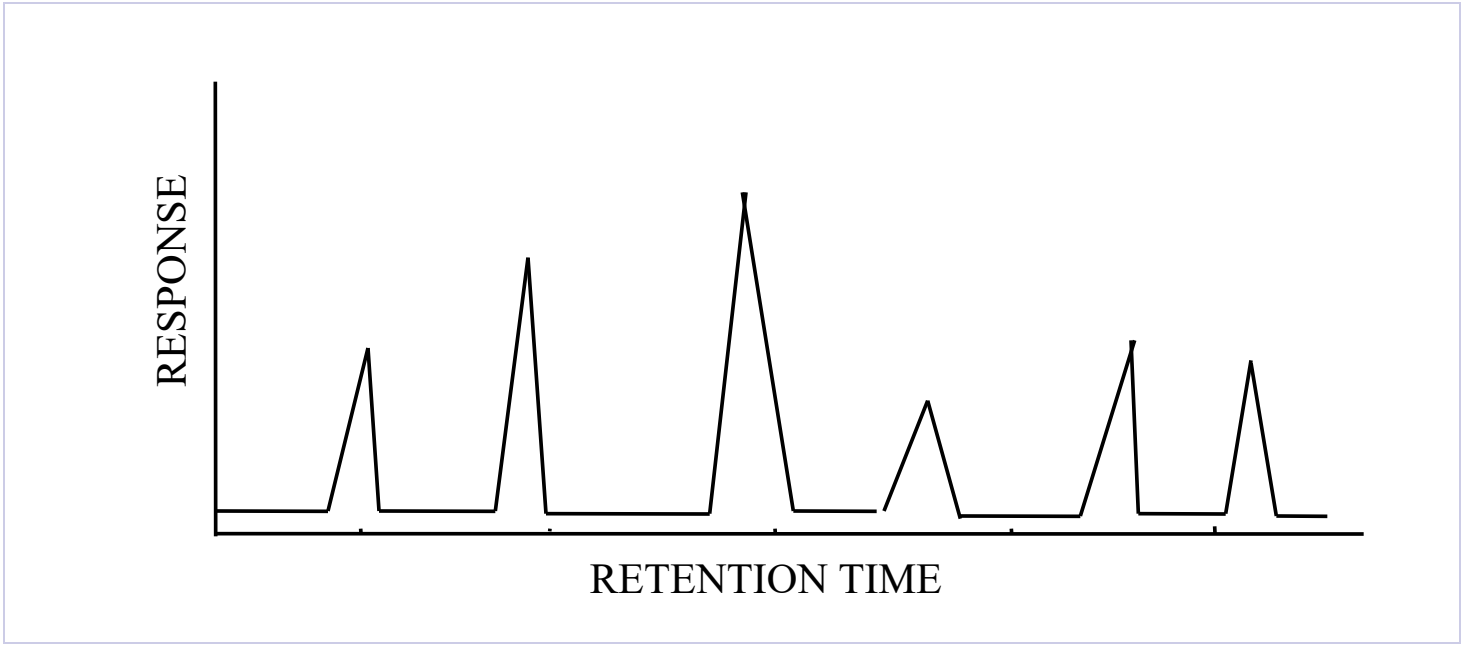
Triglyceride Analysis by Liquid Chromatography

Soybean Oil



Triglycerides in Olive Oil

Fatty Acids	Total Carbons : Double Bonds
OLL	54: 5
OOL	54: 4
OPL	52: 3
OOO	54: 3
OSL	54: 3
OOP	52: 2