

Oils and Fats

Dr/ Ahmed Ibrahim, PhD

Introduction:

Oil and fats are esters (fatty acid + glycerol):

- Oil: unsaturated fatty acid + glycerol.
- Fat: saturated fatty acid + glycerol.
- Wax: saturated fatty acid + alcohol other than glycerol.

Classification of lipids:

1. Simple lipids: esters of fatty acids with alcohols: include:
Fats (Triglycerides) and Waxes.

2. Compound lipids: esters of fatty acids conjugated with other groups: include:

- Phospholipids (phosphatides): glycerol esters of fatty acids and phosphoric acid, linked to some nitrogen bases.
- Glycolipids (Cerebrotides): Are compounds of fatty acids with carbohydrates, containing nitrogen, but no phosphoric acid

- Medicinal and pharmaceutical importance:

- **In pharmaceutical preparations,** oils and fats are used as emollients and as carriers for many medicinal substances.
- **Fats and fatty acids** are used as protective coatings for pills and tablets to improve taste or delay release of ingredients.
- **Castor oil** is used as cathartic.
- **Chaulmoogra oil** is used for the treatment of Hansen's disease (Leprosy).
- **Sesame and cotton seed oils** are used as carriers for vitamins and fat-soluble substances.
- **Cocca butter** is used as standard base for suppositories.
- **Soaps, fatty acids and detergents** are used as emulsifiers, stabilizers and solubilizers.
- **Sodium soap** is used as germicides and fungicides, deodorants and as antibacterial soaps.
- **Coconut oil, castor oil and glycerine** are used in manufacturing of transparent soaps.
- **Olive oil** is used for manufacturing of castile (baby) soap.
- **Lanolin** (wool fat) is used to make cosmetic skin lotions.

● Structure and Compositions of Fats and Oils:

Fats and oils contain different chemical compounds:

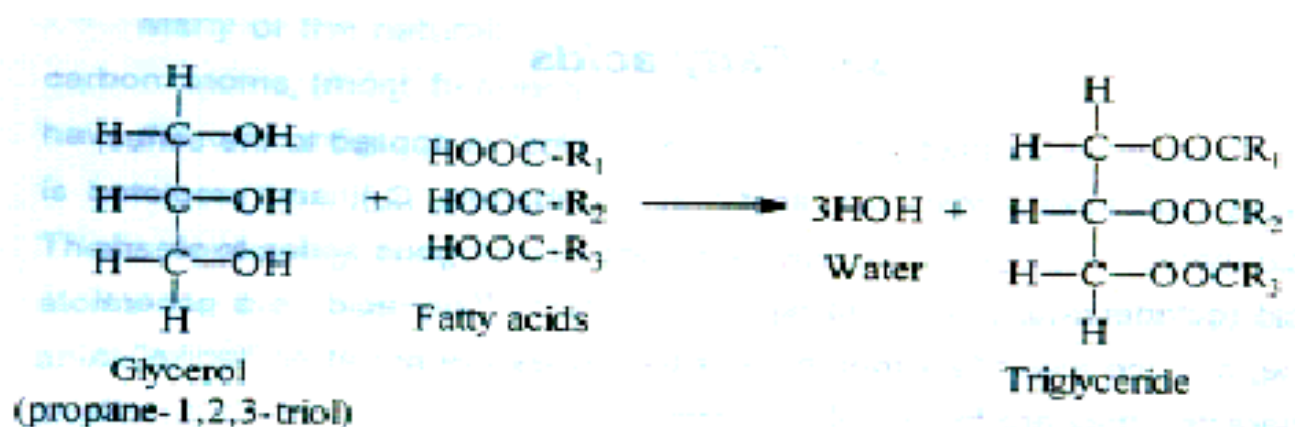
1. Triglycerides (saponifiable part):

It is reaction product of one molecule of glycerol with three molecules of fatty acids → three molecules of water and one molecule of triglyceride.

Types:

A- Simple: in which fatty acid are identical.

B- Compound: in which fatty acid are different.



2. Fatty acids (fatlike):

In organic chemistry, "fatty acids" is applied to: formic acid (methanoic, C_1), acetic acid (ethanoic, C_2), and propionic acid (propanoic, C_3) and higher carbon acids.

Types:

A- Saturated: may be water soluble (C_1 - C_4) or volatile e.g. capric acid (C_{10}).

B- Unsaturated.

- Nomenclature of fatty acids:

Name consists of number of carbon atoms followed by number of double bonds. Carbon atoms are numbered with carboxyl carbon as number 1, and the double bond locations are designated by the number of carbon atom on the carboxyl side of it e.g.

Palmitic	16:0	$\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$	Hexadecanoic
Palmitoleic	16:1(9)	$\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	cis-9-Hexadecenoic
Stearic	18:0	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$	Octadecanoic
Oleic	18:1(9)	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	cis-9-Octadecenoic

N.B: Natural fatty acids: straight chain and contain even number of carbon atoms, (most frequently 18), cis double bonds, double bond is between ninth and tenth carbon atoms, and have formula $\text{C}_n\text{H}_{2n-2}\text{O}_2$ e.g. oleic, linoleic.

Essential fatty acids: that is required for normal growth e.g. arachidonic acid.

3. Nonglyceride (unsaponifiable part):

Types:

A- Phosphatides (Phosphoglycerides):

- Found in plant and animal tissues.
- Glycerol esters of fatty acids and phosphoric acid, linked to nitrogen base.
- Play vital part in biochemical processes as transport of fatty acids and protein.
- Two common phosphatides: lecithin (antioxidant) and cephalin (not).

B- Sterols (Sterolipids):

- Used in synthesis of sex hormones and vitamin D.
- The characteristic sterol of animal fats is cholesterol.
- The sterols of vegetable oils are called phytosterols, e.g. ergosterol.

C- Components affecting appearance (color) of fats (Carotenoids):

- They are pigments.
- About 75 carotenoids are known; the best known are the isomeric hydrocarbons α -, β -, and γ - carotene.

D- Components affecting the stability and quality of oils:

- Vitamins: Fat soluble vitamins (vitamins A, E and D):

Vitamin A: Fish liver oil is rich in vitamin A. Pro-vitamin A (β - carotene).

Vitamin E: consists of at least 7 tocopherols, act as antioxidants to prevent rancidity of oils.

Vitamins D: are derived from sterols. Vitamin D or calciferol can be obtained by irradiation of ergosterol.

Examples of Oils and Fats:

- **Vegetable oils:**

- 1- Non-drying: contain 1 double bond e.g. olive, arachis, almond and castor oil.
- 2- Semi-drying: contain 2 double bonds e.g. cotton seed, sesame and maize oil.
- 3- Drying oils: contain 3 double bonds e.g. linseed oil.

- **Fish oils:** e.g. Cod liver, halibut liver.

- **Vegetable fats:** e.g. Coconut oil and cocoa butter (Theobroma oil).

- **Animal fats:** e.g. Butter.

- **Animal body fats:** e.g. tallow (from oxen or sheep), lard (from pigs).

● **Industrial Preparations of oil:** The steps:

1. Preparation of material.
- 2- Recovery of oil.
- 3- Refinement of crude oil by:

1. Preparation of the Material:

Vegetable oils and fats are found in fruits, seeds and roots of plants. Before extraction, original material has to undergo several steps of purification such as removal of foreign matter. Finally, the material is ground to get product suitable for recovery of oil.

2. Recovery of the Oil:

Vegetable oils can be extracted by one of 3 methods:

- (a) Crushing and pressing.
- (b) Extraction by organic solvent: e.g. light petroleum.
- (c) Continuous milling: The plant, seeds are hydraulically pressed.

3. Refinement of Crude Oil:

The oil obtained is called "Crude Oil". It is colored, and not clear.

(a) Bleaching (adsorption):

Color is due to carotenes, xanthophylls. To decolorize, oil is treated with aluminum silicate.

(b) Deodorization (steam distillation):

(c) Wintering:

It done with oils containing stearoptenes (mixtures of solid esters of stearic acid, high paraffin hydrocarbons and high alcohols) such as olive oil and cotton seed oil). These oils during winter become turbid due to precipitation of solid stearoptenes, it should be removed.

According to steps of purification, oils are usually divided into:

(a) Edible oils: cold pressed, have agreeable odor and flavor, free from acidity and pale in color e.g. Olive oil and sesame oil.

(b) Technical oils: hot-pressed, and need not be refined e.g. Linseed oil (used for paints and varnishes), coconut oil (used for soap industry).

(c) Medicinal oils: must be free from harmful impurities and comply with the specification of pharmacopoeia.

Oils and Fats from Animal Sources:

- Animal body fat is rendered by boiling with water, where fat or oil separates on the surface and is quickly removed to avoid yellowing due to overheating.
- Fat from milk is prepared by separating butter by churning or heating. Heating butter removes the moisture it contains and allows any curd or excess salt to settle at the bottom of the molten fat.

● Manufacture of Margarine (artificial butter):

- Oils used are coconut oil, arachis oil, corn oil, palm kernel oil, whale oil, beef fat and lard, should be bleached and deodorized before use.
- The oil must have very low acid, and peroxide values. The mixture of oils and fat is melted, and aqueous medium is milk to promote flavor of butter by adding lactic acid, if milk is not used diacetyl added as flavoring agent. Emulsifying lecithin agent added to produce good emulsion butter. Coloring matters, vitamin A and D, preservatives (sodium benzoate) are added.