Fats & Oils

Fats and oils are the esters of fatty acids and alcohols and on hydrolysis give fatty acids & alcohols.

* They are also called as triglycerides as three molecules of fatty acids condense with one mole of glycerol to form fat.

Two type

① Simple - When three fatty acids of triglyceride are same
② Mixed - When three fatty acids of triglyceride are not not identical.

Diffrence b/w Fats and Oils

Fats	Oils
① Fat are solids or semi solids at room temp.	① Oils are liquids at room temp
② Fats contains large amount of saturated fatty acids eg → Stearic acid & Palmitic acids	② Oils contain a large amount of unsaturated acids. eg - Oleic acid
③ Fats melt at high temp.	③ Melt at lower temp.
④ Fats are animal fats	④ Oils are vegetable fats
⑤ Fat do not contain double bonds	⑤ Oils have double bonds
⑥ Fats are more stable	⑥ Oils are less stable

Various Chemical reaction of fats & oils

① Hydrolysis

Saponification

$$\begin{array}{l} CH_2-O-COR \\ | \\ CH-O-COR \\ | \\ CH_2-O-COR \\ \text{fat} \end{array} + 3NaOH \longrightarrow \begin{array}{l} CH_2OH \\ | \\ CH-OH \\ | \\ CH_2-OH \\ \text{Glycerol} \end{array} + 3RCOONa$$

Soap

② By water

$$\begin{array}{l} CH_2-OCOR \\ | \\ CH-OCOR' \\ | \\ CH_2-OCOR'' \\ \text{fat} \end{array} + 3H_2O \xrightarrow[443K]{} \begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \\ \text{Glycerol} \end{array} + \begin{array}{l} R-COOH \\ | \\ R'-COOH \\ | \\ R''-COOH \\ \text{fatty acids} \end{array}$$

③ By enzyme ⇒ Hydrolysis of fat and oils can be done by adding enzyme lipase to an emulsion of fat in water.

④ By acid - Mineral acids causes hydrolysis of fats.

⑤ Hydrogenation

$$\text{Liquid oil} \xrightarrow[\text{Ni Pressure}]{H_2 \text{ gas}} \text{semi solid fat}$$

$CH_2-O-CO-C_{17}H_{33}$ (Triolein (oil), m.p 268K) + $6H \longrightarrow$ $CH_2-O-CO-C_{17}H_{35}$ (Tristearin (fat), m.p 333K)

Application :- production of vegetable ghee.

3) Hydrogenolysis ~~splitting of given compound by means of~~ hydrogen.

Fat or oil gets splits up into glycerol and higher aliphatic alcohol

$CH_2-O-CO-C_{17}H_{35}$ (Stearin (fat)) $\xrightarrow[\text{200 atm}]{Cu\,Cr_2O_4}$ CH_2OH (Glycerol) + $3\,C_{17}H_{35}CH_2OH$ (octadecyl alcohol)

4) Saponification

$CH_2-O-CO-C_{15}H_{31}$ (Tris palmitin) + 3NaOH $\longrightarrow$ $3\,C_{15}H_{31}COONa$ (Sodium palmitate, Sodium soap) + CH_2OH (Glycerol)

(5) Rancidification =>

long storage & contact with air, moisture and sunlight oil & fats undergo decomposition and start smelling unpleasant. Rancidity occurs by the following causes

(a) oxidation of unsaturated acids

Unsaturated acids present in fats/oils get oxidized by air to form peroxides which is further break down into aldehydes having unpleasant smell & taste

(b) Enzymatic hydrolysis

due to presence of enzyme organisms fat gets hydrolysed by enzyme to produce fatty acid having sour taste and unpleasant odour.

eg butter gets rancid due to production of butyric acid

(c) β-oxidation of Saturated fatty acids

Saturated fatty acid undergo β-oxidation to form keto acids which gives carbon dioxide to form ketone having unpleasant odour.

(a) Drying oils

Some glycerides of unsaturated acids

↓ absorb oxygen

polymerized to form hard transparent coating which is used in making paints and oil cloth

Drying can achieved faster by addition of driers like salts of manganese, lead etc.

(a) Non-drying oils

oils on exposure to light & long storage

↓

gets rancid

↓

decompose fatty acid & glycerol

unsaturated fatty acid → aldehydes & acid

Saturated acid → ketone

eg → olive oil, almond oil

(b) Drying oils

- they form a solid elastic film. and dry. dries with in 4-5 hours

(c) Semi-drying oil high level of Linoleic acid

- eg - sunflower oil
- cotton-seed oil.

used medium for paints, varnishes

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Analysis of fats and oils

① Acid Value

It is defined as the number of milligrams of KOH required to neutralize 1gm of the oil or fat.

It indicate the amount of free fatty acids present in oil or fat.

* The acid value is a measure of breakdown of the triacylglycerols into free fatty acids.

Procedure :-

Weight accurately a quantity of fat or oil in a conical flask then add 50 ml of ethanol - ether solution, shake it well.

Titrate the solution with potassium hydroxide using phenolphthalein as indicator until pink colour is obtained.

- Measure the amount of potassium hydroxide (ml) used and calculated the acid value as;-

$$\text{Acid value} = \frac{V_{KOH} \times 5.61}{W}$$

V_{KOH} = Volume of potassium hydroxide used (ml)

W = weight of the fat or oil being examined (gm)

Result :- High acid value indicates that the given sample of fat and oil is of low quality and store improper conditions.

(b) Saponification value

It is defined as the number of milligrams of potassium hydroxide required to completely (neutralise) saponify 1 gm of fat or oil.

Principle involved :- It is determined by refluxing a known quantity of the sample with an excess of 0.5 N alcoholic KOH for 30 Minutes and then titrating the unused alkali with 0.5 N HCl.

Procedure :- Take 2 gm of the sample in a conical flask fitted with a reflux condenser. add 25 ml of 0.5 N ethanolic KOH and small amount of pumic powder and boil under reflux on water bath for 30 minutes. add 1 ml of Phenolphthalein solution and titrate with 0.5 N HCl. (A ml). Also carry out blank titration omitting the substance under examination. ie Sample (B ml)

$$\text{Saponification value} = \frac{28.05}{(B-A)} \quad \frac{28.05(B-A)}{W}$$

Where

B = mL of HCl used for blank titration
A = mL of 0.5 N HCl used for titration
W = Weight of Sample (gm)

Significance of Saponification value

(1) Gives an idea about the molecular wt. of fat or oil. The smaller the saponification value, the higher the molecular weight.

(2) It also indicates the length of carbon chain of the fatty acids present in the tri-glyceride. Higher the saponification value greater is the % of the short chain acid present in the glycerides of oil and fats.

(3) It also helps in finding the amount of alkali required for converting a given amount of fat or oil into soap.

(4) Detection & adulteration of fats & oils

[C] Ester Value

It is defined as the number of milligrams of KOH required to react with the esters in 1gm of fat or oil.

* The difference between saponification value and acid value is called ester value.

Ester value = Saponification value - Acid value

ⓓ Iodine Value

It is defined as the number of gram of iodine taken up by 100gm of fat or oil or it is the number of grams of iodine which will combine with 100gm of fat or oil.

Principle :- It is determined by treating the given sample of fat or oil with iodine monochloride or iodine in ethanol in presence of mercuric chloride. Un reacted iodine is then calculated. It gives the idea of degree of unsaturated present in sample.

Procedure Iodine value can be calculated by one of the following two method.

1. **Hubl's Method :-** Fat or oil sample is dissolved in carbon tetra chloride and is treated with excess of standard solution of ethanolic iodine in presence of mercuric chloride. Unused iodine is then calculated by titration with standard sodium thiosulphat solution.

2. **Wij's Method**

This method uses iodine monochloride (ICl) in acetic acid in place of Iodine. Iodine monochloride readily combines with the duble bonds present in fat and oil.

The unreacted iodine is then calculated by the addition of Potassium Iodide (KI) and titration with standard solution of sodium thiosulphate using starch as indicator

$$\text{C}=\text{C} + ICl \longrightarrow \begin{matrix} | \\ Cl \end{matrix}\text{C}-\text{C}\begin{matrix} | \\ I \end{matrix}-$$

$$ICl + KI \longrightarrow KCl + I_2$$
(Unused)

$$\text{Iodine value} = \frac{(a-b) \times 1.27}{W}$$

where a = reading for blank titration
b = reading for actual titration
W = weight of fat or oil taken

Significance of Iodine value

Iodine value tells the degree of unsaturation present in the fat or oil. Higher the iodine value, highly unsaturated the given fat is. Iodine value also gives an idea of the drying characters of the fat and oil.

It also helps in determining the adulterations in the given sample of fat.

Iodine value of non-drying oils = 85-105
semi-drying oils — 105-120.
Drying oils = Above 120

It is measure of the volatile fatty acid reduces present in given fat or oil.

Principle :-

for determination of R.M value, known sample is completely saponified with alkali. The resulting solution is acidified with dil. H_2SO_4 and then steam distiled. the distillate which contains the volatile ~~oil~~ acid is then titrated against 0.1N KOH solution.

Procedure :- To the 10 gm of the sample add an excess of 0.1N NaOH solution in order to completely saponify the fat. The solution is then acidified with dil. H_2SO_4 and is undergo steam distillation. The distillate containing the volatile ~~oil~~ acid is then titrated with 0.1N KOH solution using phenolphthalein as an indicator.

$$R.M\ Value = 1.10(T_1 - T_2)$$

where T_1 = volume of 0.1N KOH used for the titration

T_2 = volume of 0.1N KOH used for the blank titration.

Significance :- R.M. value is useful for testing the purity of the butter and desi ghee which may contain a high amount of glyceride of butyric acid and other steam volatile fatty acid residue for eg: adulteration of butter has low RM value than that pure butter.

(e) Acetyl value :- It is defined as the number of milligrams of potassium hydroxide (KOH) required to neutralise acetic acid produced by the saponification of one gram of completely acetylated fat or oil.

Procedure :-

To the given sample add 5 ml of acetic anhydride - pyridine mixture (1:7). add 5 ml of water. put on a water bath for about 30 minutes then cool it. titrate with 0.5 N KOH using phenolphthalein as an indicator.

$$\text{Acetyl value} = \frac{E \times 4.3}{A}$$

A = Weight of sample acetylated (gm)
E = Acidity equivalent

Significance :-

It helps in determining the number of alcoholic group present in an oil or fat.

(f) Reichert - Meissel value (R.M value)

It is defined as the number of ml of 0.1 N KOH solution required to neutralize the wate - soluble steam or to neutralize the distillate of 5 gm of hydrolysed fat or oil. It is an indicator of how much volatile fatty acid can be extracted from fat through saponification.

In some cases, name of the substituent is written after benzene

Benzenediazonium chloride

Benzene sulphonic acid

(b) Some derivatives have special name like

Toluene

Aniline

Anisole.

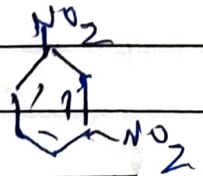
Benzoic acid

Phenol.

(2) For disubstituted benzene derivatives

(a) derivatives having two similar groups
- prefix di is added
- two groups are indicated by the symbol "O" (ortho) for 1,2, m (meta) for 1,3 and p (para) for 1,4 positions

O-dibromo benzene,



m-dinitro benzene

p-dichloro benzene

Preparation

by reaction of ammonia with sodium hypochlorite.

$$NH_3 + NaOCl \longrightarrow NH_2Cl + NaOH$$

Uses

- Disinfectant for water as it is less reactive than chlorine and more stable against light than hypochlorides
- Swimming pool disinfectant.
- Improve odour & flavour of water