Unit-3

* Fats And Oils *

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* Fats →

Fats are oily substances that occurs in the animal body under the skin or around organs.

Since, fats are higher in energy, they are good for weight gain.

Fats are animal derived. They are mainly composed of saturated fatty acids and unsaturated fatty acids.

They are solid at room temperature.

In animals, adipocytes are specialized cells which store fat in the body. Some of the fat can be found in liver also.

Dairy food products such as cheeses, butter, cream & meat contains fat.

* Oils →

These are viscous liquids which occurs in fruits or seeds of plants.

Oils are composed of unsaturated fatty acids. oils exist as liquid at room temper.

unsaturated oils lower Cholesterol level in the blood, therefore oils decreases risk of heart disease.

e.g...

Sunflower oil, Corn oil, olive oil etc.

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* Classification of fatty acids →

These are classified into two types :-

① Saturated fatty acids →

These are the fatty acids which contain only carbon carbon single bond (C-C)

e.g...

Animal fat, butter.

② Unsaturated fatty acids →

These are the fatty acids which contain C=C.

It is subclassified into two types :-

ⓐ Monosaturated Fatty acids →

These are the fatty acids which contains one double bond in their structure.

e.g...

Oleic acid.

ⓑ Polyunsaturated fatty acids →

These are fatty acids which contain two or more double bonds in their structure.

e.g...

Linoleic acid, Ficosapentanoic acid.

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* Difference between Fats and Oils →

Fats	Oils
① Oily substances in animal body, found under skin, around the organs.	Viscous liquids occurs in fruits or seed of the plant.
② Fats are made up of Saturated and unsaturated fatty acids.	Oils are made up of unsaturated fatty acids.
③ Fats are obtained fim animal sources.	Oils are obtained from plant sources.
④ e.g. are, butter, cream, milk etc	e.g. are Sunflower oil, Coconut oil, corn oil.
⑤ Fats are stored in liver and below the skin in animals.	Oils are stored in seeds
⑥ Fats are stored in Special animal cells called adopocytes.	oils are stored in form of granules in plants.
⑦ oxidative rancidity is high.	oxidative rancidity is low.

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⑧ Fats are solid at room temperature.	Oils are liquid at room temperature.
⑨ Fats increases chole-sterol level in the blood.	Oils decreases choles-terol level in blood.
⑩ Fats increases the risk of cardiovascular diseases.	Oils decreases the risk of cardiovascular diseases.

* Reactions of fatty acids →

① Hydrolysis →

$$R_1-\overset{O}{\overset{\|}{C}}-O-R_2 + H-OH \xrightarrow[\text{Pressure}]{\Delta} R_1-\overset{O}{\overset{\|}{C}}-OH + R_2-OH$$

ester → Fatty acid

Fatty acid $\xrightarrow{NaOH}$ $R_1-\overset{O}{\overset{\|}{C}}-ONa + H_2O$

Sodium salt of fatty acid.

e.g...

$$\begin{array}{l} CH_2-O-\overset{O}{\overset{\|}{C}}-(CH_2)_{14}-CH_3 \\ CH-O-\overset{O}{\overset{\|}{C}}-(CH_2)_{14}-CH_3 \\ CH_2-O-\overset{O}{\overset{\|}{C}}-(CH_2)_{14}-CH_3 \end{array} + 3H-OH \xrightarrow{\Delta} \begin{array}{l} CH_2-OH \\ CH-OH \\ CH_2-OH \end{array} +$$

Triglycerides → glycerol

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$$\begin{bmatrix} CH_3(CH_2)_{14}COOH \\ CH_3-(CH_2)_{14}-COOH \end{bmatrix}$$

$CH_3-(CH_2)_{16}COOH$

Fatty acid

↓ 3 NaOH

$$\begin{bmatrix} CH_3-(CH_2)_{14}COO^-Na^+ \\ CH_3-(CH_2)_{14}COO^-Na^+ \end{bmatrix} + 3H_2O$$

$CH_3-(CH_2)_{16}COO^-Na^+$

Sodium Salt of fatty acid

(Soap molecule)

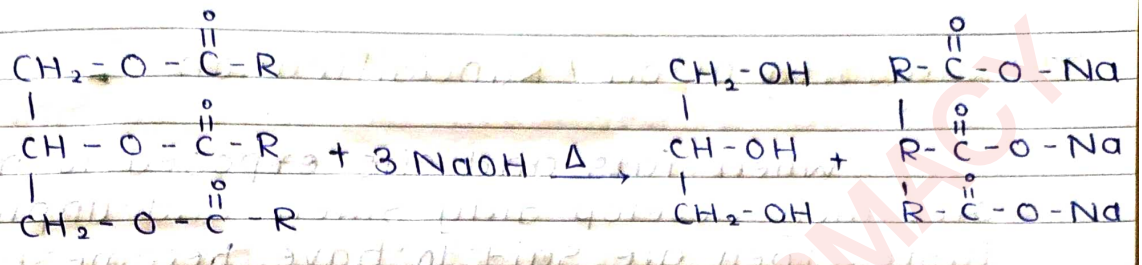
Triglycerides on hydrolysis by heating under pressure gives a fatty acids & alcohol. fatty acid on treatment with NaOH gives Sod. Salt of fatty acid (Soap molecule)

② Saponification reaction →

$$R_1-\overset{O}{\overset{\|}{C}}-O-R_2 + NaOH \longrightarrow R_1-\overset{O}{\overset{\|}{C}}-O-Na + R_2OH$$

ester — Sod. hydrolysis — Sodium Salt (soap) — Alcohol.

e.g...



Triglyceride glycerol Soap

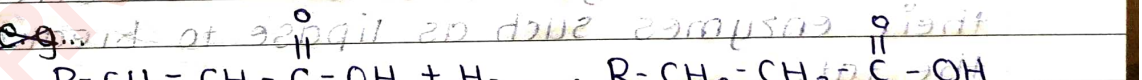
It is the base catalysed reaction in which ester reacts with NaOH or KOH to gives a Sodium Salt (Soap molecule and alcohol).

Triglycerides on treatment with NaOH upon heating gives a Soap molecule and glycerol.

③ Hydrogenation → It is a chemical process where hydrogen reacts to an organic compound

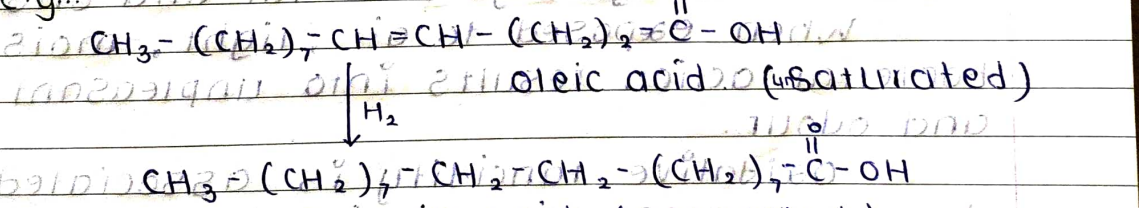
It refers to saturation of unsaturated lipid, oils with the hydrogen atoms.

e.g.



unsaturated acid Saturated acid.

e.g.



Oleic acid (unsaturated)

Stearic acid (Saturated)

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* Rancidity of oil / Rancidification →

When fats and oils exposed to moist air, they develop dirty smell and unpleasant taste. They are said to have become rancid.

Rancidification is caused by three types :-

① Hydrolysis → It involves hydrolysis of one or more ester linkage in fats & oils to produce the original acid.

② Oxidation → It involves oxidation of carbon carbon double bonds in fats and oils to produce volatile fatty acid.

③ Microbial contamination → It is a process in which micro-organisms such as bacteria use their enzymes such as lipase to breakdown the fat.

Imp

Rancidity is complete or incomplete oxidation or hydrolysis of fat and oils.

When exposed to air, light, moisture or bacterial action results into unpleasant taste and odour.

Oxidative rancidity is associated with degradation by oxygen in air.

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To prevent the rancidity, antioxidant like to-copherols are used as preservatives in fat.

Antimicrobials are added to prevent the microbial contamination and also Sterilisation can reduce this process.

* **Drying oil →**

When highly unsaturated oils are exposed to air, they undergoes oxidation and polymerisation to form a thin water proof film, such oils are drying oils and the reaction is called as drying.

* **Analytical Constants →**

Enlist IMP

There are six analytical constant as follows:-

① Acid value
② Iodin value
③ Saphonification value
④ Ester value
⑤ Acetyl value
⑥ R.M value (Reichert Meiss)

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① Acid value →

* Principle / Theory →

Acid value is no. of milligrams of KOH required to neutralize free fatty acids present in 1 g of substance.

It is a good measure of breakdown of triglycerides into free fatty acids.

$$\underset{\text{Fatty acid}}{R\text{-}COOH} + KOH \longrightarrow \underset{\text{pot. Salt of Fatty acid.}}{R\text{-}COOK} + H_2O$$

Acid value is calculated by the given formula $\approx \frac{n}{w} \times 5.61$

Where,

n = burrete reading

W = Wt. of the Sample

* Procedure →

① Weigh 1 g. of oil sample

② Add 5 ml alcohol and 5 ml ether into it.

③ Reflex it for 1 hrs. So that oil becames miscible with alcohol ether mixture.

④ Cool the reaction mixture at room temperature.

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⑤ Add few drops of phenolphthalein indicator into it.

⑥ Titrate the reaction mixture with 0.1N KOH and note down the burette reaction.

⑦ Calculate the acid value of a given OH sample.

Hence, acid value is a measure of no. of carboxylic acid groups in a chemical compound such as fatty acids.

It is the quantity of base expressed in milligrams of KOH which is required to neutralize the free fatty acid in a given oil sample.

② Iodin Value →

It is define as no. of grams of iodin which is absorbed by 100 g oil or fat.

Iodin value is used to determine the unsaturation in oil or fat & gives idea about its drying character.

Greater the iodin value more will be unsaturation and high susceptibility to oxidative rancidity.

Iodine itself reacts too slowly hence iodin monochloride (ICl) is used as a reagent in the procedure.

$$I.V = \frac{b - a}{\text{wt. of sample (g)}} \times 1.263$$

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Where,

b = burette reading of blank.

a = burette reading of Sample.

* Procedure →

① Weigh 2 g castor oil in an iodin flask.

② Add 10 ml Carbon tetrachloride (CCl_4) dissolve it.

③ Add 20 ml. ICl

④ Insert stopper & allow to stand in dark place for 30 min.

⑤ Place 50 ml KI Sol^n in it rinse with 100 ml of water.

⑥ Shake & titrate with 0.1 M Sodium thiosulphate Solution by using as an indicator

⑦ Repeat procedure omitting Sample burette reading is

⑧ Calculate iodin value

⑨ Iodin value measures the unsaturation of an oil / fat.

Iodine value & degree of unsaturation

(No. of double bond & inversely proportional to the M.P of lipid)

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③ Saponification Value →

* Principle / Theory →

Definition →

It is the no. of milligrams of KOH required to neutralise the fatty acids and Saponification the ester in 1 g of oil or fat.

* Principle →

oil sample is saponified the refluxing with a known excess of alkaline KOH solution.

The alkali required for saponification is determined by titrated excess KOH with standard hydrochloric acid (HCl)

Saponification value is calculated by the formula =

$$SV = \frac{56.1\,(B-S)\,N}{W}$$

Where,

B = burette reading of blank.
S = burette reading of sample
N = Normality of HCl
W = Wt. in gram of an oil or fat.

* Procedure →

① Weigh 2 gm oil or fat in RBF.

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② Add 25 ml of 0.5 M ethanolic KOH Sol? into it and attach reflux condensor to the RBF.

③ Boil the reaction mixture on water bath for 40-50 min.

④ Add 1 ml phenolphthalene indicator & titrate with 0.5 HCl & note B. Reading

⑤ Repeat the procedure omitting the Sample & note the B.R

⑥ Calculate S.V by using the formulla.

IMP * Significance of S.V →

① It gives idea about average mol. wt. of oil or fat.

② Higher the molecular weight of oil or fat, Smaller in its Saponification V.

③ It indicates length of carbon chain of acid present in that particular oil or fat.

④ Ester Value →

V.IMP

It is the no. of mg of KOH required to Saponify the esters, in 1 g of the substance.

In Simple, it is the difference bet?

* Saphanification value and acid value

*

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EV = S.V - A.V

⑤ Acetyl value →

* Principle →

It is defined as the no. of mg. of KOH required to neutralise the acetic acid produced when 1 g. of fat or oil is acetylated with acetic anhydride.

Acetyl no. is a measure of the no. of -OH groups present in a fat or oil.

$$\text{Acetyl value} = \frac{1335\,(b-a)}{(1335-a)}$$

Where,

b = Saphonification value of acetylated oil or fat.

a = S.V of oil or fat.

Procedure →

① Place 10 g. sample & 20 ml acetic anhydride in a RBF.

② Boil for 2 hrs, cool and pour in 600 ml water.

③ Add 0.2 g $CaCO_3$ and again boil for 30 min.

④ Cool and transfer the reaction mixture into a Seperating funnel.

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⑤ Shake the funnel, discard lower layer, wash the product with 50 ml warmed NaCl Sol?.

⑥ Finally Shake the 20 ml warm water & remove the aq. layer.
pour in porcelin dish, add 1 g. Sodium Sulphate Stirr and filter it.

⑦ Determine the S.V of that acetylated substances

⑧ R.M value →

Theory →

It is a measure of the volatile water Soluble acid constituents of the fat or oil.
It is developed by Chemist Rechert & Miessl. It is equal to the no. of millilitres of 0.1N KOH Solution necessary to neutralise the volatile, water soluble fatty acids obtained by 5 g. of fat or oil.

$$R.M\ value = (A-B) \times N \times 11$$

Where,
A = burette reading of sample
B = ——————— & blank
N = Normality of the solution.

In this, the fat or oils is saponified by heating with glycerol alkali Sol? & then Split by

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treatment with dilute Sulphuric acid in the distillate is filtered & estimated by titration with Std KOH or NaOH solution.

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