



# FOOD CHEMISTRY

## DTC-321 Credit hours-3(2+1)



## Edible fats and oils classification and chemical composition

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**Lipids** => **fats, sterols, waxes, fat-soluble vitamins (A, D, E and K), monoglycerides, diglycerides, triglycerides, phospholipids, and others.**

- Lipids => **pronounced hydrophobicity** => soluble in **organic solvents**.

- Obtained => **vegetables** (cocoa butter, various vegetable oils, etc.), **animal source** (milk fat, tallow, lard, etc.) and **marine** (cod liver oil, whale oil, etc.).

- **nutritional** as well as **physiological functions** => source of energy (**9 kcal/g**) , **essential fatty acids** and **fat soluble vitamins**.

- Some lipids => **amphiphilic** (both hydrophobic & hydrophilic groups) with surface-active properties.

- Fats => enrich **nutritional quality** and impart rich **mouth feel** and desired **body & texture** to food.

- Also => **characteristic flavour** => food & produces => feeling of **satiety** or loss of hunger.

# **CLASSIFICATION OF LIPIDS :**

- 1. Structure / Complexity ,**
- 2. saponification process and**
- 3. polarity**

# 1.STRUCTURE/COMPLEXITY:

Lipids => classified into **three groups**, i.e. simple, complex and derived lipids.

## Simple lipids:

- These lipids => composed of **fatty acids and alcohol components** & include **oils, fats and wax esters**.
- Can be hydrolyzed => 2 different components => **an alcohol & an acid**.

## Compound lipids:

- Include **glyceroglycolipids** (glycolipids), **glycerophospholipids** (phospholipids), and **sphingolipids**.
- On hydrolysis => yields three or more different compounds.

## Derived lipids:

- Meet the **definition of a lipid** but => not simple or compound lipids & include fatty acids and alcohols => **building blocks** => the simple and complex lipids.
- Includes **vitamins, sterols, pigments, hydrocarbons, etc.**

## 2.SAPONIFICATION :

**Ability of lipids => react with alkali (saponification process) => form soap.**

➤ Grouped as **saponifiable lipids** and **unsaponifiable lipids**.

### *Saponifiable lipids*

- React with alkali => form soap
- Present in large amount
- e.g. **fatty acids, Glycerides, phospholipids, cholesterol ester**

### *Unsaponifiable lipids*

- Do not react => alkali => form soap
- Present in small amount
- e.g. **carbonyls, sterols, Fat soluble vitamins, hydrocarbons**

### 3. POLARITY :

Two groups : **polar lipids** and **non-polar lipids**.

#### *Polar lipids*

- Are **charged** molecules
- **Soluble in polar solvents** like acetone, alcohol
- e.g. **phospholipids, glycerol glycolipids, fatty acids**

#### *Non-polar lipids*

- Are **uncharged** molecules
- **Soluble in non-polar solvents** like benzene, ether, hexane
- e.g. **Carotenoids, Glycerides, vitamins, sterols, sterol esters , waxes**

# TRADITIONAL CLASSIFICATION OF EDIBLE FATS/OILS

Based => **source** and **constituent fatty acids**

## 1. Milk fat

Derived <= milk of **mammals**, particularly from **cow, buffalo, goat and sheep**.

- **Major fatty acids** => **palmitic (C16:0), stearic (C18:0) & oleic (C18:1) acids**.
- **Appreciable amounts** => **short chain fatty acids (C4:0, C6:0, C8:0, C10:0)**.
- **Butyric acid (C4:0)** => **characteristic fatty acid to milk fat**.

## 2. Lauryl or Lauric acid

- **Characteristic fatty acid** => **Lauric acid (40 - 50 % of total FA)**.
- **Low amount** => **unsaturated fatty acids** => **low melting point**.
- **Moderate amount** => **C6:0, C8:0, C10:0 FA**.
- **Obtained <= certain species of palm, ex. Coconut**.

### ***3. Vegetable butters***

- Obtained  $\Leftarrow$  seeds of various **tropical trees**, e.g. **cocoa**.
- Characterized  $\Rightarrow$  **narrow melting range**  $\Leftarrow$  arrangement of **fatty acids** in triglyceraldehyde molecules.
- Used  $\Rightarrow$  **confectionary products**, eg. **Chocolates**, etc

### ***4. Oleic –linoleic acid fats***

- Most abundant & **vegetable origin**.
- Large amounts of **oleic & linoleic acids**
- Less amount of saturated fatty acids ( $< 20\%$ )
- **Cottonseed, corn, peanut, sunflower, palm, olive and sesame oils**



## *5. Linolenic acid fats*

- Large amount => **linolenic acid**.
- **Soybean, rapeseed, wheat germ, hempseed, soybean**
- Linolenic acid in **soybean oil** => **off-flavour**, i.e. flavour reversion problem.

## *6. Marine oils*

- Large amounts => **omega-3-polyunsaturated fatty acids** => up to six double bonds
- Usually => **rich in vitamins A & D**.

## ***7. Animal body fats***

- Known as depot fats <= domestic land animals e.g. **lard and tallow.**
- Large amounts => **C16 > C18 fatty acids**
- Medium amounts => **unsaturated fatty acids (mostly C18:1 > C18:2)**
- Appreciable amounts => **saturated triacylglycerols => high melting points.**
- **Egg lipids** => important => **emulsifying properties & high content of cholesterol.**

## CHEMICAL COMPOSITION :

**Table-8.1. Gross chemical composition of fats of various species**

Sr. No.	Class of lipids	Cow milk fat	Buffalo milk fat	Human milk fat
		(% weight basis)		
1.	Triacylglycerols	97.5	98.6	98.2
2.	Diacylglycerols	0.36	0.4	0.7
3.	Monoacylglycerols	0.02	0.03	traces
4.	Cholesterol	0.31	0.3	0.25
5.	Cholesterol Esters	traces	0.1	traces
6.	Phospholipids	0.6	0.5	0.26
7.	Free fatty acids	0.027	0.5	0.4

## UNSAAPONIFIABLE MATTER OF VARIOUS FATS AND OILS

- Fats and oils contain an average of 0.2-1.5% unsaponifiable compounds.
- The reaction involved in saponification process :



Saponification reaction

- The **unsaponifiable fraction** of fats consists of sterols, terpenic alcohols, aliphatic alcohols, squalene, and hydrocarbons.
- In most fats the **major components** of the unsaponifiable fraction are **sterols**.
- **Animal fats** contain **cholesterol**
- **plant fats and oils** contain **phytosterols** (no or only trace amounts of cholesterol).

- Predominant phytosterol=>**3-sitosterol** , others=> campesterol & stigmasterol.
- **Sterols** are compounds containing the **perhydrocyclopenteno-phenanthrene nucleus**, which they have in common with many other natural compounds, including **bile acids, hormones, and vitamin D**.
- **Sterols** provide a method of **distinguishing** between **animal and vegetable fats** by means of their **acetates**.
- **Cholesterol acetate** has a **melting point of 114°C**, whereas **phytosterol acetates** melt in the range of **126 to 137°C**=> provides a way to **detect adulteration** of animal fats with vegetable fats .

## Various constituents present in unsaponifiable matter of lipids :

### 1. Hydrocarbons:

- Edible oils => hydrocarbons -- even/odd carbon number (C11-C35).
- **Olive, rice and fish oils** => rich in this class of compounds.
- **Olive oil (17g/kg)** and **rice oil (~3.3g/kg)** => linear tri-terpene known as **squalene (C30)**.
- This compound => used as **analytical indicator** for **olive oil**.
- Also present in substantially **high amount** => **fish liver oil**.

## 2.Sterols:

- Compounds containing **perhydro cyclopenteno–phenanthrene tree nucleus**.
- The steroid skeleton contains **4 condensed rings** A, B, C and D.
- A characteristic in steroids => presence of an **alcoholic – OH** group in position **3**.
- In **most fats** => **major component** of unsaponifiable fraction is => **sterols**.
- In **animal fats** => mainly **cholesterol**
- in **plant fats** / => **phytosterol** => **prominent phytosterol** is **βsitosterol**.
- **Cholesterols** are obtained biosynthetically from **squalene**.
- In animals, **cholesterol** is the **precursor** for the biosynthesis of **steroids and bile acids**.
- **Cholecalciferol** (**vitamin D3**) is formed by the photolysis of **7-dehydro cholesterol**.
- **Main steroid** of yeast is **ergosterol** (**pro-vitamin D2**) => converted by irradiation (UV) into **ergocalciferol** (**Vitamin D2**)



### 3. Tocopherols and Tocotrienols:

- **Methyl derivatives of tocol** are denoted as tocopherols.
- Some **methyl derivatives of Tocotrienols** are also found in foods.
- **$\alpha$ -tocopherol** => **most abundant tocopherol** => greatest biological activity => the **most important**.
- These redox type lipids => **antioxidants** in foods containing fats and oils.

## 4. Carotenoids:

- **Polyene hydrocarbons** biosynthesized  $\leq 8$  isoprene units & have **40 carbons**.
- Provide  $\Rightarrow$  intensive yellow, orange or red colour  $\Rightarrow$  foods of plant origin.
- Synthesized only  $\leq$  plants.
- reach animal tissues  $\leq$  feed and  $\Rightarrow$  modified and deposited there.
- **Carotenoids** are divided into two classes:
  - **Carotenes:** pure polyene hydrocarbons.
  - **Xanthophylls:** have oxygen  $\Rightarrow$  form of hydroxy, epoxy or oxo groups & are present in  $\Rightarrow$  corn, egg yolk, green leaves, etc.

**Table- 8.2: Composition of the Unsaponifiable matter of some Fats and Oils**

<b>Fats/Oils</b>	<b>Hydrocarbons</b>	<b>Squalene</b>	<b>Aliphatic Alcohols</b>	<b>Terpenic Alcohols</b>	<b>Sterols</b>
Olive	2.8-3.5	32-50	0.5	20-26	20-30
Linseed	3.7-14.0	1.0-3.9	2.5-5.9	29-30	34.5-52
Teaseed	3.4	2.6	-	-	22.7
Soybean	3.8	2.5	4.9	23.2	58.4
Rapeseed	8.7	4.3	7.2	9.2	63.6
Corn	1.4	2.2	5.0	6.7	81.3
Lard	23.8	4.6	2.1	7.1	47.0
Tallow	11.8	1.2	2.4	5.5	64.0